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Title Page

Mainstreaming Water Energy Food Nexus thinking and drought preparedness into local municipal planning: An analysis in the Bergrivier Municipality.

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Plagiarism declaration

I know the meaning of plagiarism and declare that all of the work in the dissertation (or thesis), save for that which is properly acknowledged, is my own.

Abstract

The study explores the impacts of drought at a local scale focusing on the drought impacts on a local municipality and major employers through a Water Energy Food Nexus lens. The study is grounded on literature based on water-energy-food nexus, the sustainable livelihoods framework and drought. Given that natural disasters such as drought tend to affect water, energy and food, it is important to understand how municipal policy is set to try to manage these drought impacts and the interconnections that exist between these resources water, energy and food, as well as how these three resources affect local livelihoods. This study assumes that when trying to understand drought impacts on local access and use of water, energy and food as well as the influence on livelihoods, it is essential to also incorporate the municipality that not only acts as a service provider for household water and energy but also plays a role in disaster risk management in times of drought. Therefore, the interventions municipality may take during the drought may also have an influence on employers within the municipality and household use and access to water, energy and food. Employers play a role towards people's livelihood security as they contribute to households earning a living (income generating activities) and interventions taken by employers during the drought may have an influence on household livelihoods. Employers are also competing resource users of water and energy within a municipality, which is why it's important to include in them when looking at impacts of drought on water, energy food at the local scale. The study conducted interviews with Bergrivier Municipal Officials and employers to gain an understanding of their experiences and actions taken during the 2015-2018 drought. The study also made use of a desktop review to assess municipal policy with regards to drought preparedness and the extent to WEF Nexus thinking within the municipality. In conclusion the study found that the municipal still required extensive work towards acknowledging WEF Nexus thinking or the interdependencies that exist amongst these three resources holistically. Even so the WEF Nexus is still a growing concept that requires more time to be adapted by municipalities nationally and globally into their development planning.

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"*Ebenezer Lord for you have lead me this far*"

Acronyms

DRMP- Disaster Risk Management Plan

DRM – Disaster Risk Management

ENSO - El Niño Southern Oscillation

FAO – Food and Agricultural Organisation

GDP - Gross Domestic Product

IDP- Integrated Development Plan

IPCC – Intergovernmental Panel on Climate Change

SADC – Southern African Development Community

SDF – Spatial Development Plan

SLA – Sustainable Livelihoods Framework

UNISDR - United Nations International Strategy for Disaster Reduction

WCDM- West Coast District Municipality

WCDoA – Western Cape Department of Agriculture

WCDWS- West Coast District Water Supply

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Chapter 1: Introduction

1.1 Background

Drought experiences from across the world show that droughts not only affect water security but also tend to have repercussions on energy generation and food production, compromising human wellbeing and global security (Conway *et al.*, 2015). For example, China experienced in 2010 a national drought that resulted in the shortage of water and a loss for electricity generation in the form of hydroelectric power (Saidi, 2017). In the following year in 2011 water scarcity impacted the production of wheat globally, leading to price increase on wheat products in different countries (Saidi, 2017). In France the two droughts of 2003 and 2007 also impacted on food and energy production (Olsson, 2013). The reduction in water levels within rivers had a negative impact on crop production due to less water available for irrigation. The warm temperatures and low water levels in rivers also resulted in the closing down of 4-5 nuclear reactors in France (Olsson, 2013). The 2015/16 El Niño Southern Oscillation (ENSO) drought made more than 40 million people in the SADC region (14% of the SADC population) to be food insecure (Nhamo *et al*., 2018). In Malawi the 2015 drought significantly affected the country's energy supply. Due to low water levels in 2015 the hydro-electric plant, which produced 98% of the country's electricity, could not produce enough electricity to support the entire country leaving many rural areas with a power blackout (Nhamo *et al.*, 2018). These examples illustrate how a drought context brings to the fore the sometimes not obvious interdependencies between water, energy and food.

In addition to affecting water, energy and food, droughts also have an impact on livelihoods (Conway *et al.*, 2015). According to the UNISDR (2009: iii) "drought is one of the natural hazards posing a threat to livelihoods of people and community socio-economic development." For the purpose of this study a livelihood will refer to any means taken to earn a living (De Haan, 2012). A series of consecutive droughts tend to have detrimental effects that exacerbate issues such as loss of crops and livestock affecting the agricultural sector and food security within the economy and society; and tend to influence livelihood security directly and indirectly (Makoka and Donald, 2008). In a study in Zimbabwe Zimmerman and Carter (2003) discovered that drought had intensified its impacts on agricultural production, livelihoods, health, poverty and food security throughout the years. The authors also found that drought indirectly affected the environment through land degradation and lowered the welfare of households by affecting the prices of livestock and crops.

In particular, livelihoods that are dependent on small-scale farming as an income generating activity, tend to suffer from loss of crop and livestock production and an increase in food prices (Zimmerman and Carter, 2003). Another study from Ethiopia showed that experiencing a drought at least once during the five-year study period lowered household earnings and thus affecting per capita consumption by about 20 per cent (Dercon *et al.*, 2005). A drought further impacts the livelihoods of people due to other economic and social consequences exacerbated by drought (Conway *et al.*, 2015). Economic consequences may involve an impact on income generating such as small-scale farming due to loss of crops in drought periods and increasing food prices (Zimmerman and Carter, 2003). With regards to social consequences, Tandon (2007) highlights that changes in water supply due to drought conditions may affect livelihoods of many women living in poor and vulnerable households by disturbing their caregiver role, impacting agricultural production negatively or increasing the time spent collecting and storing water. Changes in water supply will make the daily lives of women more difficult since they may have to allocate more time and energy to water management (*Food Insecurity in the World*, 2004). Although this study may have only focused on women it could be used as a glimpse to the potential livelihood impacts that may occur due to drought for both women and men.

When looking at a household level, a drought may require diverting resources (Dercon and Krishnan, 2000). For instance, resources that may have been used for health care or transportation may need to get reallocated to ensure that basic needs such as water, energy and food are met (The World Economic Forum Water, 2011, Sharma, 2016). Households' dependent on farming for their livelihood, may take on a coping mechanism that involves reducing the number of crop production they sell in order to ensure their food security, reducing other household consumption such as the use of electricity to use that expense on their household needs, and many more (Pandey and Bhandari, 2009). Sharma, (2016) describes strategies involving changes in household level consumption and expenditure as one of the strategies commonly put in place by vulnerable households during and post drought period as a coping mechanism in response to low income because of drought and other drought effects. Studies done by Conway *et al.* (2015) in Malawi and Zambia looking at the 1992 El Niño year, made the use of economic modelling to indicate the severity of the 1992 drought, which caused a decrease in the GDP of these two countries at approximately 7–9% and adversely affected household poverty. Due to the above mentioned, a drought may have impacts that go beyond the scope of water, energy and food insecurity but also affect livelihood income generating activities and time.

Drought is caused by dry conditions, an inefficiency of moisture and rain. With the occurrence of more greenhouse gases climate change has become a major factor contributing to the occurrence and intensity of drought (Spinoni *et al.*, 2014). Increasing population growth and climate change have in particular placed pressure on Southern Africa to produce more food and energy with less water (Mpandeli *et al*., 2018). Due to the cross-cutting impacts of droughts on water, energy and food, there is a requirement for cross-sectorial approaches that consider the interactions and synergies that exist between these resources and related sectors (Mpandeli *et al*., 2018). Inadequate recognition of the complex interlinkages that occur between water, energy and food in management approaches, policies and governance has resulted in outcomes that ultimately add more pressure to water, energy and food resources thus affecting livelihood security (Rasul and Neupane, 2021; Putra et al., 2020; Leck *et al*., 2015; Pittock *et al*., 2013). These pressures are amplified by increasing by drivers such as unstainable use of these resources for production purposes and urbanization and industrialization (Rasul and Neupane, 2021).

WEF Nexus thinking can be described as the understanding or consideration of the connections, interdependencies, trade-offs and synergies that exist between resources water, energy and food. (Al-Saidi and Elagib, 2017; Purwanto *et al.*, 2021). According to Yuan and Lo (2022) the concept of WEF Nexus thinking evolved to from a new paradigm that focuses on the integrated management of different sectorial and cross-sectoral concepts. The concept incorporates systematic approaches which involve analysing the interactions between the three resources and their competing demands with the aim to foster water, energy and food security in the long run. (Naidoo *et al*., 2021) WEF Nexus thinking is also inclusive of planning and sustainable use of natural resources to improve water, energy and food management and efficiency (Al-Saidi and Elagib, 2017; Yuan and Lo, 2022). It places a focus on addressing issues of externalities from different sectors, taking on a more integrated and holistic perspective (Hoff, 2011). Various authors have argued that WEF Nexus thinking can be used as a framework in which cross-sectorial policies can be developed and implemented at different scales (Kurian *et al*., 2019; Simpson and Jewitt, 2019; Rasul and Neupane, 2021; Weitz *et al*., 2017; Biggs *et al*., 2015; Ringler *et al*., 2013). Integrated resource management and thinking is important in the current times where society has begun to use resources beyond their capacities resulting in resource constraints, in the aim of economic development (Midgely *et al*., 2014). Therefore, nexus thinking promotes social and economic systems perspectives

towards management, decision and policy making (Davis 2014; Hoff, 2011). Common critiques of the WEF Nexus approach often state that the approach brings nothing different from already existing approaches such as the Integrated Water Resource Management (IWRM) (Benson *et al*., 2015). The IWRM approach aims to integrate and coordinate the management of water, water users, land and meeting socio ecological needs but at the same time promoting ecological development (Benson *et al*., 2015). However, water still remains the main priority of the IWRM approach (Benson *et al*., 2015). The WEF Nexus approach, on the other hand, explicitly places an importance on all three resources. Other critiques of the WEF Nexus have been with regards to the approach lacking a common framework or methodology for nexus research (Albrecht *et al*., 2015; Purwanto *et al*., 2021) and whether the approach is inclusive of the environment and livelihoods (Biggs *et al.*, 2015; Wichelns, 2017; Simpson and Jewitt, 2019).

1.2 Problem Statement

Drought and its impacts are often discussed in relation to water security without paying adequate attention to interlinked resources such as electricity and food. This becomes an issue when drought responses and preparedness are ineffective or overlook the more latent risks and livelihoods vulnerabilities. Given the interlinkages between water, energy and food production, it is helpful to look at drought from a WEF Nexus lens. A WEF Nexus lens might be a useful approach for generating better understanding of the impacts of droughts and aid in formulating integrated management strategies to adapt and cope with increasing drought conditions and aid efforts to build resilient livelihoods (Rasul and Sharma, 2016; Salam *et al.*, 2017).

While the WEF Nexus concept has been promoted as a valuable approach for the management of natural resources in terms of tackling water, energy and food insecurity (Leck *et al*., 2015; Rasul and Sharma, 2016; Simpson and Jewitt, 2019), other essential aspects such as the accessibility to these resources through social relations, policies and governance structures have received less attention (Biggs *et al*., 2015). Furthermore, the WEF Nexus concept is still criticised for its knowledge gaps in terms of local level application and for fostering sustainable livelihoods (Biggs *et al*., 2015; Terrapon-Pfaff *et al*., 2018; Naidoo *et al*., 2021). For the most part WEF Nexus research has focused on the global and macro level application often overlooking the context specific complexities and challenges associated with WEF Nexus faced at a local scale (Biggs *et al*., 2015; Donohue and Biggs *et al*., 2015; Lui, 2016; Nhamo *et al*., 2020). The European Commission's WEF Nexus report (2015: 68) suggested that future

research should focus more on "…local level, applying local solutions and decentralized approaches as well as the inclusion of social aspects". Srivastava and Mehta (2014) rightly ask what impact the WEF Nexus discussion in the international development arena will ultimately have on the realities of everyday life at local level and highlights the challenge of translating the global level WEF debate into local practice. There is a need to understand the role played by the WEF Nexus at a local scale if it is to be used as a tool for policy, resource management and a way of achieving sustainable development and improving livelihoods (Wichelns, 2017).

Livelihoods are also a component that for the most part have been overlooked in the WEF Nexus literature (Biggs *et al.*, 2015; Wichelns, 2017; Simpson and Jewitt, 2019). One promising way in which the WEF Nexus can be operationalized at the local level is through a livelihood's perspective. Biggs *et al*., 2015 suggests that incorporating livelihoods to WEF Nexus framings can help capture more bottom-up approaches and the vulnerabilities experienced at local level. Similarly, Simpson and Jewitt (2019) argue that a livelihoods perspective that guides WEF Nexus thinking could presented a way of dealing with the inadequacy of past approaches to dealing with poverty, environmental degradation, and development (Simpson and Jewitt, 2019).

In line with the research gaps discussed above this study sets out to explore the interlinkages that exist between the WEF Nexus, livelihoods and drought at a local scale using the small coastal town of Velddrif in the Western Cape Province of South Africa as a case study. It does so by interrogating the impact of the most recent drought on the local municipality and major employers through a Water Energy Food Nexus lens.

This study assumes that when trying to understand drought impacts on households' access and use of water, energy and food as well as their livelihoods, it is essential to take into consideration the actions of other key local actors, namely the municipality as well as major employers. In South Africa local municipalities are responsible for ensuring that all communities within the municipality have access to water, electricity and sanitation (Bergrivier IDP, 2017-2022). Besides being a service provider of water and energy to households and other local actors, they also play an important role in disaster risk management. Therefore, the interventions municipality may take during a drought may influence a household's use of and access to water, energy and food. Major employers, on the other hand, play a role towards people's livelihood security as they provide employment opportunities for local households.

However, some of them are also large consumers of water and electricity within a municipality. Drought responses implemented by the municipality to try to alleviate drought impacts on the municipality and its residents may influence how employers act under drought conditions, which in turn may have direct or indirect repercussions for households. Hence, municipal responses to the drought may directly or indirectly affect household's and employers' access and use of water, energy and food as well as the livelihoods of households.

1.3 Research aim and objectives

The aim of this study is to investigate the interlinkages between the WEF Nexus and drought at the local scale and how such understanding assists in enhancing sustainable local development outcomes and drought preparedness.

To ensure that the aim of this study is adequately addressed the following research objectives have guided the research:

1. To investigate the impact of the drought on the local municipality and selected major employers within Velddrif through a WEF Nexus lens.
2. To assess the extent at which WEF Nexus thinking has been included in municipal policy response.
3. To explore how the interventions undertaken by the local municipality in response to the drought have impacted major employers and households in Velddrif.
4. To provide guidance on how local sustainable development and drought preparedness can be strengthened through WEF Nexus thinking.

1.4 Organisation of the thesis

Chapter 2, which is the literature review, is organised in two subsections. The first previews literature on WEF Nexus conceptualisation and improving integrated resource management to ensure security of these three resources. The second subsection looks at the role of governance in WEF Nexus resources management. The chapter further links livelihoods to WEF Nexus thinking for the better understanding of the WEF Nexus resources at a local scale focusing specifically on the local policies and government institutions that manage these resources at the local level, using the Sustainable Livelihoods Approach as a guiding framework.

Chapter 3 discusses the research design and introduces the study area. A desktop review is used to assess the extent of WEF Nexus thinking and drought preparedness in the local development policies (Integrated Development Plan and Spatial Development Framework) within the study area. This is complemented by face-to-face interviews with municipal officials and key

employers in the municipality, to obtain information on the 2015-2018 drought, the impacts it may have on water, energy and food and the preparedness of municipality to drought impacts. The chapter also discusses how the collected data is used in capturing, recording, transcribing, and analysing. The collected data.

In Chapter 4 the results are presented in line with the research objectives and focus on the interaction of WEF resources in the study area and awareness of these interactions among municipal officials and employers, with information obtained from interviews. The chapter also focuses on municipality and employer's experiences of the drought impacts, and actions taken to reduce these impacts. Desktop review results from the assessment of local municipal development policy is presented in the form of seven core themes that investigate the level of WEF Nexus thinking and drought management.

Chapter 5 focuses on the interpretation of the results, which is the discussion and conclusion Chapter 5 discusses WEF Nexus thinking, policy development and the connection between actions taken by the municipality in response to drought and the outcomes these responses may have had on employers, the municipality, and livelihoods. The last part of the chapter presents the conclusion, consists of a summary of the study's findings as well as recommendations for further study.

Chapter 2: Literature Review

This chapter provides an overview of relevant literature focusing on the WEF Nexus and its application. The chapter starts with a discussion on the conceptualisation of the WEF Nexus and how the WEF Nexus approach has been advocated as an integrated approach to resource management to promote resource security as well as the Sustainable Development Goals (SDGs) for different countries globally (Ringler *et al*., 2016; Nhamo *et al*., 2018). This is followed by an overview of the application of the WEF Nexus concept in research and how large-scale assessments as well as quantitative methodologies continue to shape nexus understanding. The final section investigates the local scale application of the nexus and how integrating the livelihoods approach to WEF Nexus thinking can be advantageous towards the management and security of these three resources. The Sustainable Livelihood Approach (SLA) will be used as a guiding framework with a special emphasis on the component of policies and institutions aspect of the framework due to the role they play in the supply and management of WEF Nexus resources.

2.1 The WEF Nexus and integrated resource management for enhanced security and improving the SDGs

Water, food and energy have an inextricably complex and intertwined relationship. Water is an essential part for almost all forms of energy production and power generation. Energy is also required for the treating and transportation of water, and both water and energy are required for the production of food (Lui, 2016). The complex relationships and trade-offs between these tightly linked systems are known as the water-energy-food (WEF) nexus (Lui, 2016). The World Economic Forum can be considered as one of the first international platform to draw forth the idea of the WEF Nexus as a key concept towards tackling the challenges of development such as population growth and climate change in the context of finite natural resources (World Economic Forum, 2011).

The World Economic Forum introduced the need to better understand the relationship and interlinkages that exist between water, energy, and food as these three resources are key for sustainable development (World Economic Forum, 2011). In a world where there is an increase in demand for water, food and energy due to urbanisation, population growth and climate change, there is a need for future development to be more sustainable, and also take into consideration the synergies and trade-offs that exist between the three resources (World Economic Forum, 2011). It is essential to understand these synergies and trade-offs in order to

improve the decision-making process in the management of these three resources (World Economic Forum, 2011). Hoff (2011: 5) makes an example of how WEF Nexus thinking can contribute to addressing issues of "energy intensity of desalination (bottled electricity) or water demands in renewable energy, or the water demands of afforestation for carbon storage. Not only that but actions focused on avoiding land degradation also save water and energy, through increasing soil water storage and groundwater recharge, as well as reducing the use of energy intensive fertiliser." This example shows that a nexus approach brings to the fore trade-offs and externalities of certain development decisions and intends to address this through more integrative consideration of interlinkages. (Hoff, 2011).

Another important aspect of the WEF Nexus approach is the role it can play towards promoting the sustainable development goals (SDGs) specifically in relation to SDG 2, 3, 6 and 7 (Nhamo *et al*., 2018). These goals focus on eradicating hunger, sustainable service delivery such as clean water and sanitation and clean energy, which are resources that fall within the WEF Nexus For example, SDG 2 eradicating hunger might require an increase in agricultural food production, which entails more water use and energy for the supply of water for food production. Pahl Wostl (2019) points out the SDG goals 2 (food), 6 (water) and 7 (energy) require joint consideration from different sectors of governance in order for the goals to be achieved. This shows that the WEF interdependencies need to be incorporated when implementing targets to meet specific SDGs (Ringler *et al*., 2016; Fader *et al.*, 2018)

2.2 Application of the WEF Nexus Concept

The WEF Nexus is an integrated approach intended to foster water, energy and food security globally for the improvement of livelihoods and sustainability of these resources for current and future generations globally (Naidoo *et al*., 2021). The operationalization of the WEF Nexus lies at transforming the theory into practice which can only be done through its application at different scales (Naidoo *et al*., 2021). This section therefore focuses on the conceptualization of WEF Nexus from macro to local scale.

2.2.1 Dominance of macro analyses and quantitative studies

Research on the WEF Nexus tends to focus on optimising synergies and trade-offs that exist between sectors and informing government on the management of natural resources (Davis, 2014; Asian Development Banks, 2013; Gerbens-Leenes *et al*., 2012; Hoff, 2011). Macro analysis of the WEF Nexus has allowed for global based evidence and understanding of WEF

Nexus resources (Terrapon-Pfaff *et al.*, 2018). However, this has resulted in a shortcoming in WEF Nexus research as macro level applications tend to overlook the fact that the complexities and challenges associated with WEF Nexus are also faced by communities and households at local level (Lui, 2016; Biggs *et al*., 2015).

Furthermore, Albrecht *et al*. (2018) found that most studies tend to use quantitative methods when evaluating WEF Nexus approaches and out of the 73 journal articles they reviewed 70% of the methods used when operationalizing the WEF were quantitative. Other studies tend to advocate for the use of modelling resources use and efficiency along with scenario-based analysis when it comes to assessing the WEF Nexus (e.g. (Endo *et al*., 2015; Hussien, Memon, and Savic 2017; Kenway *et al*., 2013; Leck *et al*., 2015; Mortada *et al*., 2018; Nhamo *et al*., 2019; Sušnik *et al*., 2021; Zhang *et al*., 2018). Quantitative and modelling applications of the WEF Nexus are important for understanding resource use efficiency, broadening perspectives, understanding trade-off and synergies between these three resources and for providing visual representations of nexus dynamics. (Mccarl *et al.*, 2017, Albrecht *et al*., 2018; Endo *et al*., 2015).

Despite the knowledge gained through the quantitative or modelling approaches there is still a need for mixed method approaches when looking at the WEF Nexus. Endo *et al*., (2015) point out that while quantitative methods analysing WEF Nexus trade-offs and synergies, qualitative methods, through the involvement of stakeholder perspectives and needs, are suitable for are essential for the formation of policies that are socially inclusive (Purwanto *et al.*, 2021). Yet until now, the inclusion of qualitative methods in WEF studies remains limited (Zhang *et al.*, 2021) In particular the incorporation of social and political aspects remains limited in WEF Nexus research (Albrecht *et al*., 2018; Itayi *et al*., 2021. Dalla Fontana *et al*. (2020) took a critical review of existing literature on WEF Nexus in Brazil and found that the social sciences dimension of WEF Nexus research was still lacking, and engineering and natural scientific field of research were dominant in WEF Nexus study. The study further emphasised the need for more human dimensions and local scale contexts of WEF Nexus research which can help benefit issues of rapid urbanization and poverty most especially in the global South (Dalla Fontana *et al.*, 2020)

Foran (2015) uses the complex systems approach as well as the critical social science approach (critical discourse analysis) to analyse the Mekong region looking into the trade-offs and

synergies that may occur from the development project in the region. The study reveals that the complex socio-ecological relationships or interconnection amongst resources and stakeholders such as development initiatives focused on dam construction may have an unprecedented impact on food production or an impact on the underlying power dynamics that exist within WEF Nexus development planning (Foran, 2015). Biba (2016) who looked at the political dimensions of WEF Nexus, focusing on who has access and control over WEF Nexus resources. Biba (2016) uses a case study approach in China to show that most WEF Nexus challenges occur because of the poor management of WEF resources individually and those who advocate for WEF Nexus approaches lack awareness of the role political decision makers have when trying to implement WEF Nexus approaches. Howarth and Monasterolo (2016) study used workshops which involved stakeholder participation to assess the impact of climate shocks on the WEF Nexus. These studies show how mixed methods and qualitative methods address some of the blind spots of the more quantitative perspective towards the WEF Nexus through a focus on the social dimensions of the nexus and the local institutions that play a role in governing these resources (Terrapon-Pfaff *et al.*, 2018).

It is evident from the discussion above interdisciplinary ways of thinking, which integrate qualitative and quantitative understanding of the WEF Nexus, are needed to develop and implement WEF Nexus approaches successfully. Qualitative approaches also allow for a more bottom-up perspective and grounded approach through the inclusion of stakeholder's experiences, (Hoolohan *et al*., 2018).

2.2.2 Linking the WEF Nexus to the local scale and livelihood outcomes

One of the earlier studies that have tried to incorporate water, energy and food jointly describing the linkages that exist between these three resources at a local scale is Meikle and Bannister, (2003). Whilst the study did not use specifically a WEF Nexus lens, it did explore the interlinkages that exist between water, energy, and food in poor urban communities in Ghana, Indonesia. The study found that increasing energy prices had an indirect impact on urban poor households, as it also resulted in an increase in the price of goods especially processed foods and services and ultimately negatively impacting urban poor households' affordability to these goods and services. The study also showed that some households ended up having to reduce the number of times they cooked in a day to only two meals daily (Meikle and Bannister, 2003). Increased energy prices also influenced the use of less energy to heat up water used for personal cleanliness (Meikle and Bannister, 2003). This showed that energy is

not only important to sustain life but also enables households to thrive (Meikle and Bannister 2003). Terrapon-Pfaff *et al.*, (2018) used a four-step nexus assessment approach to operationalize the WEF Nexus concept and understand it in practice. The project mapped out linkages between small-scale renewable energy applications with food and water pillars to identify solutions to improve energy development at a local level. Terrapon-Pfaf *et al*. (2018) found that there are complex links that exist in sustainable development projects such as a small-scale renewable energy projects and water and food sectors. The study found that energy needs at the local scale are almost always linked to agricultural or food activities and indirectly linked to energy for water usage in agricultural activities (Terrapon-Pfaf *et al*., 2018). The needs for water, energy and food cannot be separated for households and small businesses at a local scale (Terrapon-Pfaf *et al*., 2018). Huntington (2021) conducted a study in four rural communities in Alaska looking into whether the use of renewable energy sources improved water and food security in the communities. Collected data using interviews and workshops to formulate a model that depicts the relationship amongst the WEF Nexus resources the authors revealed that a complex relationship existed amongst these three resources and other factors such as transportation, governance and policy had an influence of the security of these resources (Huntington *et al*., 2021). The study also highlighted the importance of the co-ordination and cross scale management of these three resources for ensuring resilience and sustainability within these communities (Huntington *et al*., 2021).

A number of studies have used a technical or modelling based approach for investigating the WEF Nexus at household or community level (Guijun *et al*., 2017; Hussien *et al*., 2017; Leck *et al*., 2015) However these studies may miss the influence of social dynamics and how people earn a living in order to be able to afford but also attain access and security to WEF Nexus resources. Several studies have attempted to focus nexus research more on livelihood outcomes (Bhavnani *et al*., 2018; Nhamo *et al*., 2019, 2020; Terrapon-Pfaff *et al*.; 2018; Wichelns 2017). One example is in Asia within the Mekong River region, where the livelihoods of the people living within the region were impacted because of development decisions that were focused on improving water, energy and food insecurity through the construction of large hydropower dams, water diversion and a rubber plantation (Smajgl and Ward, 2013). When these development initiatives were analysed with the inclusion of a livelihoods perspective it showed that not all outcomes were positive. The initiatives had negative impacts on the livelihoods of those living within the region. For example, hydropower dams were likely to result in small-scale fishers losing access to wild fishing areas (Foran 2015; Smajgl and Ward 2013). The

diversion of water meant that some small-scale subsistence farmers were likely to be unable to access water for their produce which would have a secondary effect on their food security in terms of a reduction in their crop production, food consumption and income within households in the region (Smajgl and Ward, 2013). This example portrays how development decisions that take a focus on only the improvement of water, energy and food security without taking into consideration sustainable livelihoods of people may exacerbate unintended consequences on local livelihoods.

According to Bhavnani *et al.* (2018:35) "The extent of food, energy and water resources determines the growth and livelihood opportunities that a nation or society would support". The initiatives and decisions proposed by WEF Nexus applications influence the well-being and livelihoods of households (Nhamo *et al*., 2020; Wichelns 2017). Many of the income generating livelihood activities for vulnerable households such as farming, fishing, forestry or commercial services are dependent on WEF resources (Spielberg *et al*., 2015). Each component of the WEF Nexus is important for improving the wellbeing of people. Access to energy may help with the use of appliances, cooking and electricity, water and food security may have health benefits and hunger reduction (Leck *et al*., 2015). Mabhaudhi *et al*. (2019) also supports the idea of integrating livelihoods and the WEF Nexus thinking. They state that the WEF Nexus could be useful in understanding the complex relationships that exist between water, energy and food and incorporating the nexus along with livelihoods approach could aid in understanding the influence these three resources have holistically on livelihoods of households and the processes and factors that shape households use and management of these three resources. Also, since the most common application and studies of the WEF Nexus have been at macro or global levels incorporating livelihoods to the WEF Nexus can ensure that the vulnerable at the local level are not omitted in WEF Nexus decision and policy making (Mabhaudhi *et al*., 2019). Enhancing a livelihoods perspective would also bring forth a more local level people centred approach to WEF Nexus studies (Simpson and Jewitt 2019).

Biggs *et al*., 2015 proposed the use of the Environmental Livelihood Security Framework (ELS) as an approach for bringing livelihoods consideration into WEF Nexus research. The ELS Framework brings key components from the Sustainable Livelihood Approach (SLA) and WEF Nexus thinking. They argue that the joint consideration of the vulnerabilities and pressures of natural resource supply, alongside the demands for these resources by resource-users will allow for a better attainment of sustainable environmental and livelihood security

(Biggs *et al*., 2015). Biggs *et al*. (2015: 391) highlight that "security is not only driven by availability of resources but also by access to resources, the capacity to utilize resources as well as dynamics of social power relations and the strength of institutions." Mabhaudhi *et al*. (2019) also supports the idea of integrating livelihoods and the WEF Nexus thinking. They state that the WEF Nexus could be useful in understanding the complex relationships that exist between water, energy and food and incorporating the nexus along with livelihoods approach could aid in understanding the influence these three resources have holistically on livelihoods of households and the processes and factors that shape households use and management of these three resources. Also, since the most common application and studies of the WEF Nexus have been at macro or global levels incorporating livelihoods to the WEF Nexus can ensure that the vulnerable at the local level are not omitted in WEF Nexus decision and policy making (Mabhaudhi *et al*., 2019). Enhancing a livelihoods perspective would also bring forth a more local level people centred approach to WEF Nexus studies (Simpson and Jewitt 2019).

For several decades the Sustainable Livelihood Approach (SLA) has proven to be a useful tool or framework for livelihood analysis. The SLA has been inspired by the works of Robert Chambers (1980) and has been further developed by Chambers, Conway and others in the 1990s (DFID, 2000, 1.2). The SLA acknowledges the concern on environmental degradation and at the same time also places a focus on people and their livelihoods within a policy framework for sustainable development (Biggs *et al*., 2015). The SLA approach perceives livelihoods as being inclusive of resources, capacities and assets needed for survival (Gutierrez-Montes *et al*., 2009). According to Chambers and Conway (1992: 7) "A livelihood is considered sustainable when it can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets, and provide sustainable livelihood opportunities for the current as well as the future generation."

Over the past decade different versions of the sustainable livelihood's framework have been developed. These frameworks are all based on applying livelihood approaches in practice. Agencies such DFID, Oxfam, Care and UNDP are some of the agencies have focused and advanced differing features of the SLA but all have adopted their ideas from to the definition of a livelihood as coined by Chambers and Conway (1992). The Care livelihood approach framework focuses on household livelihood security whilst the UNDP livelihood framework takes a focus on poverty and the environment (Chen and Phakdeephirot, 2021). The UNDP framework also adds a focus on technology as an important strategy for poverty alleviation

(Carrey *et al*., 1999). The Oxfam livelihood approach on the other hand, investigates issues of environmental concern, economic and social rights (Sultana and Banu, 2022). For the purpose of this research the DFID livelihood approach was adopted. This approach takes into consideration both the macro and micro scale, it is also people centred and most importantly for this study, the framework is inclusive of governance and polices in promoting sustainable livelihoods (Carrey *et al*., 1999).

The DFID SLA uses five capitals namely the human, social, physical, natural and financial as a basis for understanding sustainable livelihoods (Syned, 2016; Morse *et al*., 2009). The different capitals of sustainable livelihoods are usually presented in a pentagon as shown in Figure 1 (Serrat, 2008). Each corner of the pentagon has one of each of the five capitals. These capitals can be described as the physical and non-physical materials to which one uses to attain different livelihood strategies (Scoones, 1998). For example, human capital may be labour, social capital could be social networks, natural capital may be in the form of water, physical capital may involve infrastructure and financial capital in form of money (Serrat 2008). The SLA also observes the vulnerability of these capitals to shocks and stresses (Syned, 2016; Morse *et al*., 2009). The vulnerability context of the framework consists of the insecurities that may be encountered as result of changes in the environment such as of shocks (drought), and seasonality (prices) (Serrat, 2008). Different capitals are used in combination to pursue livelihood strategies aimed at achieving livelihood outcomes (Scoones 1998). The livelihood outcomes section of the framework consists of improved: wellbeing, food security and income, as being some of the outcomes achieved from livelihood strategies pursued (Serrat, 2008). The SLA also includes a section on policies and institutions which have an influence on how individuals achieve their livelihood outcomes and these structures and policies help inform decisions on livelihood strategies that individuals follow to attain their livelihood outcomes (Serrat, 2008). The SLA structures consist of the government and private sector (Serrat, 2008). Policies determine how resources such as water, energy and food are managed thus indirectly influencing how people access these resources to attain sustainable livelihood outcomes (Serrat, 2017, Pasteur, 2001). For example, policy designed to protect certain water bodies such as marine protected areas may result in local people who depend on fishing as a livelihood strategy not being granted access to these areas for fishing purposes for food or retail to sustain their livelihood. This is the case for coastal areas where fishing is a livelihood strategy that provides an income and food security for poor households (Martin *et al*., 2013; Amevenku *et al.*, 2019).

The livelihood approach helps to understand how people use their assets focusing on natural, physical, social, financial and human assets and creates important insights about the processes and factors that shape access and use of water, energy and food at local scale (Serrat 2017b).

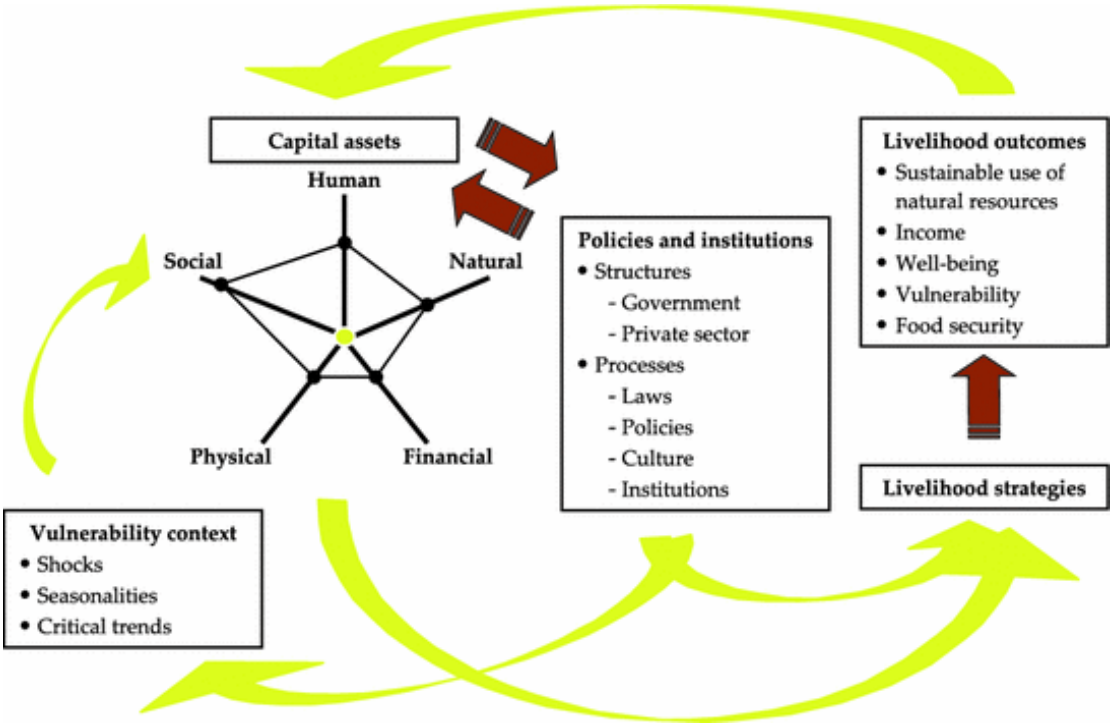

Figure 1 The Sustainable Livelihoods Framework (Serrat, 2008)

While within the SLA the five capitals are important as they represent the assets required to attain a sustainable livelihood. The focus of this study will be on the *Policies and Institutions*, specifically on the structures and processes that mediate the complex and differentiated livelihood strategies for achieving a sustainable livelihood, which have received less attention in SLA analyses (Serrat, 2017). To summarize, it is important to create a better understanding of the *policies and institutions* under the SLA as they have an influence on how WEF Nexus resources are accessed and managed at local scale (Bingen, 2000; Srigiri and Dombrowsky 2021). For instance, the way in which households can access their water and energy is largely reliant on the supply by local government (municipality), whilst with regards to food, the policies set by the municipality and food prices are set by businesses or market price which determine the affordability of food in the municipality. Furthermore, policy is an essential part of the management and decision-making in WEF Nexus resources, as the three WEF Nexus

resources even with the acknowledgement of their linkages are still managed in silos by different sectors of government and institutions. The poor management of these resources is also because of policymaking that fails to recognise cross-sectorial management of resources (Nhamo, 2018). Including WEF Nexus thinking in local government policy, can contribute or be advantageous to the reduction of water insecurity, energy insecurity, food insecurity and loss of livelihoods in times of rising extreme events such as drought (Tiepolo and Braccio 2020). In local WEF Nexus studies, it is important to create an understanding of the policies and institutions that shape nexus dynamics and disaster management, as the success of WEF Nexus planning lies with the local government and institutions setting up policies and decision-making, that aligns WEF Nexus thinking and the inclusivity of both private and public sectors (Nadioo *et al*., 2021).

It is important to note that in South Africa informal institutions playing a critical role in the access to WEF resources. Helmke and Levitsky (2004: 727) describes informal institutions as "socially shared rules, usually unwritten, that are created, communicated, and enforced outside of officially sanctioned channels". While informal institutions influence many aspects of social live in the discussion of the WEF Nexus in South Africa they can be particularly observed in the informal settlements and the informal economy where these institutions do not necessary always align with formal plans and strategies (Nhamo *et al*., 2021; Kovacic *et al*., 2019). While the researcher acknowledges the importance of these institutions in continue to mediate livelihood strategies, for the purpose of this study the focus will remain on formal institutions and structures.

2.3 WEF Nexus governance and management: policy and institutions

For the purpose of this study, the structures of interest are the local government, which are the local and district municipality as well as major local employers in the municipality. The key Processes considered in this study are local policies that have an influence on municipal development and strategic goals planning and how people access and use their assets to attain livelihood security. In the South African context within which the case studies are set, these policies include the Integrated Development Plan, Disaster Risk Management Plan, Climate Change Adaptation Plan and Spatial Development Framework.

2.3.1 Structures (Government and private sector)

The governance of resources especially water, energy and food resources tend to be managed by different spheres of government, meaning there are different stakeholders involved in the management of water, energy and food resources (Lal *et al*., 2015). According to the South African Constitution s 152(b local municipalities are responsible for basic service delivery such as water and electricity). One way in which municipalities fulfil the mandate of being a basic service provider is with their own resources - finance, equipment and employees. A municipality may also outsource the provision of a service. This means that the municipality may hire someone or a company to deliver the service, although it remains the responsibility of the municipality to choose the service provider and to make sure that the service is adequately delivered. The national and municipal level both have roles in terms of facilitating an intersectoral cooperation for achieving sustainable services for water, health, sanitation and food security impacts and managing of natural disasters (Naidoo *et al*., 2016). Many municipalities in South Africa, however, are unable to deliver services to residents (Zondi and Nzimakwe, 2017). This might be because of lack of finances or lack of capacity to provide a good service at an affordable price, this maybe due to lack of proper infrastructure or the failure to maintain such infrastructure for example wastewater treatment facilities (Zondi and Nzimakwe, 2017). Another aspect that may impact the implementation of WEF Nexus is the issue of poor governance. Failure to deliver basic services in a municipality may be due to corruption and poor management systems. In South Africa, corruption has been one of the causes of poor governance (Siddle and Koelble, 2016). This has resulted in a challenge affecting effective service delivery in many local authorities (Siddle and Koelble, 2016). Corruption can take many forms but in the context of service delivery it is often characterised by the redirecting of public funds for personal gains (Koelble and Li Puma 2008). It is therefore not suprising that even with policies and plans in place, challenges such as corruption hinder the effectiveness of service delivery (Siddle and Koelble, 2016).

From the above it is evident that local government plays an important role in basic service delivery. Thus, it is important to understand the local level management of service provision for resources such as water and electricity due to the crucial role played by local governments in service delivery. It is also important to include other key resource users such as major employers (in the municipality) when observing the relationship between WEF resources and WEF governance at a local scale. Employers are considered as important structures that inform livelihood decisions and outcomes through the opportunities they create for

households/individuals to earn an income. Employers therefore play a role in ensuring that households/individuals can sustain a living or be able to access or afford resources such as water, energy and food through employment. Employment can be perceived as a livelihood strategy, as it provides households with a livelihood outcome such as income. Livelihood strategies are considered as activities that assist people to achieve their livelihood goals (Pasteur, 2001). These livelihood strategies may be informed by activities that allow people to earn a living and to accumulate assets that allows them to recover from shocks and vulnerability (Pasteur, 2001). Employers also tend to be large resource users that access resources such as water and energy from local municipalities.

2.3.2 Processes informed by policy

Government is one of the institutions who have a role in managing and setting policies that shape and coordinate the access and use of resources. One of the difficulties faced by the government is in acknowledging the interlinkages, trade-offs and synergies that exist with WEF Nexus resources (Rasul and Neupane, 2021). This has been due to the decentralized management and governance of each of these resources which has resulted in the poor integration of these three resource sectors (Rasul and Neupane 2021). Coordination across spheres of government is essential for identifying and managing cooperative and coherent policy and management competencies for efficient supply of water, energy and food which is in line with nexus thinking (Scott *et al*., 2015). There is still a need for the different sectors of water, energy and food to be managed in an integrative manner rather than in silos by different levels of government. In a study by Pahl-Wostl *et al.* (2020) which looked into the multi-scales of governance in the management of the WEF Nexus resources, showed the importance of sectorial interdependencies and synergies within the governance of these three resources. The study further described the under-rated role played by multi-level power relations and temporal scales in the governance of WEF Nexus resources. (Pahl-Wostl *et al.*, 2020) mentions challenges of different levels (scales) of planning when it comes to the management of water, energy and food with regards to different levels of the actors that have an influence on these resources. The study also shows that the rules and norms of the different sectors have differing influences on these three resources which pose a challenge in trying to understand the interconnections and trade-offs that exist amongst these three resources jointly (Pahl-Wostl *et al*., 2020. This shows the need for government institutions to coordinate management of WEF Nexus resources through integrated policy that seek to ensure the security and sustainability of these resources.

The expansion and growth of towns and cities requires more resources meaning more demand for resources such as water, energy and food (Daher *et al*., 2019). Therefore, municipal development needs to be inclusive of WEF Nexus thinking which takes into account these three resources trade-offs and synergies to ensure their sustainable supply. According to Daher *et al.* (2019) expansion, municipal, agricultural and energy all place pressures on water demand. This is one of the reasons why it is important to incorporate WEF Nexus thinking in development planning. According to Gueli *et al*. (2007) integrated development planning should focus on bringing together different sectors and actors to work together and align under common objectives to produce coherent outcomes for the municipality and the local people within it. Therefore, incorporating WEF Nexus thinking to municipal development planning policy would allow for governance of these resources at different scales and sector coherency and alignment (Daher *et al*., 2019; Nhamo *et al*., 2020). According to Yillia (2016:87) "By pursuing a 'Nexus Perspective' in policy and implementation, it is easier to work across sectors and share experiences, lessons, tools and solutions that are emerging around the world." Yillia (2016) further on explains how the links between water, energy and food can be of benefit to policymakers, private sector (business owners) and public in managing and dealing with global challenges such as the improving of access to basic needs, the supply of water, energy and food and alleviation of poverty. It is known that the access to clean water and energy in an area is important towards improving the livelihoods of the people, poverty alleviation and economic growth (Prasad *et al.*, 2012). With this being said, local municipality policy making that is inclusive of WEF Nexus thinking requires the involvement of not only policymakers but also the private sector and general public that access and use these resources on a day-to-day basis. This is one way to ensure that policies do not end up having negative impacts on local livelihoods and economic growth.

From the above it is evident of the important role played by processes of sectoral integration by the local municipality in the management of WEF Nexus resources for the private sector (businesses and employers) and households. The above literature review shows the potential for WEF Nexus thinking in improving integrated resource management and enhancing sustainable management and utilization of these three resources through a more integrative systems perspective. The review also shows that there is a gap in implementing WEF Nexus thinking at a local scale. Hence, this research aims to speak to the gap by focusing specifically on the effect of the *Structures and Processes* that that affect the management and access to the WEF resources at the local scale using the Sustainable Livelihoods Approach as a foundation.

Chapter 3: Context and Methodology

3.1 Study area

3.1.1 The Bergrivier Municipality

The Bergrivier Municipality is a rural municipality located in the Western Cape Province that covers a geographic area of approximately 4 407.04 km² (Bergrivier Municipality IDP 2017-2022). The Municipality is geographically diverse and lies within the Olifants River Catchment and the Berg River Catchment area and includes approximately 40 kilometres of coastline (Hulley, 2015). The municipality consists of several rivers and is very mountainous most especially within its eastern parts which has allowed for a diversity of bird, mammal and vegetation life (Hulley, 2015) Land use within the municipality is predominantly agricultural farming which includes livestock, fruit and vegetable farming (Petersen, 2013). The Bergrivier Municipality has 9 urban settlements and the main urban settlements that constitute the municipality are: Piketberg, which is the administrative seat, Porterville, Velddrif (which includes Laaiplek and Noordhoek), Dwarskersbos, Eendekuil, Aurora, Redelinghuys, Goedverwacht and Wittewater (Bergrivier Municipality IDP 2017-2022).

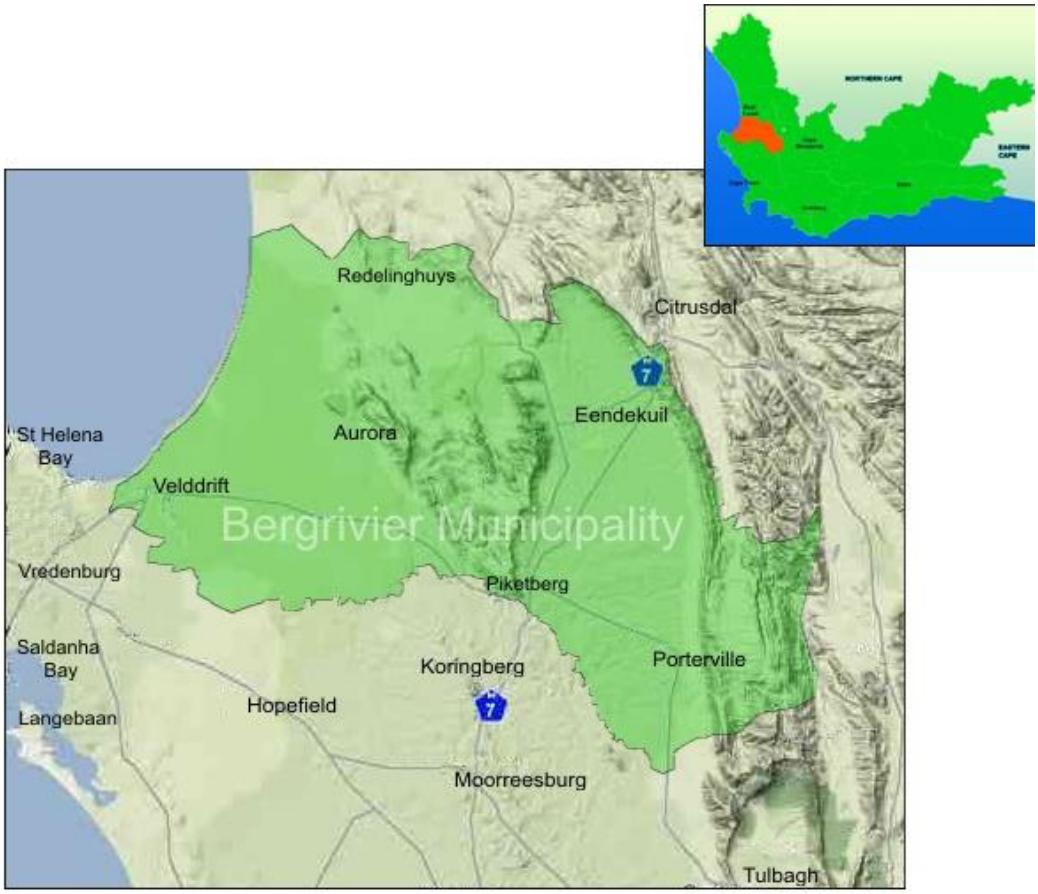

Figure 2 Map of The Bergrivier Municipality (Bergrivier Municipality IDP, 2017)

3.1.2 The coastal town of Velddrif

Velddrif has been chosen for an in-depth investigation of the impacts of the drought in a small coastal town context and whether the drought impacts, and interventions taken by the municipality and major employers could have further exacerbated the vulnerability of households and livelihoods within the town as the majority of its people's demographics considered as lower or middle class. For example, the adherence on imposed water restrictions by the municipality may force a local employer to the decision to reduce production and to cut down on the labour force (Fanadzo *et al*., 2021).

The small coastal town consists of an estimated number of 3622 households, with 57.1% of the racial composition being coloured, 29.6% white, 12.2% black African, 0.5% Indian/Asian and 0,6% other races (StatsSA, 2011). Velddrif is characterised as a town with high levels of unemployment and limited economic diversity (Bergrivier Municipality IDP 2017-2022). The town is located at the northern banks of the Berg River approximately 2 km from where the river enters the sea estuary. Velddrif has a commercial fishing harbour and acts as the focal point for the fish processing industry within the Bergrivier Municipality, which is a great contributor to the municipality and town's economic sector (Methner *et al*., 2021). The estuary provides an economic as well as recreational value to the town. Velddrif receives its water supply from both the West Coast District Municipality (Bergrivier Municipality IDP 2017-2022) and the Bergrivier Municipality and electricity provision is from the national grid, which is ESKOM (Migdley *et al*., 2014). Overall for this study the municipality is the scale used to describe the policy and vulnerability context and the town of Velddrift was chosen as a scale to explore the impact of the drought on particular actors (local employers and households) from a WEF Nexus perspective.

3.1.3 The Drought (2015-2018)

The Western Cape province is one of South Africa's nine provinces that experienced severe drought conditions from 2015 to 2018 (Mahlalela *et al*., 2019). In May 2017 the province was officially declared as a drought disaster zone by the provincial government (Government Communications Article 2017). The drought conditions induced shortage of water through the drying up of major dams within the province (Botai *et al*., 2017). This placed stress on the water supply and management in the province (Pienaar and Boonzaaier, 2018). The province's primary approach to dealing with the impact of the drought on water supplies involved increasing tariffs and imposing water restrictions on the consumers especially in major towns

within the province (Pienaar and Boonzaaier, 2018). Municipalities across the province from 2015 to 2017 implemented different levels of water restrictions from level 1 to 6. These restrictions involved having consumers pay a higher tariff the more water they consumed (Matikinca *et al*., 2020). These water restrictions were aimed at making consumers use water more sustainably and to encourage them to be mindful of their water usage. Some municipalities such as the City of Cape Town (CoCT) gave fines and penalties to consumers who were wasteful in their water usage (Brühl and Visser, 2021).

The agricultural sector was also greatly affected by the drought due to restriction on irrigation within the province (Otto *et al.*, 2018). The Western Cape province, falling into the winter rain region, experiences most of its rainfall in the months of June to August and agricultural production within the province is greatly reliant on this rainfall for the products of citrus fruit and grain such as wheat (Theron *et al*., 2021). The agricultural sector contributes greatly to employment in not only the province but South Africa as a whole from formal, unskilled and semi-skilled employment opportunities (Theron *et al*., 2021). A drought therefore presents challenges to individuals and businesses whose livelihoods depend on the agricultural sector (Western Cape Department of Agriculture, 2017). In a study by Fanadzo *et al*. (2021) that looked into the adaptation and coping strategies of small-scale farmers in the Western Cape found that farmers in the West Coast District were greatly affected by the drought through their livelihoods. The shortage of water resulted in farmers having to cut down on costs which meant a reduction in production and also having to relieve some of the farm workers (Fanadzo *et al*., 2021). Other responses required farmers to also incur costs in form of water transportation costs for irrigation and high electricity bills from pumping water from alternative water sources (Fanadzo *et al*., 2021). This shows that the drought 2015-2018 not only had impacts on the physical environment within the province but also exacerbated livelihood impacts in the agricultural sector. (Fanadzo *et al*., 2021).

3.2 Study Design

This study used a qualitative approach focusing on the perceptions and experiences of selected municipal officials and employers from the Bergrivier Municipality on the impact of drought on water, energy and food and further looks at how interventions taken by key employers and the municipality may have had unintended outcomes. Denzin & Lincoln, (2005: 3) describes qualitative research as “studying things within their natural setting and attempting to make sense of or interpreting phenomena in terms of the meanings people bring to them”. According

to (Creswell, 2017) the use of qualitative approaches in research is to attain a complex, detailed understanding of an issue which can only be done through direct conversations with people, going to their homes or places of work and allowing them to tell the stories without any impediment by what we expect to find or what we have read in the literature.

This research study followed a single case study approach to assess the impacts of drought on the small coastal town of Velddrif through a focus on the interventions undertaken by the municipality and major employers of Velddrif. Yin (2003) describes a case study approach as a strategy for conducting research, which involves an empirical investigation of a practical phenomenon. This approach allowed for the understanding of how different actors experienced the drought and the interaction of WEF resources during a drought. Focusing on a specific study area also allowed for an in-depth understanding of the drought impacts and drought interventions specific to the Bergrivier Municipality. The case study also shows the relationship between actors and the WEF resources and the influence one actor has on the other. According to (Stake, 2003) the advantages of case study design is that it presents more depth and real-life situations making results more holistic and richer. Yin (2003) also points out that a single case study is appropriate when looking into the lived experiences of a person or a group of people. For instance, this study is interested in the perceptions of municipal officials that play a role within water, electricity and food management and supply and employers that use these three resources.

The limitation of the case study approach is due to it being obtaining in-depth and rich data, which may be time consuming or too lengthy to read and use in the research (Stake, 2005). Therefore, the researcher needs to only select information from the case study data that corresponds to the objective of the research (Stake, 2005). Another common limitation are issues of generalization (Stake, 2005). Wikfedlt (2003:15) describes generalization in a case study as "…try to learn one (case) to understand many (cases)." A case study approach using triangulation methods that allows for different data collection methods also limits issues of subjectivity of the researcher (Teegavarapu *et al*., 2008). Triangulation for this study involved the use of a desktop review (document analysis) of specific municipal documents to supplement and validate information obtained from semi structured interviews with municipal officials and major employers.

3.3. Data Collection

3.3.1 Desktop Review

Secondary data was collected from drought reports, and municipal policies. The aim of the desktop review was to attain background information on:

Interactions of water, energy and food within the Bergrivier Municipality

This section of the desktop review looked into documents that provided a background of water, energy and food resources in the municipality such as their current state and how they are managed and general issues that the municipality faces pertaining to these resources. Establishing knowledge on the water, energy and food interactions and challenges during a non-drought period was an important baseline for understanding how the drought altered the interaction between water, energy and food in the study area. Information was collected from previous studies and reports within the area and government reports. See appendix 1A for a full list of reports and studies consulted.

Municipal impacts of the 2015-2018 drought

Documents that describe the impact of the most recent drought in the Western Cape drought were consulted to provide information on the impacts the drought has had on water, energy and food as well as livelihoods in the study area. The list of documents consulted can be found in Appendix 1A.

Level of nexus thinking within municipality (as an institution) through a policy analysis

A policy review was conducted to better understand the extent to which nexus thinking guides municipal development planning as well as drought preparedness. Policies such as the Spatial Development Framework (SDF) and the Integrated Development Plan (IDP) were assessed. Together these policies and plans set the framework for coordinating the work of the municipality and any future development within the municipality. The incorporation of WEF Nexus thinking into these policies would allow for more coordinated management of water, energy and food. Since the IDP is revised every 5 years the 2017- 2022 IDP and the 2012-2017 IDP were analysed to assess whether there has been an increase or change in nexus thinking throughout the two policy cycles. Under the IDP policy plans such as the Disaster Risk Management Plan (DRMP) and the Water Service Plan (WSP) and the Climate Change Adaptation Plan (CCAP) were also analysed. The DRMP and the CCAP were included because climatic disasters have an impact across sectors thus responses also need to take on a cross-sectorial approach and WEF Nexus resources being some of the most exposed resources (Pardoe *et al.*, 2018). For example, a drought may have an influence on water availability which in turn has an impact on energy production and agricultural production (Conway, 2015; Pardoe

et al., 2018). The IDP was also assessed to try and understand whether any municipality development projects in particular the social and development needs align or integrate a level of WEF Nexus thinking. The IDP as a guiding document for local development provides a good indication of the degree to which water, energy and food are addressed in an integrated holistic manner.

The SDF was chosen for assessing WEF Nexus thinking in local policy as it informs the spatial planning of the municipality. The SDF was evaluated with regard how spatial development planning takes into consideration the availability of and demand for water, energy and food and their interlinkages.

3.3.2 Semi-structured interviews

Semi structured face-to-face interviews were used to acquire in-depth information about the experiences and impacts encountered by selected key employers and municipal officials during the drought and the interventions they took during the drought period, within the Bergrivier Municipality. The interviews were conducted between June and September 2019. Each interview lasted for a duration of about 45 minutes to one hour and consisted of open-ended questions that allowed the respondents to further elaborate on each question. The interviews were recorded with the consent of the respondent and the recordings were transcribed to provide a more accurate narrative. Table 1 shows the topics discussed and information obtained for each interviewee. The interview guide can be found in Appendix C.

Table 1 Key interview informants and information gathered

	Interviewee (use code)	**Role**	**Information**
Bergrivier Municipality	Official 2	Bergrivier Municipality- Municipal manager	● Understand the impacts experienced by municipality during the drought and interventions taken by the municipality ● Understand the lessons learnt by municipality post drought

	Official 3	Velddrif Mayor	● Understand the impacts of drought within Velddrif ● Interventions taken by the town and its households during the drought ● Drought impact on the town's water, energy and food use, access and consumption during the drought ● Lessons learnt as a town from the drought
	Official 1	Bergrivier Municipality finance manager	● Understand the impacts of the drought on water and electricity supply during and post drought
West Coast District Municipality	Official 5	West Coast District-Disaster risk management Manager	● Interventions taken during the drought
	Official 4	West Coast District Water Supply-Manager	● Understand the water supply system in the Berg River Municipality and specifically Velddrif ● Understand the impact of drought in the supply and availability of water ● Understand interventions taken during the drought to ensure availability and supply of water to the municipality

	Official 6	West Coast Environmental Manager	• General impacts of the drought in the Berg Municipality

3.3.2.1 Municipal Officials

Municipal officials from the Bergrivier Municipality and the West Coast District Municipality (WCDM) were selected based on the role in the management and supply of water, electricity and/or disaster risk management in Velddrif and the Bergrivier Municipality. Six municipal officials were interviewed in total.

Interview questions for municipal officials from the Bergrivier Municipality focused on the impacts of the drought on the municipality in relation to the supply and access of water and electricity. The questions also looked into the interventions the municipality took in response to the drought and what consequences these drought interventions had on major employers and households in the town of Velddrif.

Municipal officials from the WCDM were interviewed due to their role as water providers (bulk water supply) for the Bergrivier Municipality as well as in disaster management. The West Coast District Municipality Water Supply Department acts as a bulk water service provider in the Bergrivier Municipality for certain towns such as Velddrif. Disaster risk management is based outside the local municipality and is managed at district level and is referred to as the West Coast Municipality Disaster Risk Management Centre.

3.3.2.2 Key Employers

Two of the major employers from Velddrif were chosen with the aid of municipal reports such as the Bergrivier Municipality Integrated Development Plan (2017-2022), Western Cape Government Provincial Treasury Provincial Economic Review and Outlook (2018), Bergrivier Municipality Socio-Economic profile (2017). These documents describe major employment sectors in the municipality, including Velddrif. Sectors (employers/businesses) with the highest number of employed people from the area were categorised as major employers. Interviews with municipal officials validated that the identified employers are indeed major employers. The interviews focused on the impacts key employers experienced during the drought as well as the measures they took during the drought in terms of their consumption and expenditure of water, energy and food (where applicable). Employers were also asked questions pertaining to whether these interventions taken may have had unintended effects. More specifically the

interviews aided in exploring whether any of their interventions had an impact on their employees, households in Velddrif and on the municipality**.** Senior managers representing the two employers were interviewed as they have in depth information on the running, management, and employment within their organisations.

Table 2 Major employers interviewed and the number of employees

Sector	**Interviewee (use code)**	**Role**	**Information**
Fish processing	Employer 1	Amalwandle fish factory Manager	● WEF Nexus connection visible in their daily operations ● The impacts the drought had on the factory ● Interventions taken by the factory in response to the drought ● The influence of municipal drought interventions on the factory and whether this had an influence on the actions they took to towards drought responsiveness ● The influence of the factory's drought interventions on their employees
Retail	Employer 2	OK Foods-Manager	● Evidence of WEF Nexus interconnection in their daily operations ● Impacts of the drought in the store's operations ● The interventions taken by the store during the drought period ● The influence of municipal drought interventions on the store and whether this had an influence on the

			actions they took to towards drought responsiveness ● The influence of the store's drought interventions on their employees

3.4 Data Analysis

3.4.1 Document analysis

In order to aid the policy, review a set of questions were formulated to assess the level of nexus thinking within the municipal policies (i.e. Bergrivier Municipality IDP and SDF). These questions aided in assessing the extent to which the municipality looks at the different domains of water, energy and food as interconnected rather than in isolation. The review focused on how the three resources are described within the IDP and SDF and whether there are any mentions of their interlinkages and potential trade-offs.

The review focused on the following core themes:

1) Inclusion of adequate and context-specific information on the interaction between water energy and food in the municipality in the IDP and the SDF included adequate and context-specific information on the interaction between water energy and food in the municipality;

2) Main developmental concerns in the IDP and SDF and how they relate to water energy and food;

3) Types of interventions mentioned in response to addressing challenges in relation to either water, energy or food security and what the implications might be on the other two resources;

4) Evidence of nexus thinking in the IDP's disaster risk management section;

5) Extent to which livelihood vulnerability and poverty are mentioned in relation to drought or water, energy and food security;

6) Improvements of WEF Nexus considerations in the IDPs over the two policy circles; and

7) Improvements of WEF Nexus considerations in the SDF over the two policy circles.

The assessment of the IDP and SDF comes with its limitations as these policy documents tend to follow a fixed structure and therefore may not be inclusive of important nexus related understanding that may exists among municipal officials. The three resources are also managed by different sectors in isolation therefore each resource in the IDP sections may be addressed by the different officials without consulting each other on possible interactions. The study tries to supplement this with municipal official interview questions probing a WEF Nexus thinking.

3.4.2 Semi structured interviews

All semi-structured interviews were recorded and transcribed prior to the commencement of data analysis. The second step involved thematic analysis for grouping data according to themes, this was done using the transcribed data to help identify occurring trends and interlinks in transcribed data. These themes were grouped according to the ways municipality and employers were impacted by the drought and the connection between drought and nexus thinking. The themes include:

1. Drought impacts on employers
2. Drought impacts on municipality
3. The responses to drought by municipality
4. The responses to drought impact by employers
5. Influence of municipal drought responses on employers and WEF Nexus resources

3.5 Limitations

Originally this study intended to undertake focus group discussions with household members from Velddrif and farmers in the Berg Municipality area. These focus group discussions would have been relevant in providing in-depth understanding of the impacts of drought from the bottom resource users who are dependent on WEF Nexus resources for their basic needs and livelihoods. It would have also provided important insights into how actions of the municipality (district and local) as well as employers affected the household's utilization of the WEF resources. Due to the research restriction under COVID 19, this part of the intended fieldwork could not be conducted. The researcher decided to undertake a detailed analysis of local policies to explore the level of nexus thinking in these guiding documents as an alternative (See section 3.3.1.). Due to this study being a mini thesis, time was a constraint to the researcher unable to go into depth with some other aspects such as more insight on a non-drought period. Furthermore, the drought period had already elapsed and not all participants were able to recall the specifics of their experience during that time period.

3.6 Ethical Considerations

Obtaining consent is an essential part of the research process (Christians, 2005). This involves a voluntary agreement with individuals on their participation in the on-going research with information provided to them on the purpose, risks and benefits of the research being conducted (Christians, 2005). The research adhered to ethical considerations based on standards and

principles set by the University of Cape Town Science Faculty. The research also obtained permission from the University's ethical clearance committee for data collection. The study provided participants with full knowledge on the research and asked for consent before commencement of the interviews. Consent was given verbally and in the form of a signed consent form (Appendix B). For purposes of confidentiality the participants were assured that any information provided, and any form of personal details obtained from the participant was to be solemnly used only for the research and would not be accessible to anyone else besides the researcher and supervisor. The participants were assured that they would remain anonymous if they wished to do so. The interviewees were informed that their organizational affiliations could not be completely disguised. The research study did not pose any form of harm or danger to participants, the research was also based purely on a voluntary basis therefore if participants felt any form of discomfort, they had a right to withdraw from the research and were not forced to partake.

Chapter 4: Results

4.1 Interaction of WEF resources in the study area and awareness of these interactions among Municipal Officials and Employers

The first part of this section provides a background on water, energy and food resources in the municipality, its current state, how these three resources are managed and general issues that the municipality faces pertaining to these resources. The second part reports on the extent of awareness among municipal officials of the interactions of water, energy in food in the study area.

4.1.1 Interaction of WEF resources in the study area

Water resources

The Bergrivier Municipality is located on the lower catchment area of the Berg River and is highly dependent on the river as a water source. The Berg River forms part of the Western Cape Water Supply system (WCWSS), which provides the bulk supply of water to the West Coast District Municipality (WCDM), which in turn supplies local municipalities such as Bergrivier Municipality (Green Cape, 2018). Like many other regions in South Africa the study area faces challenges of water supply and pollution as well as income inequality (Von Bormann and Gulati, 2014). The WCDM for example, has already exceeded its water allocation from the WCWSS since the year 2008 (Pengelly *et al*., 2017). The WCWSS supplies about 590 million m^3 per year to users. Despite the large allocation, demand still exceeds the

system's standard provision of 545 million m^3 per year (Green Cape, 2018). Consequently, the WCWSS is unable to meet competing demands for water for agricultural use in the Upper and Middle Berg areas as well as industrial development needs of other municipalities such as Saldanha Bay (Pengelly *et al*., 2017). This shows that prior to the drought the demand for water outweighed supply already prior to the drought. According to the Western Cape Provincial Economic Review (2018) the WCWSS had been experiencing strain in water supply due to increasing population growth in the greater region as well as subsequent economic growth.

Currently all households within the Bergrivier Municipality have access to the minimum standards of water and the water-related backlogs that exist are only because of insufficient housing issues due to RDP housing supply constraints (Bergrivier Municipality IDP, 2017-2022). The census data for 2016 shows that 97.5% of households within the Bergrivier Municipality have access to piped water within 200 meters of their household yard (Bergrivier Socio-Economic Profile, 2017) which can be perceived as relatively efficient for a small coastal town. This shows that although there are water backlogs in housing, the RDP households have sufficient access to piped water for basic needs.

Energy sources

The Bergrivier Municipality electricity provision comes from the national grid, which is managed by ESKOM (Migdley *et al*., 2014). ESKOM produces its electricity using coal and the electricity is supplied nationwide. Electricity in the municipality at household level is the main energy source used (Methner *et al*., 2021). The Bergrivier Municipality IDP mentioned the use of gas and wood by some households as alternative energy sources for cooking (Bergrivier Municipality IDP 2017-2022). In the Bergrivier Municipality 97.9% of households have access to electricity (Western Cape Government, 2019). The high access rate for electricity and water shows that the municipality has an efficient rate of providing basic municipal services such as water and electricity to households. In 2018 the municipality recorded 713 households that are dependent on free basic electricity and 1746 household's dependent on free basic water (Western Cape Government, 2019) which shows the high dependency level of a significant number of households on free basic services from the municipality.

Despite the high access rate for electricity supply, there has been a constraint in the supply of electricity in the province prior to the drought. Eskom, the country's main supplier of electricity

which conducts a national load reduction in electricity usage which is referred to as load shedding. Load shedding involves the controlled shut down on electricity in different areas of the country for a certain duration of time, to prevent the country from a power system complete blackout (Eskom webpage). This national load reduction poses a constraint to many consumers within the municipality and nationally with disruptions in electricity supply. South Africa has a major threat in energy security as a result of inadequate energy generation which is required to meet the demands of both industrial and domestic use and the over-reliance on coal generated electricity (Ateba and Prinsloo, 2018).

Agriculture/ Food source

The Berg catchment in which the municipality is located, is of significant agricultural importance, as 60% of the land use in the catchment is used for agriculture and 53% for irrigation purposes (Methner *et al*., 2021). Agricultural production in the municipality consists of grain such as wheat and fruit farming such as grapes (Bergrivier Municipality IDP, 2017-2020).

While the Bergrivier Municipality is known for its beautiful agricultural landscapes, the municipality, must also be seen against the backdrop of a series of interrelated challenges following from the slowdown in economic growth, reduced employment, impacts of climate change and serious social ills facing the wellbeing and livelihoods of communities within the municipality (Bergrivier Municipality IDP, 2017-2022). Prior to the economic recessions in 2008/9 the agricultural sector was the highest sector of employment (Bergrivier Municipality IDP, 2017-2022). The economic recession resulted in a closure of farms and lower exports in agricultural products, which also forced farmers to reduce their workforce. s (Bergrivier Municipality IDP, 2017-2022). Despite the decline in employment opportunities, agriculture is still regarded as an important contributor to the municipal economy (Bergrivier Municipality IDP, 2017-2022). Energy is an important input within the production phase of the agricultural sector for irrigation purposes, storage, fuel in terms of transport and many other roles (Notten *et al*., 2014). The Bergrivier municipality households mainly obtain their food through retail stores and have a few cases where households partake in subsistence fishing as a way of ensuring food security (Methner *et al*., 2021).

The interaction between all three WEF Nexus resources can be best seen in the Bergrivier Municipality within the Agriculture/Fisheries sector where both water and electricity play an

important role towards food production. Farmers within the Bergrivier area are highly reliant on the dams in the Berg catchment area for the supply of water for irrigation (Midgley *et al*., 2014). A study conducted by Hulley (2015) showed that farmers within the municipality's access to water had an influence on how much energy (for irrigation and production) the farmers used, the type of agricultural practices. In the study, the interaction of water and food is also evident in relation to the fish processing industry within the municipality which has a strong reliance on water (Pengelly *et al*., 2017). From the findings at the district level connections or trade-offs amongst these three resources are not so evident. Whilst in the coastal town Velddrif, the connection between water and electricity is evident at the town scale. This is relatively due to the coastal town being on flat land, which makes it reliant on the pumping of water into the town (Methner *et al*., 2021). The pumping of water within the municipality requires electricity to function (Methner *et al*., 2021). The findings above provide some insights into nexus interaction at various scales in a non – drought period mainly at municipal level. The reviewed studies tend to incorporate water-energy and food together when looking at agriculture within the Bergrivier Municipality, whilst energy and food together is observed when assessing the municipality's supply and access of these two resources (water and energy) at a municipal scale. Thus, the aspect of food is omitted in discussion of supply and access to individuals within the municipality but is seen from a perspective of agricultural production.

4.1.2 WEF Nexus understanding by Municipal Officials and Employers

Most of the interviewees were aware of the WEF Nexus concept in terms of the interconnection, relationship and trade-offs that exist between water, energy and food. The interviewees described how they see the connection between these three resources in either the municipality or the daily operations of their businesses.

For municipal officials the WEF Nexus was evident mainly between two resources, which were water and food (agriculture). Official 5 confirmed that water is an important aspect for food production within the agricultural sector. This involved the extraction of water from the Misverstand Dam by farmers for irrigation purposes. Official 4 explained that for bulk water supply there was a dependence on electricity for the purification of water as the water pump used for water purification required electricity to run.

With regards to the linkages between water and energy Official 1 mentioned the connection between the municipality's electricity and water service delivery also exists as a result of the

link the municipality makes on consumer accounts for water and prepaid electricity. This results in a deduction in the amount of electricity units if a consumer still has an outstanding water bill. This aids the municipality in reducing household water account debts. Official 2 stated that the municipality saw a connection in the affordability of electricity and water by households. Households who could not afford their water also could not afford their electricity. This shows that the need for electricity and water goes hand in hand within households. Municipal Official 2 also stated that the largest consumer (Fish Factory) of water in the municipality is also the largest consumer of electricity. Employer 1 confirmed that the fish factory is heavily reliant on fresh water and energy for its daily operations and production. The factory's machinery used for canning and thawing is dependent on electricity to function, and the steaming and thawing of fish and cleaning is also dependent on the use of municipal water. Employer 2 identified the relationship between electricity and food as important for the retailer as the store is reliant on electricity for the running of the fridges for the storage of foods.
Employers and municipal officials focused mainly on the interaction between two resources which is mainly water and electricity or water and agriculture rather than all three resources.

The interview results portray a discussion primarily in relation to employer's day to day activities with regards to their water and energy use and municipal challenges on the supply of these two resources. There is a limited discussion around the trade-offs and general interaction that exist amongst these three resources. The sectoral management of these three different resources as completely different entitles has resulted in this limited or poor collaboration and acknowledgement of these resources trade-offs and interactions.

From the desktop review and the interviews, it appears that at municipal scale the use and need for water is highly dependent on the access and availability of electricity. The challenges with this lie at water intensive consumers, most especially employers, needing bulk amounts of these resources to be supplied by the municipality. Other challenges on the dependency on both water and electricity at household scale are seen with households to the extent where both resources are illegally bypassed by some households.

4.2 Level of nexus thinking within municipality (as an institution)

An important part of the desktop review was the analysis of municipal policies, namely the Spatial Development Framework (SDF) and the Integrated Development Plan (IDP), that inform development of the Bergrivier Municipality.

Six core themes were developed to explore whether the IDP and SDF acknowledge the interdependencies of water energy and food and support integrative planning and management of these resources jointly. These results under each core theme are described below:

1. **Adequate and context-specific information on the interaction between water energy and food in the IDP and SDF**

The IDP recognizes the competing demands for the three resources and acknowledges an increasing interdependencies amongst water and energy. For example, the section on the status quo of bulk infrastructure and basic services the IDP states that "energy, mining, agriculture, and households compete for water resources which, in turn, are compromised by their waste; water resources are becoming increasingly energy/carbon intensive, due to deeper well, more inter- basin pumping and more reliance on desalination." (Bergrivier IDP 2017-2022: 111). However, the IDP does not refer to specific interdependencies between water, energy and food. Instead, the IDP mentions the connection that occurs between water and agriculture and water and energy. For example, the interaction between water and energy is highlighted in the IDPs strategic goals in terms of providing bulk infrastructure and development to reduce competing demand from resources of water and energy. Improvement of bulk infrastructure for water and electricity may result in the improvement of service delivery thus reducing municipal backlogs. In relation to water and agriculture the IDP touches upon the interdependence that exists between energy and agriculture for the use of water (i.e. energy used for pumping water and water used for irrigation in agriculture).

The municipality also commissioned a study to analyse the status of service delivery looking into water, energy and wastewater treatment. The study found that many towns within the municipality require an upgrade in water and electricity supply infrastructure between 2020 and 2025.The municipality has placed a priority towards increasing the access of water and energy through the improving bulk infrastructure used to supply water and electricity. The improvement in the infrastructure would ensure supply efficiency and security of water and electricity, which also play an important role in food production. The IDP makes suggestions of upgrading water and energy infrastructure through the transition to renewable options such as hydropower and solar energy although not much is elaborated on actions towards this, but financial constraints are stated as some of the challenges that hinder the upgrade of basic service delivery infrastructure within the municipality.

The SDF which provides a reflection on the status of a municipality's economic, social, environmental, spatial situation as well as guidelines for land use and development, does not focus on the interaction between the three resources. This is surprising given that the social and economic development of the municipality is highly dependent on sustainable access to water, energy and agricultural production. The SDF touches on water and electricity in relation to service delivery, bulk water and electricity infrastructure development and the need to improve the capacity of these to sustain future development. This is similar to the IDP goals set in place to focus on improvement of infrastructure for water and electricity. The SDF also addressed energy and agriculture in relation to each other, through the need for a transition to more energy efficient and renewable energy for more low-carbon agriculture. This involves the suggested use of smart agriculture, solar plants, wind farms and waste-to-energy initiatives. For example, the SDF states that the province has already assessed likely climate impact areas with the Bergrivier Municipality. The municipality plans on making the use of "energy efficiency and renewable energy case studies to inspire the transition to low- carbon agriculture" in these selected climate impact areas (Bergrivier SDF 2019-2024: 45).

Overall, the two policies lack context specific information on critical interactions that exist between water, energy and food. Such deficiency will most likely result in not being able to identify specific trade-offs, interdependencies and/or synergies that interfere with municipal development objectives. The three WEF Nexus resources are stated in silos in the IDP and SDF and any interrelation is discussed in the relation to two resources rather than all three.

2. The main developmental concerns in the IDP and SDF and how they relate to water energy and food (Situational analysis)

The municipality has formulated its IDP into 5 strategic goals, which target the municipality's development objectives. These include strengthening financial sustainability and good governance, sustainable service delivery, facilitating economic growth to alleviate poverty, promoting educated and integrated communities and a sustainable and inclusive and integrated living environment.

One of the strategic goals focuses on the sustainable service delivery of water and energy through increasing bulk infrastructure for efficient supply and also developing alternative energy supply sources such as solar energy and biomass. This is the only goal that is articulated in relation to both water and energy. In terms of the strategic goal focused on poverty alleviation, food is mentioned in terms of developing programmes focused on municipal food

security through food gardens with the aid of sector departments and investors within the municipality. The strategic goal does not address how water will be made available for these initiatives. When looking at the goal focused on facilitating economic growth to alleviate poverty, economic growth is also not articulated in relation to availability of required resources such as water and energy. The goal only looks into issues of social development, social justice and new businesses development. Whilst a municipality's economic growth may be constrained by the insecurity of WEF Nexus resources. The goal of a sustainable and inclusive and integrated living environment as stated on the IDP is not addressed directly in relation to water, energy and food but rather speaks of regulating the built environment. It also addresses targets to develop the municipality to have a zero-carbon footprint. The goal does not mention sustainable initiatives to the conservation of water and energy which could aid attaining a sustainable and integrated living environment.

From the IDP's situational analysis most development concerns in the Bergrivier Municipality in relation water, energy and food is mainly with regards to water resources and funding of water infrastructure, the increase in the cost and unaffordability of basic services especially for the poor and the impacts of climate change on agriculture. There seems to be little regards to these three resources jointly. Food security is addressed in the situational analysis but does not look specifically to the Bergrivier Municipality area, but in relation to increasing poverty levels in South Africa in general (Bergrivier Municipality IDP 2017-2020: 94). The IDP also states how the Berg Municipality is predominantly agricultural and there is a growing concern on the impacts climate change will have on the sector with rising temperature conditions and the impacts this will have on existing water resources and the local economy. The municipality is also concerned with how the current drought may affect the sustainability of water resources required to support economic growth (Bergrivier Municipality IDP 2017-2020).

Table 3 Bergrivier Municipality developmental concerns aligned with strategic goals

IDP Development Concern	**Strategic goal**
Affordable basic services and tariffs Funding for infrastructure improvement	Goal 1: strengthening financial sustainability and good governance
Poverty alleviation	Goal 3: Facilitate an enabling environment for economic growth to alleviate poverty

High level of education for all, and a safe and healthy life environment	Goal 4: Promote a safe, healthy, educated and integrated community
Climate Change	Goal 5: A sustainable, inclusive and integrated living environment

When looking into the Bergrivier Municipality SDF, most of the goals within this policy plan are in correlation with the SDGs which include SDG 6 that focuses on the implementation of policies that promote the supply of clean water and sanitation as well as infrastructure that helps the supply. SDG 7 is also mentioned which promotes the transition towards more sustainable energy forms for development as well as Goal 9 which speaks to infrastructural innovation that is inclusive of both irrigation and energy infrastructure for sustainable development and attaining resource use efficiency. Most of the developmental concerns of the municipality are in relation to these SDGs mentioned above for example, the SDF stated that the agricultural sector was an important economic contributor in the municipality and challenges with this come from the municipality being a water scarce area and most of the issues with agricultural development in the municipality seem to be occurring in riparian zones, which poses a threat to water sources in the municipality (Bergrivier SDF 2019-2014: 48). Other development concerns mentioned in the SDF include the unsustainable use of groundwater for agriculture in certain parts of the municipality. The emphasis on the SDGs is placed in the SDF as majority of the municipality's development objectives lie within acknowledging that development requires the sustainability of resources like water and energy, which is the main objective of the SDGs. (Bergrivier SDF 2019-2014: 81) states that "the provision and conservation of, and the management of the demand for, energy should be considered in land use planning" and also sets development planning goals which focus on "Applying water-wise and energy-smart urban design and infrastructure delivery systems" (Bergrivier SDF 2019-2014: 82). The SDF plans to achieve the SDGs through different strategies for example goal 6 the SDF addressed the improvement of water supply systems to attain this goal and for goal 7 one the strategies stated involves finding of alternative forms of sustainable renewable energy. These goals are inclusive of the WEF Nexus resources which are water and energy. The aspect of food security is left out in the SDF, although there is mention of land with regards to agricultural development.

The SDF also mentioned development challenges in terms of water pressure in some towns such as Velddrif and Redelighuys water networks are dependent on a sustainable electricity

source as sufficient pressures in these areas are supplied by booster pumping stations. This water network needs reinforcements and additional reservoir storage. These are some of the examples to which a interdependency between water and electricity is mentioned within the municipal SDF. The role of water is continuously emphasised throughout the SDF acknowledging the inability of current water infrastructure to be able to supply future water demands in most of the municipality due to future development and projected growth in the municipal towns.

There is insufficient evidence of WEF Nexus thinking when it comes to the development concerns in both the IDP and SDF. For example, the concerns within both policies only focus on each of the resources individually rather than perceiving as a nexus. To further emphasize this point, development concerns on water solely addressed water with no mention of energy. This is the same with development concerns pertaining to energy. Each of the developmental concerns of water and energy are based on insufficient supply infrastructure and leave out how the two or three resources interact with each other and influence or impact development. There is also a lack of understanding on how to sustain the supply and use of these three resources without having to over extract the already depleting natural resources. For example, most statements in the IDP relating to water speak towards improving water extraction infrastructure focusing mainly on increasing supply of water.

3. **Types of interventions mentioned in response to addressing municipal challenges in relation to either water energy or food security and what the implications might be on the other two resources**

Most interventions stated in the IDP relating to water and energy were technical and mainly related to building bulk infrastructure such as increasing the number of water reservoirs and boreholes within the municipality, an upgrade of electricity meters and forming new electricity networks. The SDF touched upon conservation of resources as one of the intervention areas in the Bergrivier Municipality objectives, which focuses on water and energy security by promoting the reduction of water and energy use in the municipality through the use of awareness campaigns.

Food security is addressed with regards to creating an environment for economic growth in order to alleviate poverty. This is said to be achieved through creating food security programmes in different sectors such as the agricultural sector and social development sector

of the municipality which will provide employment for the locals and aid in ensuring food security. More specifically the municipality is looking for investors who will be able to finance food-producing areas for small farmers and households with the aim of supplying to a national retailer. The issue of food insecurity in the IDP is stated to be a key component of poverty although the municipality has no current records of statistical data available for the number of households without food. The municipality also has a plan to mainstream climate change into their policy and one of the issues pointed on in this section (Climate Change Adaptation Plan interventions) deals with designing climate resilient low-cost housing which decreases the vulnerability of these households to climate change impacts. One of the suggested plans in the Climate Change Adaptation Plan interventions is the development of green housing which will be designed to divert stormwater run-off. Stormwater run-off poses a challenge for low-cost housing in the municipality during intense rainfall times. Another intervention suggested for this issue involves the collection of stormwater run-off as an opportunity to be used in communal food gardens to try and ensure food security for poor households.

A challenge that is emerging is the expanding presence of backyard dwellers due to homeowners renting out structures on their properties. It is difficult to ensure that these backyard dwellers have access to sufficient water and the municipality undertook a survey to assess the extent of the issue of backyard dwellers. The presence of backyard dwellers has placed pressure onto municipal water supply, which is why the municipality's IDP includes the need to upgrade its bulk service infrastructure. The funds obtained through the National Government (Municipal Infrastructure Grants funds) shall be used for the upgrading of bulk water and sanitation service infrastructure.

When looking into the SDF with regards to addressing municipal challenges the framework takes into consideration the issue of water scarcity in the municipality and proposes an intervention that involves changing to different types of agriculture and farming practices such as smart agriculture to tackle issues of water scarcity and climate change. Smart agriculture involves the use of technological agricultural practices which are sustainable to improve the quality and quantity of production within different climatic extremes (Nhamo and Chikoye 2017). The SDF has also proposed applying water wise and energy smart infrastructure for service delivery in order to monitor and save water. Interventions that the municipality has taken with regard to water security include increasing the number of reservoirs in the municipality for additional storage of water for any future water risks.

The policy documents both mentioned the importance of measures such as renewable energy, alien clearing, protection of rivers and better farming practices for water security, although do not indicate the specific interventions that implement these measures for improved water security. Hence the emphasis remains on technological fixes rather than formulating sustainable management initiatives for the current resources in the municipality.

In summary the evidence shows the municipality takes a focus on infrastructural development to most challenges faced with regards to water and energy. This has been seen as an appropriate approach to increase the supply of these two resources by the municipality. From a WEF Nexus perspective this approach still lacks an integrated approach as suggested solutions are still only sector specific to only water and energy neglecting the aspect of food or the trade-off that exist between the three resources jointly. In the case of food, the municipality mentioned food insecurity only as a bypass for economic growth through the use of agricultural food programmes aimed at providing employment for locals. Thus, food security is only discussed through food gardens that form part of these agricultural programmes. The municipal planning levels of engagement with food security still requires an in-depth assessment, of the extent of household food insecurity in the municipality.

4. **Evidence of nexus thinking in the IDP's Water Services Development Plan, disaster risk management plan; Climate Change Adaptation Plan**

The Disaster Risk Management Plan (DRMP) states drought as a major concern resulting in decreasing water levels in dams and aquifers in the municipality. The disaster risk management plan proposes mitigation solutions such as the use of alternative sustainable water supply e.g., the use of desalination plants. The DRMP also mentioned the creation of a control system for the monitoring of the current boreholes in the municipality. The disaster risk management plan also includes a plan to increase reservoirs to ensure sustainable water supply during drought conditions. The disaster risk management plan further includes climate change responses, which involve the clearing of alien invasive plants, which are said to compromise the availability of water in the Berg River. Climate projections in the province show a trend towards increasing temperatures in the area, which will affect water supply due to low dam levels and the presence of invasive vegetation surrounding water supply sources such as dams along adds to the decreasing of water levels in these water sources as invasive vegetation use large amounts of water.

The Water Service Development Plan (WSDP) is a policy plan that focuses on ensuring the municipal residences have a sustained and continuous supply of water and also aims to reduce the water supply backlogs, which are as a result of development of new houses, and backyard dwellers within the area as mentioned above. The WSDP does not make any acknowledgement the nexus resources as interconnected or the trade-offs that may exist between these three resources rather takes a focus on the water infrastructural developments. Water and energy are mentioned with regards to aligning water infrastructural costs with energy costs in the future.

The Bergrivier Municipality has an economy that is reliant on agriculture and there is a growing awareness of the possible impacts climate change will have on the agricultural sector which will in turn impact the local economy (Bergrivier IDP 2017-2020). The Bergrivier Municipality Climate Change Adaptation Plan (CCAP) has five main objectives which are mainstreaming climate change into adaptation and municipal governance, stormwater management, conserving natural resources, forming climate resilient low-cost housing and agriculture. The plan includes a section which focuses on developing alternative energy plans such as green energy i.e., reducing emissions and improvement of energy access /supply using renewable energy. The CCAP has also aligned itself with infrastructure development, on the completion of the Bergrivier Municipality Electricity Master Plan (Bergrivier IDP 2017-2020) to incorporate aspects of emission reduction and looking into low carbon energy alternatives in energy plans of the municipality. Other than the mention of water conservation with regards to the agricultural sector the Climate Change Plan has not addressed any interactions of these three resources together. The plan investigates these three resources individually: water with regards to conservation and storm water management, energy in the form of alternative green energy sources and food in the form of agricultural management. The CCAP proposes important measures towards a green economy but even here interactions between WEF still remain ignored. When assessing the CCAP, proposed adaptation solutions have not had much of an influence on the interventions put forward by the IDP towards development or WEF Nexus resources.

The two plans (SDF and IDP) seem not to take into consideration all three resources holistically but do place an emphasis on the sustainable management of water and energy individually. The three plans (SDF, IDP, WSDP) mentioned the importance of prioritizing the threats and opportunities in sectors of water, energy and agriculture to ensure the security of these three resources within the municipality. Nexus thinking involves the joint consideration of all three

resources, interrelationship and dependencies which is evidently not displayed within any of these three plans. There is still a need to incorporate nexus thinking in these plans to balance the social, economic, and environmental goals of the municipality.

5. **Whether vulnerability and poverty are mentioned in relation to drought or water, energy and food security**

Household vulnerability is discussed in relation to water and energy basic service delivery. The IDP socio-economic profile sections as well as the individual ward sections discuss service provision for indigent (poor) households that cannot afford municipal services such as water, electricity and waste removal. The municipality provides a certain level of free service to these households. This shows a glimpse of the existence of poor households within the municipality, as mentioned in prior sections of the results, the job losses in the agricultural sector as a result of the drought further exacerbated the vulnerability of poor households and their ability to afford basic service delivery such as water and electricity.

The SDF addresses poverty alleviation in terms of SPLUMA (Spatial Planning and Land Use Act of 16 of 2013) which mentions the municipality's aim to try to eliminate poverty. SPLUMA is a national legislation informing land use planning in South Africa, is inclusive of land use management, spatial planning and institutions involved in the decision making of land. Under SPLUMA there are principles that guide the legislation such as spatial justice; spatial resilience; spatial sustainability; efficiency and good administration which have a correlation in the accessibility and management of WEF Nexus resources which are land based. SPLUMA can be perceived as an integrative planning tool that has the potential to integrate or collaborate the spatial planning and coordination of the different WEF Nexus resources. The principle on spatial justice addresses inclusion and flexibility for all types of settlements and informality settlement upgrading (Barclay *et al*., 2016) which is important in ensuring that all forms of settlements have access to basic needs such as water, electricity and food as equitably. The principle of spatial resilience in this context is understood as an important precondition for livelihoods resilience against shocks (Barclay *et al*., 2016), and illustrates the important role of SPLUMA as a legislation towards WEF Nexus thinking through integrative and collaborative approaches.

The Bergrivier Municipality rural areas within Ward 1, 5, and 6 experience high levels of poverty, although the SDF does not address poverty levels with regards to Wards water, energy

and food insecurity. The SDF does not mention any specific impacts on the severity of the drought on the municipality but only speaks towards projected concerns. The SDF mentioned the impacts of 2015-2018 drought on agriculture and potential threat on food security within the municipality. The SDF also spoke to the impact of the drought on job losses in the primary, secondary, and tertiary sectors of the municipality. In challenges currently facing the municipality, the SDF mentioned the need to address rural poverty and vulnerability due to joblessness, homelessness, tenure and food insecurity. Some of the proposed solutions included promoting investment into or building on existing rural development opportunities that would combine housing as part of small-scale farming opportunities close to town to tackle poverty issues. For some towns in the municipality like Redelinghuys, spatial strategic priorities to alleviate poverty would involve a dedicated space where local farmers and urban agricultural gardeners can sell local produce.

The results show evidence of vulnerability with relation to drought and WEF Nexus within the sections of the Climate Change Adaptation Plan within the IDP. The context of vulnerability is observed according to the impacts of the drought on low-income housing and the use of the plan to bring forth strategies that contribute to climate resilient housing for the poor. In instances where the poor and vulnerability were stated in the overall IDP is with regard to the access of free basic services by indigent households and some of the social ills that face the municipality such as high school dropout rates, health care and unemployment rates.

6. **Whether there have been improvements over time in terms of WEF Nexus considerations in the IDPs**

The Bergrivier Municipality reviews and produces an IDP every 5 years. This section reviews the current IDP 2017-2022 in comparison to the previous IDP 2012-2017 specifically with regards to any improvements in the incorporation of WEF Nexus in these plans. These two IDPs are quite similar with only a few differences mainly with regards to structure. The IDP 2012-2017 only places a connection or relationship between resources such as water and agriculture and water and electricity with regards to improvement of bulk service delivery infrastructure. Comparing the 2012-2017 the current 2017-2022 IDP differs in taking a strong emphasis on sustainability with regards to any mention of either water or electricity. There is more recognition that the use of these two resources needs to be sustained for the municipality to thrive. For example, the 2017-2022 makes more suggestions to finding other alternatives of renewable forms of energy such as hydropower that are more sustainable for the future. There

is still a lack of the acknowledgement of the dependency that exists between all three resources (water, energy and food) in both the 2017-2022 and 2012-2017 IDP. The municipality still requires engagement on the interdependency of all the three resources jointly beyond just infrastructural improvement or service delivery when setting up these policy plans.

7. **Whether there have been improvements over time in terms of WEF Nexus considerations in the IDPs**

The SDF both 2012-2017 and 2019-2024 only account for individual parts of the WEF Nexus for instance water is addressed with regards to infrastructural development for water harvesting and increased storage capacity within the municipality. The 2012-2017 SDF mentioned the protection of development within water zones for the overall protection of ecosystems. The 2012-2017 and 2019-2024 SDF mentioned water and agriculture with regards to how any agricultural farming intensity should be in line with the available amount of water within the land. Electricity is also discussed in relation to increasing the number of transformers for household provision and finding alternative forms of energy such as solar water heating. The major difference with two frameworks is that the 2019-2024 SDF is more aligned with international and national policy and goals such as the SDGs and Integrated Urban Development Framework. Overall, the SDF does not incorporate any WEF Nexus thinking towards the municipality's spatial planning.

Overall, the policy documents IDP and SDF show that there is still need for improvement in the thinking of these three resources jointly. The policy documents seem to focus on technological fixes that focus on improving infrastructure for supply of water and energy with little consideration of the sustainable management of these resources and the trade-offs that exist between water and energy The IDP follows a fixed format throughout the years when formulating the municipal plans which is why there seems to be no improvements over time in the inclusivity of WEF Nexus overtime.

4.3 Drought impacts on the Bergrivier Municipality and West Coast District Municipality as service providers

4.3.1 Impact on supply

Bergrivier Municipality

Official 1 and 2 stated that the drought impacted the availability and supply of bulk water from the West Coast District Municipality water supply. The WCDM has a service level agreement

in place with the Bergrivier Municipality for the provision of bulk water to the towns Velddrif and Dwarskersbos. The other towns within the Bergrivier Municipality receive their water directly from the Bergrivier municipality. The drought had an impact on the main water sources that contribute to the bulk water supply in the Bergrivier Municipality, namely the Miservstand and Voelveil Dam. Official 2 further stated that during the drought towns such as Velddrif were the most vulnerable to running out of water. Official 1 also stated that the drought had an overall impact on the ability for the municipality to supply enough water for individuals to continue with their daily operations such as businesses daily water use and household consumption.

West Coast District Municipality

Official 4 stated that water can only be extracted until the water level of 13% is reached. However, during the drought the water level in the dam reached a low of 12%. which meant that the West Coast District Municipality had to take measures such as installing extra pumps in the Voelvlei Dam to be able to extract water at water levels below 13%. This made it imperative for the WDCM water supply to find alternative ways to pump water out of the dam, thus incurring a financial cost with the installation of more pumps. Official 4 further went on and stated that as a district water supplier their electricity consumption also increased significantly due to interventions such as running water purification pumps even past off-peak times. The water purification plant prior to the drought would run at off peak times in order to save electricity costs. During the drought the water level was so low that the water purification plant had to pump throughout the day. This resulted in the West Coast District Municipality electricity bill increasing about 3-4 times more than their usual bill. Farmers also posed a challenge to the municipality water supply as some farmers illegally extracted large volumes of water from the already low water levels in the Berg River. Official 4 stated: “One of the biggest challenges created by the drought was the issue with farmers in terms of channelling out large volumes of water from the Berg River. This prevented water from reaching dams such as the Misverstand, which is important for water supply”.

4.3.2 Impact on revenue

Municipalities generate some of their income from service delivery, property rates and fines (StatsSA 2018). Official 1 mentioned that during the drought the municipality obtained lower revenue from water supply. This was because the municipality had advised large water consumers to reduce their consumption levels. Official 1 also stated that most of the large water consumers had resolved to use alternative water sources such as desalinated water.

Official 1 made use of the example of the Fish Factory in Velddrif, "just from the fish factory alone installing the desalination plant the municipality lost around 250000kl of water income."

Domestic water users were also asked to reduce their consumption, which also impacted municipal revenue. Figure 3 below which shows the difference in water use per sector from 2015-2018, with peak drought years 2017/18 showing the lowest water consumption in the 3-year period (Bergrivier Municipality Water Service Audit Report 2017-2018). The commercial users in Figure 3 is inclusive of large industries and companies such as the Fish Factory. According to Official 1 reduction in water usage by consumers within the municipality also had unintended repercussions on the consumption of electricity. For example, the municipality experienced an increase in electricity losses in revenue from 8.88 % in 2014/15 to 10.53 % in 2015/2016 (Berg Municipality Annual Report 2015-2016). Official 1 stated that the installation of a desalination plant by the biggest water consumer did not increase the electricity revenue for the municipality. The fish factory production rate was low due to water quality of the desalinated water, which was not suitable to produce the fish. Thus, the use of the desalination plant was of no benefit to the municipality in terms of an increase in electricity revenue from the factory as the low production rate meant less consumption of electricity thus less revenue for both water and electricity for the municipality. In addition to the 2015-18 drought, load shedding throughout the years was a contributing factor in the loss of electricity revenue within the municipality.

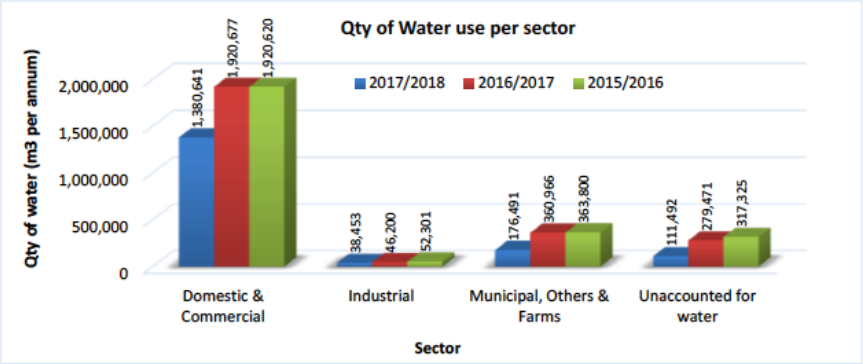

Figure 3 Bergrivier Municipality water use per sector 2015-2018 (Bergrivier Municipality Water Service Audit Report 2017/2018)

Official 1 also mentioned that the municipality had experienced a decrease in electricity income from households as well. Official 1 illustrated the linkage that exists between water and electricity consumption through the following example: "… I don't shower for 10 minutes

anymore, I only shower 2 minutes and the electricity consumed with the geyser is also declining." As people conserved more water during the drought less electricity was also used.

The findings above show that the municipality financially suffered a financial loss from the drought not only due to low dam levels but also the change in water consumer patterns of using less water. Consumers (domestic and bulk service consumers) reduced water and electricity consumption. The implementation of technological fixes such as the installation of pumps also presented a financial burden towards the WCDM water supply.

4.4 Responses of the municipality to the drought

Certain drought impacts are mediated through institutions and processes; here the local municipality can be regarded as the mediator between local resource users from the impacts of drought. During the drought period the municipality put in place specific interventions to maintain water security which may result in local resource users becoming more resilient or more vulnerable. Thus, important insights can be gained from investigating the influence of municipal actions on the responses to and impacts of the drought for local resource users such as employers or households within a municipality. The interventions taken by the Municipality during the drought were categorised into two sub sections: 1) interventions taken by the municipality with the intention to try and maintain water supply or utilize alternative water sources and 2) Interventions aimed at trying to reduce water consumption. Each intervention taken by municipality was grouped with the possible influence it may have had on the response of employers or households' consumption and behavioural changes.

4.4.1 Maintaining water supply or alternative water supply

The Bergrivier Municipality implemented water restrictions on water consumers in the new financial year of 2017 and by October 2017 the municipality had reached up to level 5 water restrictions. Official 3 stated that most employers that were large (bulk) water users opted for alternative water sources. This was due to their businesses needing large amounts of water to continue functioning.

For households the Municipality started a water augmentation plan, which involves the installation of pipelines from the springs and other local water sources to join the main municipal water reservoir. This involved drilling pipes into springs and boreholes from ground water in order to try to supplement water supply for towns such as Velddrif. These pipelines were put in place for domestic users to be able to still be able to access water if water could no

longer be available for extraction. Official 1explained that “The idea was also that should another drought situation occur in the spring as well boreholes could provide an alternative water source other than the main municipal water”.

4.4.2 Reducing consumption

According to municipal officials in order to try and ensure that the municipality could still be able to supply water for resource users, the municipality established a list of bulk water users which were visited at the beginning of the drought. These users were requested to reduce their water consumption to ensure that other water users still had enough water. The municipality also acted through reducing water supply for construction sites within the municipality during the drought to cut down water use in the municipality. Level 5 water restrictions required water consumers to use no more than 87 litres of drinking water per person per day. This was implemented to maintain water supply in light of the extremely low dam levels. Other activities such as irrigation and filling of swimming pools were prohibited and households which consumed more than 7000 litres per month in their water bill were required to pay an increased tariff.

The municipality also focused on trying to get residents to save water and did this through speaking to the people as well as awareness campaigns on saving water. The campaigns created a sense of consciousness amongst households on the importance of reducing their water consumption. Official 1, 2 and 3 all confirmed that households responded well to the water saving campaigns. This meant that the municipality did not need to go as far as enforcing strict restrictions on domestic users. Official 3 stated that some households in Port Owen (Upper income residential area in Velddrif) went and placed well points in their properties, others went to the extent of installing home desalination as alternative water sources. The municipality also took the initiative of hiring plumbers to make household checks on households that couldn’t afford to pay their water utility bills which were suspected to be caused by household leakages.

The municipality embarked on interventions that focused on encouraging consumers to reduce their water consumption during the drought period and tried to aid poor households towards reducing water wastage as a result of leaks. This was done through awareness campaigns and hiring of plumbers to fix leaks. All these interventions taken by the municipality were with the focus to ensure that consumers within the municipality still had access to water for basic

consumption despites the extremely low levels of water in the dams as stated by Officials 1 and 2.

The drought responses by the municipality towards the drought have mainly focused on water demand management through targeting the change in water use behaviour by consumers through measures such as implementing water restrictions and awareness campaigns. Other initiatives were technological solutions focused on maintaining current water supply and finding alternative water sources such as the use of springs. These interventions show evidence of the serious impact the drought had on water sources and the threat it posed to the water supply and consumption within the municipality. The municipality prioritized ensuring that the current water remaining in dams could sustain the municipality for a longer period until the rains returned. Therefore, an importance in reducing consumer use of water was regarded as a high priority as compared to finding alternative water supply sources.

4.5 The impact of the drought on main employer and responses

This section addresses the impacts of the drought from the perspective of the two major employers within the Bergrivier Municipality, being the Fish Factory and Food retail store. The section also incorporates the aspect of drought impacting the Fish Factory not only as an employer by as well as a large water and electricity user in the municipality.

4.5.1 The Fish Factory

Official 1 stated that the Fish Factory prior to the drought consumed about 35% of the water in Velddrif, which is about 250000kl-30 000kl of water. The drought affected the factory significantly due to the large volumes of water required for its operations. Employer 1 stated that the request by the municipality to reduce their water usage meant they would incur a financial burden in trying to find an alternative water supply source. The request by the municipality for the Fish Factory to reduce its water consumption was the main reason that motivated the factory in installing the desalination plant and seawater infiltration system as an alternative water supply source. According to Employer 1 the desalinated water brought a lot of issues because this alternative water source was not suitable for the type of food processing the factory required. Some of the fish processed with the desalinated water showed high salt concentrations levels, which were a health hazard if they were to be consumed. Consequently, the production of fish had to be slowed down. A reduction in production meant also less production inputs such as electricity. Other than the reduction in municipal water usage the

Fish Factory had already been experiencing seasonal decrease in fish stock capture, which had already reduced their full functioning capacity. With less usable water available they had to reduce production even further. According to Employer 1 the desalinated water also resulted in the rusting of some of their machinery, which was a large expense to them to have this machinery replaced.

4.5.2 Food retail store

Employer 2 highlighted that the drought period impacted retail food stores with the supply of fresh produce. Many food retail stores were no longer supplied on the normal schedules due to a shortage of fresh produce in the province. For the food retail store water is not a major factor in their daily operations although a relationship between energy, food and the impact of the drought was evident. Employer 2 for example stated that electricity is a necessity for food storage. During the drought period the store experienced an increase in the electricity bill as a result of having to run more fridges for fresh produce storage. The municipality had asked all consumers to reduce their water consumption and try to save water with this Employer 2 stated that their biggest challenge faced as a retail store during the drought was trying to get employees to manage and use water wisely. This meant that the retail store had to put in place water saving strategies for their employees and daily operations such as the cleaning of the bakery and flushing toilets. The water used for cleaning the bakery was also recycled to clean other parts of the store and toilets were flushed only when it was necessary. Unlike other businesses the retail stores were not as greatly affected by restrictions put in place by the municipality as their operations are not highly dependent on the use of water.

4.6 Responses by main employers to the drought

Interventions taken by main employers were driven by both the drought and the interventions taken by the municipality. Interventions such as the installation of a desalination plant which are more physical can be considered as direct interventions. These direct interventions were influenced by municipal actions which required large water consumers to reduce their consumption. Other businesses could not reduce their water consumption and therefore had to look for alternatives. Some of the interventions taken by employers, as means to continue saving water during the drought and post drought period can be considered as a drought response. For example, Employer 1 stated that they started a laundry water recycling routine where water from the washing staff uniform is used for the staff toilets as a measure to save water. Other measures mentioned by Employer 1 included the placement of catchment tanks, which they use to capture water currently since the rains have returned, and the water captured

from the tanks is also recycled into the staff toilets as a strategy to conserve water. These actions were continued even post the drought period when the municipality had stopped issuing the need to reduce water consumption. Official 2 stated that the drought had changed a lot of people's lifestyles and since then have become more cautious and sustainable towards water and electricity saving.

4.7 Chapter Conclusion

The Bergrivier Municipality needed to keep itself abreast during the drought period. This study assessed the measures the municipality took to achieve this and how these measures influenced employers and the municipality. From the interview findings it is evident that the connections between WEF are visible in different ways from municipality to employer. For the municipality the evidence on the connection between water and energy was seen in the reduction of the revenue from water and electricity consumption. The change of consumption patterns by people within the municipality through saving on water also resulted in a decrease in their electricity consumption. The responses by the municipality to the drought have shaped some of the actions taken by households and employers in reducing and changing their consumption patterns. With households the reduction in electricity usage was an indirect or unconscious action that occurred with a change in behaviour as result of taking up more water conservation actions. The evidence of this will further be discussed in the next chapter (Discussion chapter). The desktop review on the other hand showed that there is not much consideration of these three resources as a whole due to their management under different sectors, although connections in policy management between water and electricity show some form of interaction when it comes to municipal service delivery. The municipality still requires more engagement in inclusive policy making that takes a holistic perspective towards WEF Nexus thinking. All these three resources interplay with each and have direct and indirect influence on the resource's users within the municipality. Therefore, it is important for the separate sectors of water, energy and food (social development) to come together in policy development to ensure that development initiatives focused on one sector do not have a negative impact on the other, rather they both have a positive correlation. This can be seen from the results which revealed how the influence on water interventions set by the municipality had both unintended and direct impacts on consumers consumption patterns and businesses (employers and households).

Chapter 5: Discussion and Conclusion

The aim of this study was to investigate the interlinkages between the WEF Nexus and drought at the local scale and how the municipality understands and assists in enhancing sustainable local development outcomes and drought preparedness.

5.1 Impact and responses to the drought

This section discusses the impacts of the drought on the Bergrivier Municipality and addresses how the interventions undertaken by the local municipality in response to the drought have impacted major employers and households in Velddrif. The section starts off with discussing the drought impacts on the municipality followed by the impacts on the employers and ends of with a section on drought responses, and the influence these responses had on employers and households.

5.1.1 Drought impact on the Municipality

The Bergrivier Municipality as well as the West Coast District as service providers both reported having been most impacted by the drought financially. A drought may result in different impacts on an area through affecting water supply from dams, rivers and other major sources of water (Ding *et al*., 2010; Payus *et al.*, 2020). According to the Bergrivier Municipality Water Service Audit (2016-2017) the drought impacted the availability and supply of bulk water for the municipality and the larger region. The shortage of water because of the drought came with other numerous impacts for the Bergrivier Municipality such as financial impacts due to the change in consumption patterns by their customers. The municipality had advised large water consumers and households to reduce their water consumption drastically. This resulted in large consumers (major employers) and households within the municipality cutting down on their water consumption and ultimately causing a financial water revenue decrease for the municipality. Simpson *et al.* (2019) who looked at the drought impacts on municipal finance of the City of Cape town similarly reported that the drought disrupted the municipality's expenditure and revenue due to households' newly adaptive sustainable practices to water consumption. Simpson *et al.* (2019) also pointed out that the use of alternative water sources by consumers to conserve water also led to the decrease in municipal revenue.

The findings from this study also showed a correlation between the decrease in the consumption of water alongside with electricity. There are many reasons why these might be, for example in a study by Majid *et al.* (2020) stated that when it comes to the water and energy

use connection, water users use higher amounts of energy for cooling and heating of water. Which may explain why the municipality also experienced a decrease in the electricity usage with lesser water consumption. Efficient basic service delivery is essential to ensure the security of WEF Nexus resources. The drought posed a threat to the municipality's capacity to provide basic services such as water, as well as the ability for municipal users to adequately use both water and energy. For others such as farmers and food processing businesses this impacted the ability to produce food according to their normal standards.

5.1.2 Drought impact on the Employer

The Western Cape drought resulted in water shortages that exacerbated municipalities restrictions in water consumptions as dam levels continued to decrease during the drought. For employers such as the Fish Factory technical approaches had to be taken such as the desalination plant construction, which was a huge burden financially for the business as the plant was expensive to run and the produce of fish from desalinated water produced a high salt concentration that posed a health hazard if it would have been consumed. Therefore, the factory for cleaning and other maintenance purposes used desalinated water and for the processing of the fish maintained the use of municipal water but at a lower scale than previously. Other large water intensive businesses such as the ones involved in food processing showed to be greatly affected by the drought period as compared to retail stores that only had issues in relation to increased electricity consumption impacts, which were an indirect contribution from the drought. This was expected as for the food processing employers in the area water plays an important role to their day-to-day operations thus the limitation and restriction on how much water they can use placed a burden on how much they can produce with limited water usage. Whilst for food retailers' electricity rather than water plays an important role for their daily operations. In times of the drought period the Western Cape experienced a decrease in fresh produce because of water scarcity due to the drought (Goudriaan *et al.*, 2019) a lot of fresh produce had to be kept in storage as stated by one of the retail store owners interviewed. The running of numerous refrigerators in the store and as well as load shedding within the municipality posed a challenge for the food retail store.

This study's findings showed less evidence of the impact of drought on WEF Nexus resources interdependencies or trade-offs within the municipality. Although the impact of drought resulting in low water levels did show a connection between the three resources in the agriculture/fisheries sector of the municipality. There is a significant role played by water and

energy in food processing (fish factory). The reliance on water showed an interdependence in the need for water and energy in food processing and motivated them to undertake large scale interventions that affect nexus dynamics. Thus, the less amount of water used, the less electricity required and a reduction in the amount of fish production.

5.1.3 Drought responses

Municipal interventions taken during the drought could be categorized into two which were: 1) trying to maintain water supply during drought conditions and 2) trying to reduce consumer water consumption. This is in accordance with a study from Maggioni (2015) in South California that describes the different approaches that are adopted by water authorities in times of drought for reducing water demand or approaches that involve increasing and maintaining current water supply with initiatives such as the installation of water efficient tools, using prices in form of water rates as a conservation tool and educational campaigns on water saving.

The Bergrivier Municipality took on more voluntary and social approaches as interventions to the drought impacts, to consumers. These responses included awareness campaigns, projects that focused to promote water conservation and the sustainable use of water. Other initiatives involved visiting large water consumers within the municipality encouraging them to reduce their water consumption. Municipality even went further to door-to-door approaches to try to help the less privileged households with high water demand through sending plumbers to fix any leakages that would be found in the household. In a study by Fielding *et al.* (2013) looking into the effectiveness of different voluntary approaches to urban water demand management found that these voluntary approaches showed significant water consumption reduction but with regards to households in the long run, water consumption levels eventually returned from their original levels (Fielding *et al.,* 2013). Although in another study conducted by Matikinca *et al*. (2020) based on interviews conducted with a number of households within the City of Cape Town found that non price interventions had positive impacts on behavioural changes on water consumption on household use activities. The findings of this study in the Bergrivier Municipality showed that the municipal interventions in terms of public awareness and campaigns had a much greater influence than any of their other interventions such as fines for water use reduction during the drought. Both households and employers took initiative towards saving water that the municipality did not see a need to even stricter implement higher water restrictions or tariffs. Other studies from Syme (2000) and Rabe *et al. (*2012) also show the effectiveness of using awareness campaigns as a strategy for reducing water consumption by

users, especially households. One of the respondents during the interview mentioned how it as if user's mind-sets and consumption behaviour had completely been changed towards conserving and sustainably managing their water usage and this in accordance with the study by Syme (2000) who stated that in the long-term public awareness campaigns promote a change in the way of thinking to promote a more conservation mind-set towards water use.

There are limited studies that have taken a focus on evaluating the management of water demand approaches with specifics to bulk water consumption of business or organisations. Most studies tend to take a household or market-based focus (industries and sectors) within a study area. This study assessed businesses/employers within a study area, looking into the influence of drought interventions in reducing water demand. This study found that social, non-monetary and voluntary water demand management strategies put in place by the municipality were effective in reducing the municipalities overall water consumption to the extent of also decreasing the electricity water usage by employers/businesses. Major employers within the municipality reduced their water consumption where partially motivated by the interventions taken by the municipality. Employers heavily dependent on water ended up opting for alternative ways of obtaining and conserving water. These included for the fish factory the installation of a desalination plant and recycling system of water for their staff. Other responses tried to encourage water conservation and sustainable use of water by staff in the workplace such as recycling of laundry water into staff toilets.

In order to try and maintain the supply of water in the municipality also used technical solutions which involved the formation of the water augmentation plan drilling pipes for groundwater abstraction and adding water from springs to join the main municipal water pipelines in order to ensure that there was still water being supplied to consumers from alternative sources other than the dams during the drought period. This aided the municipality in their attempt to ensure continuous water supply when water levels in the dams were extremely low. A report by Shivakoti *et al.* (2019) supports the approach of using groundwater as a response to manage and mitigate drought impacts to secure water supply. The report makes use of examples in Asia where groundwater has been used as a contingency plan to distribute water to households during drought periods and used ground water as storage in times of flooding. This response proved to be efficient for the Bergrivier Municipality as they were able to sustain their supply of water further than the day, they had estimated that the "taps would run dry" referring to the point where there was no longer any water in the dams to supply. Although this response may

be viable for the time being (drought period) but when observed through a WEF Nexus lens, the abstraction of groundwater by the municipality may have implications in the long run on WEF Nexus resources. For example, the energy requirements for groundwater pumping, the depletion of water tables and the impact on ecosystem services and agricultural production. This can be supported by evidence from a study by Mukherji (2020) in India that discusses ground water depletion over the years from ground water extraction to meet the demands for agriculture and the unstainable outcomes this has had on water and energy use. The study further emphasises the importance of including WEF Nexus policies when considering the extraction of groundwater (Mukheji, 2020).

The WCDWS also took on a technical approach towards maintaining water supply through the installation of pumps adjacent to dams to extract the water at low dam levels. Other technical responses to the drought impacts taken by the municipality included the sending of plumbers to fix leaks in poor households; this was an effective plan by the municipality to reduce the loss of water and maintain the current water they had left. According to (Hedden, 2016) most water loss by municipalities in South Africa can be attributed through leaks within the water supply system either by households or faults within large water supply infrastructure.

5.2 WEF Nexus thinking and policy within the Bergrivier Municipality

The study found that in general these three resources are not perceived holistically within the municipality. The above evidence shows that the municipality along with its policies are fully aware of some aspects of the relationship or interdependence that exists amongst these three resources but miss a holistic understanding of how they impact each other. The aspect of food security according to the municipal IDP is specifically tasked to the provincial government. Whilst food security is also impacted at household level when households need to decide whether they use their finite income for cost of water/electricity or food. Hence, trade-offs may occur there or sometimes they may find alternative means to illegally access water and electricity. Which are important WEF Nexus aspects omitted in municipal policy. Nhamo *et al*. (2020) refers to how most sector policies and institutions in local governments within South Africa are set up to function in silos most especially when it comes to approaches to service delivery and social development. This could be one of the main reasons why these three resources are not approached or managed integratively within the municipality as food and aspects of food security are considered as a social development issue. Findings from both IDP

and SDF showed how important the interactions between WEF are for the agricultural sector as water and energy are important for irrigation purposes in crop production (food).

It is important that municipal policies put in place take into consideration the trade-offs and synergies that exist amongst these three resources. Nhamo *et al*. (2020) reflecting on their study of the Sakhiwe Municipality in the Eastern Cape point out that the silo sector-based approach in the management of these three resources often results in policies and institutions that create an imbalance in development initiatives that further exacerbate poor resource use efficiency.

The livelihoods in the Bergrivier Municipality which are centred around agriculture and fish processing sectors are significantly affected by interdependencies between water, energy and food. It is therefore important that the municipality understands key interdependencies of the three resources at various scales and manages them jointly. Nhamo *et al*. (2020:15) emphasise that "[I]n the absence of integration, intentioned sector-based approaches may actually increase the vulnerability of communities and livelihoods due to continued resource degradation and depletion." From the results it is evident that a great priority of municipal development planning policies focuses on improving service delivery through construction of bulk infrastructure. The only way in which service delivery can be sustainable is through the inclusivity and coordination of different sectors as the drought and the use of desalination plants as an alternative water source already place significant implications on the other two resources, hence a system or coordinated approach is required. WEF Nexus thinking in policy planning can be advantageous in formulating development strategies that are resource efficient, sustainable and take into consideration the local livelihoods that depend on these resources (Nhamo *et al.*, 2020).

When evaluating responses from municipal officials regarding the WEF Nexus interconnections, a common response showed water as a central resource and concern. Water was consistently described as an underlying factor for example water and food production, water and energy use consumption. This shows the important role played by water within the municipality as water from the findings seems to also influence energy consumption within the municipality.

Having looked at WEF Nexus literature from global scale to a local level, WEF Nexus literature in this study showed that there is still a gap in the conceptualization of WEF Nexus thinking at

a municipal scale though there is an evident growth in the inclusivity of livelihoods in WEF Nexus research. Key findings from the policy review show a lack of nexus thinking and consideration. This represents a challenge for the municipality, as this hampers informed decision making with regards to future developments and the strengthening the resilience of livelihoods. This lack of integration could have significant implication in terms of future sustainable development but also in relation to preparing and responding effectively to extreme events

Droughts are becoming more frequent as the years pass as seen from literature, the municipality may have managed to set interventions that prevented them from completely running out of water to supply during the 2015-2017 drought but there is still much that must be done with managing the current supply of water in more sustainable ways. In the policy documents and municipal interview findings, there seems to be little mention of the underlying impact of WEF Nexus resources on livelihoods or development concerns on the influence of drought on livelihoods as a result of WEF insecurity. Moving forward there is a need for local policy development that takes a joint and coordinated approach to WEF management. This would benefit the municipality through cost saving from replicating activities in each sector and more focus and priority on strategic goals, as the sectors would cooperate and work on common goals. Furthermore, there is a need for local level policy development and planning to be informed by lessons learnt and insights gained from drought impacts on WEF resources at the local level and household. This can open a way for local people to be included in policy making and increase overall effectiveness of municipal drought preparedness. The interviews with municipality and major employers showed that a three-way relationship existed between municipality, employers and households.

To further elaborate on the statement above on the three-way relationship for example, the municipality played an important role in the management and provision of water and energy. Employers also play an essential role in how households can access or pay for resources such as water, food and electricity in terms of financial capital. Employers provide job opportunities to which people can earn a living through income and sustain their livelihoods. Employers also form part of the resource users that share water and energy resources with households within a municipality. The study showed how interventions taken by the municipalities in response to drought influences not only employers and ultimately people's water consumptions but also in some instances their energy and food consumption patterns. This was seen through the change

in consumer behaviour after water saving measures were encouraged by the municipality. Findings also showed that as consumers reduced their water usage, their electricity consumption also decreased. The municipal officials stated that during the drought period they also noted a decrease in electricity revenue. This was likely due to some household activities such as heating of water being reduced. In the municipality farmers and food processing businesses were impacted by the need to reduce their water consumption. To some extent their ability to produce food according to their normal standards was constricted. For example, the fish processing factory could no longer consume their standard amounts of water, hence they opted for desalinated water. Interviews showed that most of the responses taken by the municipality focused more on trying to reduce the consumption of water by consumers through raising awareness of the potential risks the drought could have. The findings of this study could lead to further research on, changes in policy/practices where WEF Nexus thinking is transitioned from a theoretical concept to a development policy and disaster risk management guiding tool. This could be beneficial in formulating efficient development policies and disaster risks plans that are sustainable and incorporate WEF Nexus security and livelihoods.

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Appendix 1A: Interactions of water, energy and food within the Bergrivier Municipality

These documents listed below were best suited to provide information in order to understand the municipalities socio-economic status and asses the interlinks of water, energy and food in the Bergriver Municipality.

6. Bergrivier IDP 2017-2022
7. Pengelly, C., Seyler, H., Fordyce, N., Janse van Vuuren, P., van der Walt, M., van Zyl, H. & Kinghorn, J. 2017. Managing Water as a Constraint to Development with Decision-Support Tools That Promote Integrated Planning: The Case of the Berg Water Management Area. Water Research Comission. (Report)
8. Midgley, S., New, M., Spelman, S.S. and Parker, K., 2014. The Food-Energy-Water-Land-Biodiversity (FEWLB) Nexus and Local Economic Development in the Berg River Catchment: Framework and Description. Draft research report for submission to the Foreign and Commonwealth Office, South Africa.
    - Methner, N., Midgley, S., Price, P., Ningi, T., Nxumalo, N., Rebelo, A., Stuart-Hill, S., Zhou, L., Mjanyelwa, V., Taruvinga, A. 2021. Exploring the evidence of water-energy-food nexus linkages to sustainable local livelihoods and wellbeing in South Africa. Water Research Commission. (Report)

    - Hulley, S.M., 2015. The food-energy-water-land-biodiversity (FEWLB) nexus through the lens of the local level: an agricultural case study (Master's thesis, University of Cape Town).

Appendix 1B: Municipal impacts of the 2015-2015 drought

Drought Reports

This documents provided an understanding of the extent of vulnerability that resulted from the drought in the study area.

- Western Cape Department of Agriculture, WDoA. 2017 Informing the Western Cape agricultural sector on the 2015-2017 drought. (Report)
- Goudriaan, R. *et al.* 2019 'What was the impact of the 2017/18 drought? A case study using Fruit Look data' (Journal Article)
- Survey – QLFS Q3: 2017 | Statistics South Africa, (Report)
- Pienaar, L. 2017. Response to a question by the Standing Committee. Western Cape Department of Agriculture, Agricultural Economic Services. (Report)
- Green Cape 2018. Water Outlook 2018 Report. https://www.greencape.co.za/assets/Uploads/Water-Outlook-September-2018.pdf.
- Bergrivier Municipality 2017/18 Water Service Audit Report. http://www.bergmun.org.za/sites/default/files/documents/Bergrivier%20Water%20Services%20Audit%202016-2017.pdf

Policy analysis documents

- Bergriver Municipality IDP 2017-2022 and 2012-2017

i) Climate Change Adaptation Plan 2014

- Information on drought, renewable energy and vulnerable sectors in the municipality

ii) Disaster Risk Management Plan 2015

- Information on drought and drought interventions

iii) Water Service Development Plan 2016-2017

- Water supply and user access in the municipality

Spatial Development Framework

Appendix B: Consent Form

DEPARTMENT OF ENVIRONMENTAL AND GEOGRAPHICAL SCIENCE

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Informed Voluntary Consent to Participate in Research Study

Project Title: **Exploring the Water-Energy-Food Nexus Linkages to Livelihoods and the recent drought: a case of Velddrift**

Invitation to participate; You are invited to participate in a research study conducted with Western Cape provincial and Bergriver Municipal officials, Velddrif household members and employers. The study aims to:

- To explore the relationship between water, energy, food and livelihoods in Velddrif
- To better understand the relationship between water-energy-food nexus, livelihoods and drought

I believe that your experience would be a valuable source of information, and hope that by participating you may gain useful knowledge.

Procedures: During this study, I will ask you to participate in a focus group discussion. This will consist of a set of questions that you will be asked to respond to and will be administered by the researcher. A group will consist of 6-8 individuals from the Velddrif community. Focus group questions will be based on the experiences and impacts during drought may have had on the household members water, energy, food use and affordability and their livelihood.

Recording: I may take an record audio of our conversations as part of the study. These will be used solely for the purposes of transcription and data analysis. If you object to this, please indicate below.

Risks: There are no potentially harmful risks related to your participation in this study.

Feedback: You will receive feedback about the results of this research in the form of a workshop and feed back meeting with the community.

Disclaimer/Withdrawal: Your participation is completely voluntary; you may refuse to participate, and you may withdraw at any time without having to state a reason and without any prejudice or penalty against you. Should you choose to withdraw, the researcher commits not to use any of the information

you have provided without your signed consent. Note that the researcher may also withdraw you from the study at any time.

Confidentiality: if you wish to remain anonymous the researcher will not identify you by name in any reports using the information obtained from the interview. All information collected in this study will be kept private.

What signing this form means: By signing this consents form, you agree to participate in this research study. The aim, procedures to be used, as well as the potential risks and benefits of your participation have been explained verbally to you in detail, using this form. Refusal to participate in or withdrawal from this study at any time will have no effect on you in any way. You are free to contact me, to ask questions or request further information, at any time during this research.

I agree to participate in this research (tick one box)	☐ Yes	☐ No	_____ (Initials)
I agree to be photographed	☐ Yes	☐ No	_____ (Initials)
I agree to be audio-recorded	☐ Yes	☐ No	_____ (Initials)

_____	_____	_____
Name of Participant	Signature of Participant	Date
_____	_____	_____
Name of Researcher	Signature of Researcher	Date

DEPARTMENT OF ENVIRONMENTAL AND GEOGRAPHICAL SCIENCE

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Ingeligte Vrywillige Toestemmig Om aan navorningstudie deel te neem

Projek Titel: Verkenning van die verband tussen water-energie en voedesel NEXUS, aan die lewenesbestaan op die onlangse droogte in die geval van Velddrif

Uitnodiging om deel te neem: U word uitgenooi om deel te neem aan die navordsing studie wat met die Wes-Kaap en die Bergrivier Munisipale amptenare gedoen word as ook lede van die Velddrif – huishoudelike lede en wekgewers.

Die doel van die studie:

- Om die verband tussen water-energie, voedsel en lewensbetsaan in Velddrif te ondersoek.
- Om die verband tusen water-enegrie, voedsel Nexus, lewensbetaan en droogte.

Ek glo dat u ‘n waardevolle bron van inligting sal wees tydens die ondersoek, en ek hoop dat u deelname u kan nuttige kennis opdoen.

Prosedures: Tydens die studei sal ek u vra om deel te neem aan die fokusgroepbespreking. Dits al betsaan uit ‘n stel vra waarop u gevrae sal word om te beantwoord en wat deur die navorser geadministreer sal word. ‘N groep bestaan uit 6-8 individuele persone uit die Velddrif gemeenskap. Fokusgroepvrae sal gebaseer wees op die ervaaring en die gevolge wat die droogte op die huishoudelike lede se water, energie, voedselverbuik, bekostigbaarhied en hul lewensbetaan gehad het.

Opname: Ek mag dalk ‘n opname van ons gespreke maak as deel van my studie. Dit sal gebruik word uitsluitlik vir die doeleindes van transkripsie en data-analise. As u hierteen beswar maak, dui dit hieronder aan.

Risiko’s: Daar is geen potensiële skadelike risiko’s verbonde aan u deelname aand hierdie studie nie.

Terugvoer: U sal terugvoering ontvang oor die resultate van hierdie navoring in die vorm van ‘n werkswinkel en terugvoering met die gemeenskap.

Vrywaring/Ontrekking: U deelname is heeltemal vrywillig, u mag weier om deel te neem en u mag ten enige tyd ontrek sonder om deel ‘n rede of endge vooroordele hoef te stel. As u kies Om te ontrek, verdind u die navorser om nie een van die inligting wat u verskaf het sonder u ondertekende

toestemming bloot te stel nie. Let daarop dat die navorser di took mag doen Om u te ontrek tydens die navorsing studie.

Vertroulikheid: As u anoniem wil bly, sal die navorser u nie met ‘n naam identifiseer tydens verslae van gebruik gemaak word van die verkyde inligting tydens die onderhoud. Alle inligting wat tydens die studie versamel is, sal privaat gehou/versamel word.

Wat beteken die ondertekening van hierdie vorm: As u hierdie toestemmingvorm onderteken, sten u in om aan hierdie navorsing deel te neem. Die doel, procedure wat gebruik gaan word, asook die potensiële risiko’s en voordele van u deelname word mondelings aan u verduidelik met behulp van hierdie vorm. Weiering van deelname of ontrekking uit hierdie studie sal ter enige tyd geen uitwerking op u hê nie. U is vry om my te kontak om vrae te vrae gedurende hierdie navorsing.

Ek stem in om deel te neem in die ondersoek (tik een af (Initials) ☐ Yes ☐ No _____

Ek stem in om af te neem te word ☐ Yes ☐ No_____(Initials)

Ek stem in om opgeneem te word ☐ Yes ☐ No _____ (Initials)

_____	_____	_____
Naam van Deelnemer	Handtekening van Deelnemer	Datum

_____	_____	_____
Naam van die Navorser	Handtekening van Navorser	Datum

Appendix C: Interview Guide

Velddrif Mayor and Bergrivier Municipality Mayor

- Where most people are employed

1. What is the role of municipality in terms of water and energy provision and are of any challenges pertaining to these?
2. Are there any neighbourhoods where households struggle with food security (including nutrition and affordability)?
3. Are you aware of any challenges related to the interlinkages between water, energy and/or food at municipal level?
4. What were the impacts of the drought to the municipality? (and Velddrif)
5. Were there any visible impacts of the drought on households in Velddrif?
6. Besides the issues in water supply during the drought, what other challenges did Velddrif experience. These could relate to energy use or the provision of food or employment opportunities?
7. Did the municipality put any strategies in place during the drought to try and deal with the impacts in Velddrif
    - How did the strategies put in place by municipality influence households and key employers?
8. Are there any lessons in relation to the drought you might have learnt as a municipality?
9. Which sectors of employment in the Berg Municipality were greatly affected by the drought?
    - In Velddrif which were key employers greatly affected by the drought
10. Why do you think these sectors were greatly impacted?
11. Who are the key employers within Velddrif?
12. Did responses taken by the key/major employer to the drought have an influence or impact on the municipality?
13. How did the municipality deal with trade-offs between service delivery to industry over delivery to households during the drought period?
14. When looking at the livelihoods within Velddrif have you noted any changes from pre and post drought period (poverty, household expenditure, employment)

West Coast District Municipality

1. What is the role of the West Coast District (WCD) Municipality in provision to water and energy?
2. How has the drought impacted the fulfilment of this role?
3. Did the drought cause any changes in terms of the availability, supply and affordability of water within the District?
4. Were there any strategies put in place during the drought to try and deal with the impacts?
   - How did these strategies affect the Bergrivier Municipality Velddrif
   - Where these strategies effective?
5. Were there other impacts faced by the West Coast District other than the lack of water during the drought?
6. How did the WCD municipality deal with competing demands in water provision for industrial, domestic and agricultural users?

West Coast Disaster Risk Management

- Agriculture
- Impacts on drought on farmers
- What adaptation or mitigations plans have been put in place for drought
- Available documentation
- Most affected areas

1. What is the role of West Coast District Municipality in disaster risk management?
2. Which areas within the Berg Municipality experienced the worse impacts of the drought and why?
3. Which sectors of employment were impacted by the drought in the West Coast District and specifically within the Berg Municipality?
4. What interventions did you take during the drought to mitigate the drought impacts?
5. Did these responses have any influence in the District Municipality, Bergrivier municipality and households in Velddrif?
6. did interactions between water, energy and food become apparent, at what scale household, sectoral / municipal?

7. As a Disaster Risk Management organisation what lessons did you learn from the drought?

Foods Retail/Fish Factory

1. How many people do you have employed from Velddrif? (number of permanent and contract workers)
2. In terms managing your daily operations what are you most concerned about
    - Energy security (affordability and availability)
    - Water security (in terms of supply and affordability)
    - Food security (supply quantity and quality of products and products affordability)

Please explain why?

3. Where do the interactions between water-energy-food become most visible for a retail store?
4. To what extent does your food supply depend on local production? (Are you highly dependent on fresh produce from the region?)
5. How did the recent drought that hit the Western Cape and other parts of South Africa affect your food supply? (looking at quality, quantity of produce and price)
6. What measure did you take to respond to these impacts? (Drought impacts from the response above)
7. How else did the recent drought affect operations of the retail store? (Besides those mentioned above)
8. For example, did the recent drought impact you as a retail store in terms of water supply and consumption?
9. Have you had to pay more for water and electricity than previously (prior to drought

Or

Did you have to make any trade-offs in your consumption such as having to cut down your electricity expenses to cover your water bill or reduce the number of electrical machinery functioning at the same time?

10. Did the measures you took to mitigate the drought affect your employees? (If yes how)
11. Did the measures you took to mitigate drought affect the residents of Velddrif and surroundings, who shop at your retail store?
12. Did the municipality enforce any water restrictions and how did this impact the operation of your retail store?

13. Did the municipality enforce any other restrictions besides that of water during the drought?
14. Are you of the opinion that the municipality took the right interventions to mitigate the drought? (What could've been done better)
15. Are there any lessons you might have learnt during the drought and how have you incorporated these lessons in your operations?