

**Putting nature back in the water, energy, and food
nexus: Exploring opportunities to improve local
livelihoods in the Kavango East Region in Namibia.**

by

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Declaration

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Abstract

Many communities in the Kavango East Region of Namibia are dependent on ecosystem services for their livelihoods and wellbeing through several important relationships between ecosystem processes and people. Should these ecosystems be degraded and natural resources over-exploited, the livelihoods and wellbeing of these communities could be at risk. Traditional silo-ed development policies, which are often one-dimensional and non-consultative, are a major barrier for implementing interventions intended to enhance livelihoods. The lack of clean water, energy and sufficient food for many households necessitate more systems-based approaches that look for interactions and relationships between food, water, and energy systems.

The livelihoods of rural communities like those in Mayana and Uvhungu-vhungu in the Kavango East Region of Namibia can benefit from interventions that put the emphasis on healthy ecosystems for ecosystem services that underpin many livelihoods for people living in the region. The main objective of this study was to explore whether a nexus approach could help to better understand critical water, energy and food interdependencies in the livelihood systems of the Kavango East Region. The study used a mixed-methods approach focussing on two villages: Mayana and Uvhungu-vhungu in the Kavango East Region of Namibia to explore food-water and energy interconnections. The mixed methods approach allowed the researcher to collect both qualitative and quantitative data. The study started with a document analysis and expert workshop to develop a draft conceptual model of the social-ecological system in question. Telephonic interviews, online surveys and key informant interviews were used to collect data, and a total of thirty-two respondents took part in the study. The study applied content and thematic analysis using deductive coding to analyse major themes from interviews and descriptive statistics to summarise quantitative data from surveys. The findings from the interviews and survey were used to refine the conceptual social-ecological system model of the study sites to understand some of the key interactions and relationships.

The study found that the residents of the two villages are heavily dependent on the river, fertile land, and rich biodiversity for their daily livelihoods. Respondents indicated that some of the residents in the two villages are poor and do not have formal employment. Most of the residents use contaminated water directly from the river which is often far from their homesteads. Wood is the main source of energy in the two villages but has become scarce. Major interventions in the past were mostly focused on food production and did not sufficiently enhance livelihoods, while small-scale farmers lack support. Issues of inequity were found amongst residents of the two villages in terms of distributional and recognitional equity such as lack of basic services and infrastructure, lack of vocational training, lack of financial capital, limited access to the river, roles for men and women in

decision-making and ownership (land and livestock), as well as a lack of consultation in relations to interventions by the government and NGOs.

The study concludes that a nexus approach could be useful for understanding how to enhance development interventions. More importantly, the role of ecosystems and nature needs to be integrated into the nexus given the fundamental role nature plays in supporting local livelihoods while making sure that the environment can support future generations. The study further concludes that it is imperative to consult the residents of the two villages before implementing any new project in future, and any intervention should consider who might benefit or be further burdened by any decision.

Opsomming

In die Kanvango-Oos streek van Namibië is daar landelike gemeenskappe wat volkome afhanklik van ekosisteem-dienste is vir hul oorlewing en bestaan. Indien hierdie ekosisteme verwaarloos word en afgegradeer of die natuurlike hulpbronne uitgebuit word, plaas dit hierdie gemeenskappe en mense in 'n weerlose en benadeelde posisie. Tradisionele silo-beleide, wat meestal een-dimensioneel en nie gunstig vir konsultasie is nie, is 'n kritiese struikelblok in die weg van die verbetering en groei van lewensnoodsaaklike ingrypings.

Die volslae gebrek aan skoon water, energie en genoegsame voedsel vir huisgesinne dui op die noodsaaklikheid daarvan om 'n sistemiese benadering te gebruik om die verhoudings en interaksies in die genoemde drie sektore volledig te begryp. Dit kan waarskynlik sekere geleenthede ontsluit vir mense en ekosisteme. Die lewens van afgeleë plattelandse gemeenskappe soos Mayana en Uvhungu-vhungu kan dus ook baat by ingrepe wat die klem op gesonde ekosisteme vir ekosisteemvoorsiening verskaf. Die hoof-doelwit van die studie is om die ekosisteem se welstand te eksploreer, veral met 'n neksus-benadering wat insig kan verleen rondom kritiese water, energie en kosafhanklikheid in die lewens-sisteme van die Kavango Oos-streek. Die studie het van 'n gemengde-navorsingsbenadering gebruik gemaak. Die genoemde dorpie van Mayana en Uvhungu-vhungu in die Kavango-Oos streek is as gevallestudie gebruik om die kos-water-energie-verbintenis te ondersoek. Dit het die navorser in staat gestel om beide kwalitatiewe en kwantitatiewe data te versamel. Telefoniese onderhoude, aanlyn-vraelyste en sleutel-informante is gebruik as data-insamelingstegnieke. Twee-en-dertig respondente het aan die studie deelgeneem. Die studie het inhouds- en tematiese ontleding met deduktiewe kodering gebruik om die hoofemas van onderhoude en beskrywende statistieke te isoleer vir kwalitatiewe data. Die bevindings van die dokument-ondersoek, die onderhoude en vraelys is alles aangewend om 'n konseptuele sosio-ekologiese sisteem-kaart te ontwikkel sodat die sleutel-interaksies en -verhoudings volledig begryp kon word.

Die studie het bevind dat die inwoners van die twee dorpie swaar steun op die rivier, goeie grond, en ryk biodiversiteit vir hulle daaglikse lewensbehoud. Die meeste inwoners is brandarm en het geen formele werk nie. Die meeste van hulle gebruik gekontameneerde water direk uit die rivier wat ver van hulle wonings is. Hout is die hoofsaaklike bron van energie in die twee dorpie, maar het ook begin skaars raak. Groot vorige intervensies in die verlede was meestal op voedselproduksie gefokus wat nie werklik bygedra het tot lewensbehoud nie, terwyl kleinboere geen ondersteuning het nie. Ongelykhede bestaan in terme van geleenthede soos grondbesit en gesag, tov rolle vir mans

en vroue, sowel as 'n volslae gebrek rondom konsultasie met betrekking tot intervensies deur die regering en NROs.

Die studie vorm die gevolgtrekking dat 'n nexus benadering suksesvol kan wees om ontwikkelingsingrepe te ondersteun. Die belangrikste is dat die rol van ekosisteme en die natuur ingesluit moet word in die nexus, gegewe die fundamentele rol wat die natuur in die instandhouding van lewensmiddele speel, en so seker te maak dat die omgewing die toekomstige geslagte kan steun.

Die studie sluit af met die herinnering dat dit krities belangrik is om die inwoners van die twee dorpie te betrek alvorens enige new projekte in die toekoms aangepak word – en daar moet ernstig besin word oor wie hierby sal baat en wie sal ly.

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List of Acronyms and Abbreviations

AAA	Affirmative Action Act
Agribusdev	Agriculture Business Development
CA	Conservative Agriculture
CAS	Complex Adaptive Systems
CBO	Community Based Organisation
CRIDF	Climate Resilient Infrastructure Development Fund
CST	Centre for Sustainability Transitions
DAPP	Development Assistance from People to People
DESA	Department of Economic and Social Affairs
EIA	Environmental Impact Assessment
EIF	Environmental Investment Fund
ES	Ecosystem Services
EU	European Union
FEEDME	Food Estimation and Export for Diet and Malnutrition Evaluation
GBV	Gender-Based Violence
GDP	Gross Domestic Product
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
GW	Gigawatt
HDR	Human Development Report
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Service
IPCC	Intergovernmental Panel on Climate Change
KIFI	Kamutjonga Inland Fisheries Institute
MA	Millennium Ecosystem Assessment

MAWF	Ministry of Agriculture, Water, and Forestry
MFMR	Ministry of Fisheries and Marine Resources
MLR	Ministry of Lands and Resettlement
MPLA	People’s Movement for the Liberation of Angola
NAMPOWER	Namibia Power Corporation
NAMWATER	Namibia Water Corporation
NDC	Namibia Development Corporation
NDP	National Development Plan
NGO	Non-Governmental Organisation
NGP	National Gender Policy
NGPA	National Gender Policy of Action
NNF	Namibia Nature Foundation
NPC	National Planning Commission
NSA	Namibia Statistics Agency
OKACOM	Permanent Okavango River Basin Water Commission Strategic Programme
REC	Research Ethics Committee
RSBER	Social, Behavioural, and Education Research
RWP	Resilient Waters Program
SADC	Southern African Development Community
SAREP	Southern Africa Regional Environmental Programme
SDG	Sustainable Development Goals
SES	Social-Ecological Systems
SIA	Social Impact Assessment
SIDA	Swedish International Development Cooperation Agency
SSCF	Small Scale Commercial Farming
UFF-Finland	U-landshjälp från Folk till Folk i Finland sr

UGSIP	Uvhungu-vhungu Green Scheme Irrigation Project
UNEP	United Nations Environmental Programme
UNITA	National Union for the Total Independence of Angola
USAID	United States Agency for International Development
USD	United States Dollar
WASH	Water, Sanitation, and Hygiene
WEF	Water, Energy and Food

Definition of Terms

Term	Definition	Reference
Adaptation	Ability of a system, and entity, or a group to respond to change by making incremental adjustments to maintain overall structural and function.	Folke et al., 2018, www.wayfinder.earth .
Anthropocene	An era in which human activities are dominating and having an influence of the environment and climate change. Anthropocene is about destruction of ecosystems and raising inequities.	Haraway (2015), Anthropocene, Capitalocene, Plantationocene, Chthulucene: Making Kin. <i>Environmental Humanities</i> , vol. 6, 2015, pp. 159-165 www.environmentalhumanities.org
Complex adaptive systems	Social-ecological systems that are seen as complex adaptive because they are interlinked and inseparable. A CAS perspective sees structures as 'becoming' rather than 'being', they are dynamic and require multi-dimensional approaches.	Preiser, R. <i>et al.</i> 2018. 'Social-ecological systems as complex adaptive systems: Organizing principles for advancing research methods and approaches', <i>Ecology and Society</i> , 23(4).
Ecosystem service	The contributions that humans derive from nature in order to sustain life. Ecosystem services are divided into, supporting, provisioning, regulating, and cultural ecosystem services.	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services for Africa (IPBES). 2018, ' <i>The Assessment Report on Land Degradation and Restoration</i> '. In: Montanarella, L., Scholes, R., & Brainich, A., eds.
Equity	Ensuring that everyone has what they need for wellbeing in a given context, implying more for those who need it. Some equity	Leach, M., Reyers, B., Bai, X., Brondizio, Eduardo S., <i>et al.</i> 2018. 'Equity and

	dimensions are recognitional, distributional and procedural.	sustainability in the Anthropocene: A social-ecological systems perspective on their intertwined futures', <i>Global Sustainability</i> , 1.
Livelihood	A livelihood is made up of the capabilities, natural materials, human resources, and activities needed to live. A livelihood is sustainable deal with and handle tresses and shocks, retain its capabilities and assets, while maintaining a healthy ecosystem.	Scoones, I. 1998. 'Sustainable rural livelihoods: a framework for analysis.
Nexus	A valuable connection between systems or group of things.	Cambridge Dictionary. https://dictionary.cambridge.org/dictionary/english/nexus
Resilience	An ability of a social ecological system to navigate change and maintain a desired set of ecosystem services against shocks and stresses.	Biggs, R. <i>et al.</i> 2012. <i>Toward Principles for Enhancing the Resilience of Ecosystem Services</i> . Annual Rev.
Social-ecological system	A combined system of humans and nature, whereby they are constantly interacting with each other.	www.wayfinder.earth .
Stakeholder	A group or a person that has vested interests in a system and most likely to be affected by what happens within the system or effect changes within the system.	www.wayfinder.earth .
Sustainable development	The ability of the current generation to operate within planetary boundaries so that they can meet their current needs without compromising that of the future generations.	www.wayfinder.earth .
Systems thinking	Systems thinking is interested on how elements within a system interact with each other in an integrated and holistic way to generate overall patterns.	www.wayfinder.earth .

Vulnerability	The likelihood at which an exposure to hazard or stress can cause harm on a person, group, or a system.	www.wayfinder.earth .
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Chapter 1: Introduction

1.1 Introduction

The aim of the United Nations (UN)'s 17 Sustainable Development Goals (SDGs) are to achieve a more sustainable future for all by the year 2030 through a unified implementation approach (Sachs *et al.* 2019). While many stakeholders hold diverse perspectives on how to implement the strategies to achieve the SDGs, Sachs *et al.* (2019: 805) argue that individual countries must design their own strategies, which need to be aligned within local realities, and supported by public investment, civil society, enabling national environments and associated multi-sectoral regulations. At the same time, the implementation of the SDGs need to promote fairness and equity regardless of gender, race, social status and other social categories in order to 'leave no one behind' (Sachs *et al.*, 2019:808).

Water, energy, and food consumption are expected to increase in the next decades due to increasing populations and rapid globalisation (Aboelnga *et al.*, 2018; Stevens & Gallagher, 2015; FAO, 2014). An increase in the demand for one of the three resources has a direct impact on the other two, because they are interlinked, and interdependent (Aboelnga *et al.*, 2018). The increased use of water and pollution often associated with intensive farming practices requires energy for purification, with food production using up to 30 percent of global energy (FAO, 2014; McNamara *et al.*, 2018). Moreover, 70 percent of global water consumption is used in agriculture and energy generation activities (Stevens & Gallagher, 2015; UNEP, 2019). Thus, unchecked consumption of these three resources will create insecurity in one or both of the other resources. Due to this, the three resources and associated sectors should be considered as interconnected parts of a coupled system, which can be facilitated through "*nexus thinking*" approaches (Stevens & Gallagher, 2015:3).

McNamara *et al.* (2018) define the water, energy, and food (WEF) Nexus approach as a way to describe complex relationships between water, energy, and food. It aims for holistic and coordinated resource management that accounts for interdependencies among elements (Aboelnga *et al.*, 2018; McNamara *et al.*, 2018; Mohtar, 2013). Imperatively, the WEF Nexus approach facilitates the understanding and management of trade-offs within dimensions of the nexus in order to move away from pursuits of individuals goals (McNamara *et al.*, 2018).

A WEF Nexus approach is important because the three resources are highly interlinked, and the demand for them keeps increasing due to population growth and the impacts of climate and other land-use changes (Juvonen, 2015). Meeting the needs of growing populations within natural resource constraints strongly depends on how issues related to food, water and energy are dealt with holistically. Therefore, a nexus approach aligns with a social-ecological systems approach that focuses on the interactions between social and ecological systems and the associated management of ecosystems, livelihoods and the inherent complexities of these relationships (Juvonen, 2015).

Many approaches using a nexus-based framing are water-centred and promoted by water disciplines and institutions (Juvonen, 2015). As it will be discussed in the next sections, this thesis focuses on the management of transboundary resources, in this case, water, as it connects and relates to other resources and underpins livelihood options. Aboelnga *et al* (2018) asserts that water is central to the WEF Nexus because it is a basic human need and critical for food production and the production of alternative and clean energy through hydropower. However, while there are clear interconnections between water, food and energy systems, the governance of these systems often occurs in silo-ed sectors, thus there is a need for the institutions governing these systems to be better aligned, especially in terms of policies regarding the use, allocation and trade-offs associated with these resources (Aboelnga *et al.*, 2018).

About 60 percent of people in Southern Africa Development Community (SADC) reside in rural areas, are heavily reliant on rain-fed agriculture, and face challenges of access to clean water and energy (Aboelnga *et al.*, 2018). Notably, only 10 percent of power efforts rely on engines for agricultural activities in Sub-Saharan Africa (Aboelnga *et al.*, 2018). In order to increase efficiency in farming practices, for example in smallholder farming practices, more energy is required (Stevens & Gallagher, 2015). The latter authors emphasise that animal manure can provide biogas which is a good source of energy at no extra cost, as well as biomass which is a good source of nutrition for plants. Yet, these animals can only continue supplying manure if there is adequate rainfall to grow the grazing land.

1.2 Background

Subsistence farming remains a major activity in rural Namibia as households rely on it for their livelihood in addition to direct harvesting and use of natural resources. About 22 percent of residents in the Namibia are reliant on rain-fed agriculture, 75 percent rely on fuelwood for cooking and heating, while 14 per cent have no access to safe drinking water (NSA, 2016). The Kavango East Region is experiencing challenges of rapid urbanisation, high unemployment rates (48 percent of the population), poor sanitation (only 37 percent of the population have access to toilet facilities) (NSA, 2016), insufficient roads which means poor access to hospitals and services, and a Gini coefficient of 0.303 (OPM, 2018). As a result, the Kavango East Region of Namibia has been identified as a development priority in the Permanent Okavango River Basin Water Commission Strategic Action Programme (OKACOM SAP) and the Namibia Development Plan 5 (NDP5).

The comprehension of the interdependencies between food, water and energy systems are crucial for understanding how people rely on ecosystems for livelihoods in Kavango East and how development interventions focusing on one of these systems alone, might have unintended negative impacts on the other systems. Large-scale irrigation projects planned in the Kavango East Region (such as irrigation linked to the construction of a dam) may create future employment possibilities,

but this will also directly affect freshwater, fish, wild animals, and people who live along the river in many ways. Such projects also have a direct impact on energy needs and food production.

This research study was part of the USAID-funded Resilient Waters Project (RWP) which is implemented in the Okavango and Limpopo River Basins. The goal of the five-year (2018-2023) RWP is to build more resilient and water-secure Southern African communities and ecosystems through the improved management of transboundary natural resources and increased access to safe drinking water and sanitation services.

1.3 Problem statement

Livelihood activities are affected by many factors including unsustainable use of natural resources, climate change, and silo-ed policies and interventions. Livelihood activities are often discussed in nexus literature; however, few studies address the effect of different livelihood strategies and options on each other within these nexuses, and how ecosystems and ecosystem services underpin many of these livelihood opportunities (Aboelnga *et al.*, 2018). Given the urgency to diversify livelihoods and increase resilience, it is crucial to understand how livelihood options enhance or obstruct one another within complex adaptive systems (CAS). Although there have been several interventions linked to irrigation projects by the government and NGOs in the Kavango East Region, they have in essence failed to improve livelihoods of many of the residents by not creating enough employment opportunities or enhancing food security as intended, because the majority of community members still rely on state food relief, mostly during drought seasons (NSA, 2016).

This research is focused on the exploration of livelihood options in two villages – Mayana and Uvhungu-vhungu – of the Rundu Rural Constituency to understand these livelihood options' connection to water, energy and food as well as investigating the interactions between these three resources and how such interactions affect livelihood and human wellbeing.

1.4 Research objective and research questions

The research objective of this project is to explore whether a nexus approach can help to better understand critical water, energy, and food interdependencies in the livelihood systems of the Kavango East Region of Namibia in order to develop recommendations and response options for enhancing livelihoods in the area.

1.4.1 Primary research question

The research question driving this study is approached through a series of interlinked questions.

The primary research questions are:

What are the main livelihood activities connected to water, energy, and food for communities in the Kavango East Region of Namibia? How do these livelihood activities interact with existing interventions to enhance people's lives? How can future intervention strategies for improving livelihoods be more effective?

1.4.2. Secondary research questions

1. What factors affect livelihoods in the region and what coping strategies do households use for livelihood improvement?
2. What interventions are made by governments, NGOs, and other factors and how have these interventions enhanced livelihood?
3. Who are the winners and/or losers from existing interventions?

1.5 Rationale for the study

Most of the people of the Kavango East Region in Namibia heavily depend on shared grazing land, freshwater, infrastructures, and shared knowledge or their survival. The knowledge derived from understanding local livelihood options and strategies is necessary for this research, because it will bring clarity on the use of ecosystem services such as water (drinking, food production, and energy), forests (fuelwood) and land (crop and animal farming) in Mayana and Uvhungu-vhungu villages. Economic activities and livelihoods in the East Kavango Region are reliant on water (NSA, 2016), such as through irrigation projects, tourism, craft, and fishing and thus make this region an ideal area to explore the interdependencies of water, energy, and food systems, and how these relationships can be better understood through using a nexus-based approach.

The challenges facing communities in this region require an approach that acknowledges the complexities of how people benefit from and impact their surrounding environment. Water is used to produce food and provide other livelihood options while energy is required for food production, water delivery and purification and for other economic activities. The three sectors encompassing water, food and energy constantly interact with each other, which means that activities in one sector have a direct effect on one or two other sectors. Looking at this interaction from a social-ecological systems perspective, means finding a balance between interconnected social, economic, and environmental dimensions of sustainability (Juvonen, 2015). Understanding the interdependencies between food, water, and energy systems by means of a nexus approach can be beneficial for informing decisions, identifying research gaps, and making recommendations for future research (Aboelnga *et al.*, 2018; Juvonen, 2015).

The two villages Uvhungu-vhungu and Mayana were chosen for this study because they offer a wide range of livelihood activities connected to the river, including an irrigation project, fishing, and subsistence farming activities. Thus, this project seeks to identify possible trade-offs and challenges that may limit equitable sustainable development and the attainment of sustainable livelihood opportunities. This research will also contribute to the limited literature related to the WEF Nexus in Namibia and enable a deeper understanding of what livelihood interventions might be possible that can deliver multiple co-benefits.

1.6 Delimitations of the study

This research is limited to the exploration into the interaction and interrelationships within the water, energy, and food (WEF) Nexus in the Kavango East Region. The research was done in the villages of Uvhungu-vhungu and Mayana of the Kavango East Region in the Rundu Rural Constituency. The reasons for their selection are because they are situated along the shore of the Okavango River and are within the hotspots of the research funders' focus area. The two villages offer a wide range of livelihood options that are heavily dependent on water from the Okavango River.

This study has been burdened by numerous restrictions. The methodology of the study had to be altered due to the covid-19 pandemic. As such, the researcher was unable to collect data in person from the study sites, instead had to use alternative methods such as telephone and online surveys. Added to that, the language barrier was also found to be one of the limitations to this study because the researcher found it challenging to comprehend the vernacular language (Shambyu) which is widely spoken in the two villages of Uvhungu-vhungu and Mayana. A translator was used but this still affected the interpretation of certain issues (such as translating key English words into the local language).

1.7 Research methodology and design

This research used a nexus approach to better understand key relationships and interconnections between different food, water and energy dimensions in order to understand what opportunities might exist for the improved and sustained management of resources and avoidance of related risks (such as the exploitation of resources) (Mohtar, 2013:1). A Nexus approach defines interconnections within water, energy, and food resources in order to identify a unified way of managing these resources for improving policies and creating greater knowledge and awareness of the interdependencies (Aboelnga *et al*, 2018; GIZ, 2018; Mohtar, 2013). The researcher made use of a mixed-methods approach by exploring the interactions between water, energy and food systems, by looking at both trade-offs and synergies of livelihood activities informed by a case study research design. The mixed-methods approach combined both quantitative and qualitative data within a single project (Bryan *et al.*, 2016:62). The data was then analysed and summarised using thematic

analysis, descriptive statistics, and the development of a conceptual social-ecological systems map. The research design and methodology are outlined in more detail in Chapter 3.

1.8 Chapter outline

This thesis uses the following six (6) chapters which are summarised below.

Table 1.1: Chapters of the thesis

Chapter	Description
Chapter 1	<u>Introduction:</u> This chapter introduces the research, provides a background, problem statement, rationale for the research and outlines the main research questions and delimitations of the study. It also briefly outlines the methodology that was undertaken to achieve the objectives of this study.
Chapter 2	<u>Literature review:</u> The main literature that is outlined links to social-ecological systems as complex adaptive systems, the water-food and energy nexus, ecosystem services and livelihoods, sustainability, and equity.
Chapter 3	<u>Methodology:</u> This chapter provides an overview of the methodology, the research process and how the data were collected and analysed
Chapter 4	<u>Results:</u> In this chapter the key findings from the research are presented
Chapter 5	<u>Discussion:</u> This chapter discusses the key findings in light of other research that exists
Chapter 6	<u>Conclusion and recommendations:</u> The conclusion with some of the most important findings and how this research can inform further interventions in the region and what additional research needs to be undertaken
List of References	Books, documents, policies, online websites, peer-reviewed articles and all sources used for research study
Appendices	The research tools are provided as appendices to this thesis

Chapter 2: Literature review

2.1 Introduction

More than one billion people worldwide still live-in abject poverty. Poverty, inequality, and inequity are proving to be bigger challenges than ever, mostly pertinently in the global South. About 45 percent of sub-Saharan Africa is classified as extremely poor (World Commission, n.d.). Paradoxically, Africa is still blessed with abundant resources which should contribute to the wealth and wellbeing of countries and their citizens, highlighting that the governance of natural resources needs to be strengthened in order for local communities to benefit from the abundant natural resources present.

Sub-Saharan Africa also has high unemployment rates at around 30 percent, lack of clean water and sanitation, insufficient access to infrastructure and energy (mostly in rural areas), food insecurity, high teenage pregnancy, and extreme inequity (NSA, 2016; World Commission, n.d.). By 2030, it is estimated that there will be a need to produce 50 percent more food, 50 percent more energy, and 30 percent more fresh water in the world (Beddington, 2009). Although governments and many NGOs are tirelessly trying to intervene and bring about change in line with achieving the SDGs, there is a lack of coordination, mostly in the sectors of water, energy, and food. A nexus approach can help with this coordination effort by explicitly highlighting the points of interaction between the three sectors so interventions can be implemented that has positive impacts across all three sectors.

This chapter aims to explore an existing body of literature that has addressed the issues of livelihoods, ecosystem services, and sustainable development mostly in the global south. The researcher, therefore, identified four crucial bodies of literature relevant to this research:

- Social-ecological Systems;
- The Water, Energy and Food (WEF) Nexus;
- Ecosystem Services (ES), Human Well-Being (HWB) and Livelihoods; and
- Equity.

The final section outlines some of the key drivers of change that are threatening livelihood options in Namibia.

2.2 Social-ecological systems (SES) as complex adaptive systems (CAS)

Research on Social-ecological systems (SES) focuses on the interaction and feedback between components of social and ecological systems. The social-ecological systems approach recognises that ecological and social systems are intertwined, requiring an integrated approach (Preiser *et al.*, 2018.). Social-ecological systems are complex and adaptive, and are often called complex adaptive systems (CAS) because they exhibit nonlinear dynamics, and are unpredictable (Preiser *et al.*, 2018; Heyligen, Cilliers & Gershenson, 2013:125; Snowden & Boone, 2007; Cilliers, 2006). In a CAS, the interaction between and within components results in emergent properties which can render them unpredictable (Hammod, 2017; Eberhard, 2009). Conflicting interests and outcomes between components of the system where equilibrium cannot be reached can result in the system adapting to the new conditions (Preiser *et al.*, 2018; Heyligen *et al.*, 2013). The adaptability of interactions between components allows a system to change and evolve with time as they respond to feedbacks and changes. This also implies that the system has memory which allows it to recall past responses and configuration to inform future trajectories (Preiser *et al.*, 2018).

Using a CAS lens allows one to better understand the interactions amongst the elements of the system (humans, ecology, policies & laws etc.) and the linkage to its surrounding (society and nature) which can assist with the understanding of the links between structure and function, but also between the interaction with external elements such as government interventions, culture, and human movements in the area. The CAS perspective sees structures as 'becoming' rather than 'being' (Preiser *et al.*, 2018) requiring a multi-dimensional approach. Preiser *et al.* (2018) and Turner *et al.* (2016), argue that understanding phenomena in CAS are better dealt with from a holistic approach, by listening to alternative voices, embracing new technology and including communities during decision-making which gives us a deeper insight into the system and can help identify challenges.

Preiser *et al.* (2018)'s notion on a holistic approach echoes that of Hammod (2017) and Ostrom *et al.* (1994) who argue that different voices help come up with solutions that serves the system better. This implies that all stakeholders' interests are included in the socio-economic planning. People's ability to look at the structure of the system holistically will allow them to have a better viewpoint and manage organizations and institutions inclusively of all the internal and external structures as well as nature (Preiser *et al.*, 2018; Hammod, 2017:16). Exclusion or separation between understanding and action, may lead to the undermining of sustainable development programs by relevant stakeholders.

Given that complex systems are made up of elements that interact amongst and with the surrounding environment, several frameworks (such as social-ecological conceptual framework for multiservice issues in agro-ecosystems and the nexus framing) exist, which all attempt to connect or operationalise the social-ecological interconnections (Lescourret *et al.*, 2015:69). They however

warn that there is no framework of frameworks. This thesis uses a water, energy and food nexus framing to understand how these resources are interrelated, and to connect them to ecosystem services and livelihoods.

2.3 The water-energy-food (WEF) nexus

Water, energy, and food are intricately linked – food production requires both water and energy; energy production requires water (e.g., biomass production, firewood); and water availability in one sector (e.g. for food production) is affected by and affects allocation in other sectors (see Figure 2.1). McNamara *et al.* (2018) argue out that the WEF sectors are so closely interlinked that agriculture (food production) use up 70 percent of global water needs. Over 90 percent of global energy is produced using water (water-intensive), while agriculture and food chains account for over 33 percent of global energy. The interlinkages within the WEF sectors imply that an intervention in one sector can reduce or increase security in the other sector. Although past efforts to improve water, energy, and food security have been done independently this resulted in the waste of resources and opposing goals (Aboelnga *et al.*, 2018; Matros-Goreses 2018).

A WEF Nexus approach describes complex relationships in the global resources of water, energy, and food, and across scales in order to understand and find an integrated and coordinated resource management strategy that improve policies, knowledge and advances sustainable development (Aboelnga *et al.*, 2018; Galaiti & Huber-lee, 2018, 2018; McNamara *et al.*, 2018). It first came to prominence in the last decade after the 2011 Bonn conference titled “The Water, Energy and Food Security Nexus” (Stevens and Gallagher, 2015:3). The WEF Nexus approach ensures the management of the trade-offs in order to find synergies and do away with single-minded pursuits of individuals goals (Aboelnga *et al.*, 2018; Matros-Goreses, 2018; McNamara *et al.*, 2018).

Additionally, Juvonen (2015:8), argues that “the WEF Nexus also introduces the notion of social equality in access to resources”. McNamara *et al.* (2018) support Juvonen’s above argument and therefore believe that WEF is the pillar of development as all communities strive to achieve security in the three sectors. The WEF Nexus approach is imperative because owing the fact that water, energy and food are highly interlinked, and their demand keeps increasing due to associated drivers and factors (Juvonen, 2015) that will be discussed in section 2.6 of this chapter

A Nexus problem

The fact that the WEF Nexus approach is attempting to find solutions to complex interconnections and relationships does not imply that the Nexus as a concept is difficult to understand. Juvonen (2015:8) contends that the WEF Nexus (see Figure 2.1) is simple: “for example water extraction and distribution require energy; energy production in most cases requires water; and food prices are highly sensitive to the cost of energy through fertilizer use, irrigation, transport, and processing”. However, these associations confirm that it is difficult to address one WEF sector without interacting with the other, consequently constituting a Nexus problem. It is therefore imperative to understand

that “an intervention in one of these three sectors may cause positive or negative consequences on one or both other sectors” (Aboelnga *et al.*, 2018: 8-9).

Indeed, a Nexus approach is faced with barriers of which some of them are already discussed in the earlier paragraphs of this section such as a lack communication between sectors; different sectoral established agendas and interests; unequal sharing of power and know-how between the sectors; lack of trust and cooperation amongst stakeholders and government agencies (Aboelnga *et al.*, 2018: 9-10). Also, there is an unclear definition of the WEF Nexus scope, silo-ed policies and interventions, level of governance, definition of stakeholders, and policy tools that can necessitate implementation (Juvonen, 2015:40). However, Aboelnga *et al* (2018:9) argue that in order to solve Nexus problems there is a need to create stronger and better interlinked institutions which will help advance a Nexus thinking.

Water at the centre of the Nexus problem

The WEF Nexus is water-centred and being promoted by water fields and institutions (Juvonen, 2015). Aboelnga *et al* (2018) argue that water is however central to the WEF Nexus because: it is a basic human need and important for development where water is prominent in food production and clean energy; water is scarce and unequally distributed around the world; water is imperatively connected to the other two sectors. Even approaches like integrated water resources management (IWRM) advocates for the Nexus approach through promoting a multidisciplinary approach in addressing water resource governance. This research focuses on how water and the other interlinked resources of food and energy interact, and how understanding these interactions can help advance sustainable development within rural communities. The research is mainly focused on water within the context of being a transboundary resource.

Why the WEF Nexus approach?

Translating a theoretical understanding of complex issues to practical (implementation) engagement is nonetheless still proving to be a challenge since complex systems are dynamic in nature as highlighted by Bizikova and Swanson, (2013:1) who state that “while the interconnected nature of WEF has been recognized and supported by some examples around the globe, there is a relatively limited understanding of how to tackle these complex relationships when conducting assessments and taking action”. Therefore, McNamara (2018) argues that it is important to understand and explore the WEF interactions because this will enable us to participate in “knowledge-based” discussions about interrelations of natural resources, and using a system approach ensures an understanding of the security of the three sectors simultaneously. Security in all sectors does not just ensure enough food, clean water, and energy – but this will help to attain most SDGs as per the UN’s agenda 2030.

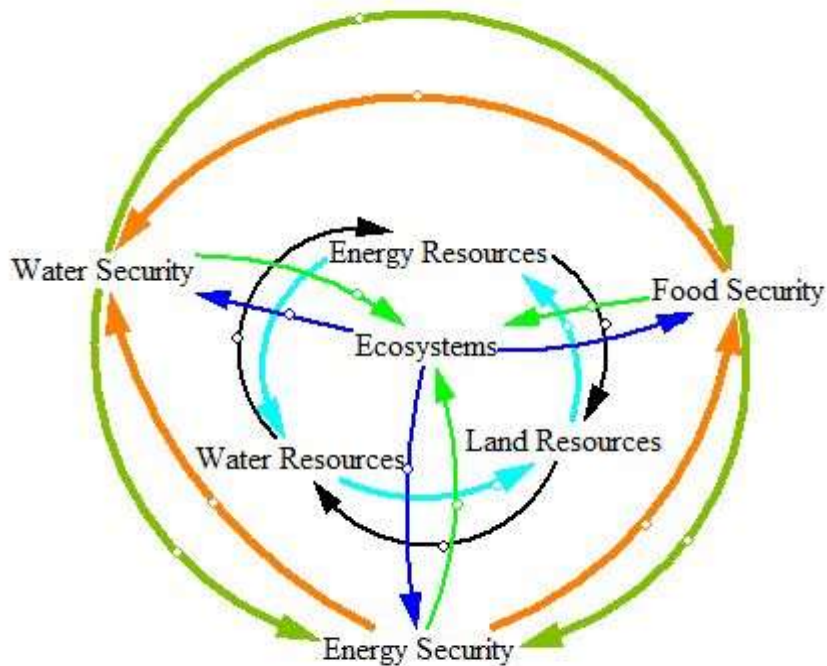


Figure 2.1: WEF Nexus as seen from ecological lens. The WEF sectors interact and are interlinked to each other. Imperatively, the security in the WEF sectors cannot be achieved without a healthy ecosystem. A healthy ecosystem ensures that there are ecosystem services that contribute to livelihood strategies to enhance human well-being and sustainable development. Credit: Romanus Kasino.

Moreover, isolated planning in either water, energy, or agricultural sectors leads to unintended consequences, putting additional stresses on WEF resources, which in turn worsens livelihoods and undermines sustainable development (Aboelnga *et al.*, 2018:8; Bizikova & Swanson, 2013:1). Another implication is that increasing agricultural output may result in the degradation of the biodiversity and creation of water insecurity. This leads to trade-offs in the Nexus such as trying find a balance between channelling electricity to pumping water for the household, production use, irrigation, drinking, and industrial uses (Stevens & Gallagher, 2015). The latter two authors (2015:13) thus suggest that energy and water use must be decentralised in communities for the benefit of communities and households.

Furthermore, the interconnections between three sectors complicate a traditional (or linear) approach to the WEF nexus. Juvonen (2015:9) noted that the WEF Nexus face challenges such as the connection between resource users and their consequent impact on the other sectors. For example, the spread in biofuel use could lead to a reduction in available water and land for other purposes, most importantly for food production; the increase in water demand for agriculture and energy competes with the demand for more drinking water; and increasing utilization” (Aboelnga *et al.*, 2018: 9-10). The literature under this section has exposed the importance of integration and a

holistic approach which is necessary to manage the WEF resources while ensuring that the safeguarding of ecosystem services and human well-being

2.4 Ecosystem services and the links to livelihoods & human wellbeing

Through a holistic perspective

It is hard to imagine that we can grow our economy or improve the society's well-being without a supportive and healthy environment that provides a wide range of ecosystem services – these are the contributions of nature to human wellbeing (Diaz *et al.*, 2018; Guerry *et al.*, 2015). Some ecosystems provide immediate benefits (such as fish and wild fruits), some are intermediate and requiring interventions to provide service such as setting up fish farms or cultivating fields for food (MA, 2005). Most of the rural communities in the global south use ecosystem services for medicine, food, energy, building materials and for income (MA, 2005). The heavy reliance of rural communities on ecosystem services creates uncertainty as areas with low functional natural resources endowment are prone to droughts, flooding, or other natural hazards (Scoones, 1998; Speranza, Wiesmann & Rist, 2014).

The Millennium Ecosystem Assessment classifies ecosystem services into four categories (MA, 2005) of supporting services:

- Supporting services: nutrient cycling; soil formation; and primary production;
- Provisioning services which include food, fresh water, wood, and fibre, and fuel;
- Regulating services which include climate regulation, flood regulation, disease regulation, and water purification; and lastly
- Cultural services which include aesthetic, spiritual, educational, and recreational services.

Human well-being is dependent directly and indirectly on ecosystem services as we discussed already. However, we have to be careful with how we use of ecosystem services because we may deplete them before they are able to recover. Carpenter *et al.* (2005:54) point out that there has been a significant change in the ecosystems in the last half a century due to growing population: more humans are needing more food, water, timber, fuel and (IPBES, 2018). This has therefore negatively affected (sometimes to an un-reversible extent) the ecosystem's abilities to provide services. Folke *et al.* (2011:720) share the same view by arguing that "human's action alters ecosystem support not only locally and regionally but also globally".

Indeed, when ecosystems are not able to support human needs, it eventually leads to a web of events such as migrations, drought, and battles over resources that span across continents and countries. Carpenter *et al.* (2005:54) therefore warn us that if the current trend of exploiting

ecosystem services is allowed to continue without appropriate interventions, fixing the damage will come at a high price, which will also increase the potential for exclusion of some groups particularly in rural communities

Through a cultural perspective

Culture is of particular significance to rural communities because it helps differentiate a community's identity from others. Schnegg, Rieprich & Pröpper (2014:2) see culture as a complex whole. It incorporates knowledge, belief, art, morals, law, custom, norms and values governing nature. It organises the social world, including family and kinship, religious life, politics, and economy, as well as the ways activities in these domains, are practiced. Lastly it also embraces other capabilities and habits acquired by a person as a member of a society. Cultural ecosystem services encompass aesthetics, recreational and educational activities, and the spirituality of places, but do not limit culture exclusively to non-material categories (Schnegg, Rieprich & Pröpper, 2014). This makes it imperative to view cultural ecosystem services as an inseparable from, inter alia, other three ecosystem services.

Most ecosystem services although they can be viewed as either of the afore-mentioned categories of the ecosystem services, are perceived as culture, but the separation of culture and ecosystem is problematic. Schnegg, Rieprich and Pröpper (2014) believe that the ecosystem and use of natural resources indeed serve livelihood needs, but also operate as cultural motives that bear identity and belonging. The latter authors use the illustration of domestic and wild animals that are assigned cultural significance, but they simultaneously generate income (as tourism and meat sales). Collecting firewood is certainly part of the culture, initiations, and hunting – but it is also an ecosystem service. Culture should not be seen as opposed to nature because “people share cultural meanings, which they attach to nature” (Schnegg, Rieprich & Pröpper, 2014:2).

Again, latter researchers provide another example: “whether most people in a group eat insect larvae or beef, which are provisioning services, is not only a natural but also a cultural choice”. Therefore, services can be in one or two categories, e.g. the landscape represents cultural significance and provisioning services and income generation opportunities (Schnegg, Rieprich, and Pröpper, 2014).

From a human well-being perspective

Our behaviours toward ecosystems are often determined by how and what we benefit from them. It is thus imperative to understand the interconnections between healthy ecosystems and human well-being to advocate for sustainable development. Masterson *et al.*, (2019) believe that an understanding of these interconnections dictates the maintenance of the well-being of the ecosystem services and humans while eradicating poverty and inequality. Guerry *et al.* (2015:1) share the same notion by arguing that there is a need to incorporate natural capital and ecosystem services into

decision-making. They recommend that we can focus on three dimensions of progress and on-going challenges:

Sharing knowledge about the interdependence between ecosystems and human well-being, encouraging further consolidation of interdisciplinary understanding of ecosystems services, and using such understanding during implementation to recover natural resources and use them sustainably.

Consequently, this will help to address existing gaps in environmental sciences as Mace, Norris, and Fitter (2012:20) reason that there are already efforts to harmonizing conservation biologists, local communities, and that of ecosystem managers. Integration becomes even more pronounced through the recognition that human well-being and environmental systems are coupled.

Managing ecosystems to improve livelihoods

The management of ecosystems can be further enhanced through the formulation of the right policies and their effective implementation. To manage ecosystem services better, there is a need for a change in policies, the creation of strong intuitions and the change in practices such as farming methods, fishing, and timber harvesting (Carpenter *et al.*, 2005). Indeed, Guerry *et al.* (2015:2) elaborate that it is imperative to comprehend “who affects the generation of ecosystem services (providers or suppliers) and who benefits from ecosystem services (beneficiaries or consumers)” to assess costs and benefits from policies. Additionally, Guerry and colleagues believe that institutions and policies in place can help motivate “potential ecosystem service suppliers by using payments for action, access, or maintenance of a service”. Incentives can award fishermen who practice better fisheries and water ecosystem management, as an example.

Ecosystems services support for livelihood options differ from one place to another; as do livelihood options. A livelihood is made up of “the capabilities, resources (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets, while not undermining the natural resource base” (SIDA 2001:5).

Different activities can optimize livelihood options known as a ‘livelihood portfolio’ (Scoones, 1998). Some portfolios are more reliant on one activity or a limited range of activities while other livelihood portfolios are diverse (Scoones, 1998; Speranza, Wiesmann & Rist, 2014). The more livelihood assets or resources at the disposal of people, the better their chances of securing better livelihoods (Speranza, Wiesmann & Rist, 2014).

Sustainable livelihoods must have the capacity to support other livelihood options (Scoones, 1998). Speranza, Wiesmann, and Rist (2014) as well as Scoones (1998:6) argue that a sustainable livelihood is one that can reduce poverty levels, improve human well-being and capabilities, enhance adaptation and resilience decrease vulnerability, and increase natural resource base. However, a

sustainable livelihoods approach looks more beyond the conventional perspective of assuming that sustainable livelihood is just about reducing poverty.

Sustainable livelihoods are not only concerned with low income but with bad health, low literacy levels, lack of social services, vulnerability and powerlessness, equity and social exclusion (SIDA, 2001). Inclusion of marginalised people in planning and decision-making is vital for sustainable development – because they are aware of their needs and can help develop policies that can help address their needs within their specific contexts (SIDA, 2001). Sustainable livelihood's weakness is that it does not explain how to identify the poor or vulnerable communities that need assistance as it is not always informed by informal social structures in communities (SIDA, 2001). Therefore, consideration should be given to what livelihood approach or combinations of tools are used for the measuring, analysis, and verification of the impacts of any development in the community (Speranza, Wiesmann & Rist, and 2014:111).

Most ecosystem services which underpin livelihood options cannot be substituted. We must therefore verify whether different people (according to certain social characteristics e.g. wealth, gender, age, etc.) have access to a diverse range of livelihood options at their disposal. One first needs to identify the trends in livelihood resources, for example, are there change in access, what new livelihood options were or being created, and who is accumulating new capitals, and how?) (Scoones, 1998; Speranza, Wiesmann & Rist., 2014). The next step is to analyse recovery pathways and implications for maintaining or enhancing livelihood resilience (Speranza, Wiesmann & Rist, 2014).

Institutional processes and organisational structures that link various elements of a social-ecological systems together require a holistic approach to achieve greater results (SIDA, 2001:2). Additionally, institutional capacitation and support are critical to achieve sustainable livelihoods since these influences and reinforce positive “livelihood strategies, and associated livelihood outcomes and trade-offs” (Speranza, Wiesmann & Rist, 2014:111). Scoones (1998:12) agrees with this notion and argues that institutions are the foundation that determine how stakeholders achieve positive or negative adaptation. Scoones further argues that they are important for the recognition of restrictions or barriers and opportunities to sustainable development, highlighting the social processes (which are the basis of sustainable development), and emphasising the complexity of dealing with both formal and informal organisations.

2.5 Sustainability and equity

The concepts of equity and sustainability have evolved over the last few decades. The terms ‘sustainability’ and ‘sustainable development’ emerged in the 1970s and rose to prominence after the World Summit on Sustainable Development and the Brundtland Commission (WSSD 2002). More recently research on sustainability has evolved into its own discipline: Sustainability Science

(Kates, 2011). While sustainability is an emergent intended outcome of sustainable development, 'what' is sustainable depends on the focus of the work, like a focus on environmental sustainability versus economic sustainability.

Sustainable development – although commonly used – has drawn debate for its definition. The Human Development Report (HDR) 2011 argues that the sustainable development definition “does not adequately capture sustainable development” because it does not “refer to the expansion of choice, freedoms, and capabilities intrinsic to human development” (UNDP, 2011:17). It is further argued that the definition does not recognise that some dimensions of human well-being cannot be measured by the same standards, i.e., they are incommensurable. An example is the required standards of living in an urban or rural setting.

Although there may be different perspectives on sustainable development, there has been general agreement on the UN's definition of sustainable development by the Brundtland Commission's Report of 1987 which states that sustainable development is the “development that meets the need of the present without compromising the ability of future generations to meet their own needs”. The commission argues that sustainable development is not merely about economics, as poverty can still exist amid accelerated growth. It must find a balance between the creation of opportunities and equitable use of resources to benefit all (DESA, 2013). Blewitt (2018) and Swilling and Annecke (2012) all maintain that sustainable development has three aspects: economic, environmental, and social aspects. The definition used in this thesis includes these earlier definitions, but also includes the notion of tipping points and thresholds, therefore sustainable development is considered as “the ability of the current generation to operate within planetary boundaries so that they can meet their current needs without compromising that of the future generations” (Folke et al., 2018).

The UN's Sustainable Development Goals released in 2015 set in motion an agenda to achieve a better world for all through the attainment of these goals and their implementation mechanisms. The SDGs at the RIO+20 summit agreed on goals such as ending hunger, promoting clean energy access for all, and promoting urban sustainability through more sustainable consumption and production patterns built on the perceived unfinished business of the MDGs (DESA 2013). In addition, sustainable development as articulated in the SDGs prioritises human rights as well as poverty eradication, energy, urban sustainability, inclusivity, better housing, clean water and sanitation, better health services, education (DESA, 2013; UN, 2013). However, these challenges are complex, and need to be addressed in an integrated approach as many of the goals rely on the achievement of some of the 'foundational goals' (Biggeri *et al.*, 2019; Le Blanc, *et al.*, 2017; Smith, *et al.*, 2018).

Indeed, achieving the 17 SDGs, especially in the global south, correlates with achieving energy, water, and food security while making sure that natural resources are used sustainably. The UN (2012) recommends that the SDGs will be better achieved through the provision of clean energy for

economic development; food security; sustainable use of natural resources, and waste management. The enablers are better attained through integrated solutions that are established at a local, national, regional, and global level as no country will succeed at attaining sustainable development and dealing with its challenge alone (SDSN, 2012).

Furthermore, understanding sustainable development implies exploring two commonly used terms: equity and sustainability, however, while there is growing attention for the need to address sustainability and equity, “there is little remarkable systematic work to address their interlinkages” (Leach *et al.*, 2018:2). Leach *et al.* (2018) provide a framework for understanding how equity and sustainability are coupled and how a social-ecological systems lens can assist with understanding which pathways, decisions and interactions can lead to more sustainable and just outcomes in the future.

Strong sustainability recognises that socio-economic development can only be achieved when environmental well-being is prioritised and not merely a concern with the environment but social equity and the economy (Harris, 2015:2; Commission World, n.d.). “Sustainability aims to achieve both intra-generational and inter-generational equity” (Nieslony, 2004:6). Folke *et al.*, (2011) further contend that humans should operate within the boundaries of the biosphere.

It is therefore imperative to create an integrated approach as well as the understanding of complex, dynamic social-ecological systems that see people and nature as an intertwined social-ecological systems (Leach *et al.*, 2018). In essence, equity is both a driver of achieving sustainability as well as a major component of sustainable development. Leach *et al.* (2018:3) describe equity as “ensuring that everyone has what they need for wellbeing in a given context, implying more for those who need it”. They emphasise that equity “refers to fairness and justice”, but it also varies “across culture and over time”. However, equity is sometimes confused with equality whereby the latter is more concerned with the state of being equal when it comes to status, rights, and opportunities.

Amartya Sen in the Human Development Report (HDR) 2011 reasons that we should see equality in the case of capabilities. “Equality is neither necessary nor sufficient for equity. Different individual abilities and preferences lead to different outcomes, even with identical opportunities and access to resources” (UNDP, 2011:18-19). To enhance equity through equality, we should look at inequalities between and the poor, but also other categorisations are equally imperative such as those linked to poor and underprivileged groups, together with people with mental or physical disabilities in order to attain “equality of capabilities” (UNDP, 2011:19). The terms of inequality and inequity are therefore immediately interconnected because unequal access to capabilities leads to inequality.

The HDR 2011 in the UNDP (2011:19) compared the average life expectancy of a Malian and Norwegian resident: a Malian is expected to live 32 years fewer than the Norwegian resident because they have high possibilities compared to Malawians. The same can be said for the average lifestyle of a resident of Swakopmund to that of a resident of Mayana/Uvhungu-vhungu. Although

they live around greater sources of water, fisheries, and tourist-attracting ecosystems, the possibilities are excessive in Swakopmund and not in the Mayana/Uvhungu-vhungu. Inequality is a proxy of inequity and should be extended beyond income inequality to inequity in health, education and wider political freedoms opportunities and choices is a key imperative of the human development approach (Leach *et al.*, 2018).

To further understand equity, Leach *et al.* (2018) divided equity into two forms whereby we interrogate for “equity of what” and “equity between whom” (see Figure 2.2).

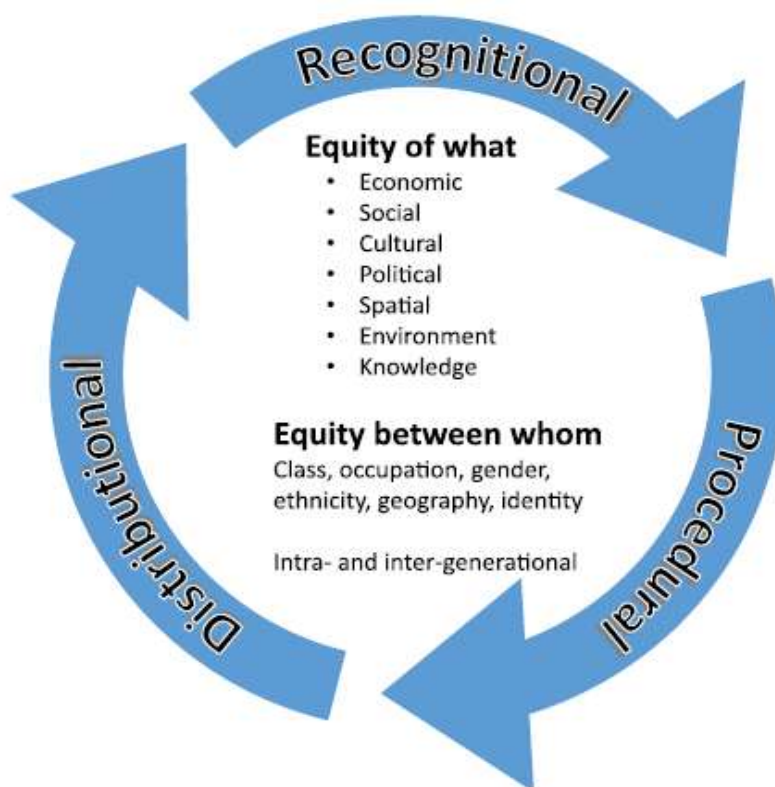


Figure 2.2: Dimensions of equity (Leach et al., 2018:4). Distributional equity refers to proportionality of resources use and how benefits and resources are shared. Procedural equity, highlights institutions, governance, and participation and the degree to which people and groups can influence these decisions

Multidimensional equity represents an all-embracing classification that differentiates between distributional, recognition, and procedural equity (Figure 2.2.). Distributional equity refers to proportionality of resources use and how benefits and resources are shared. It acknowledges identity, dignity, rights, and it is against discrimination that leads to inequity (Leach et al., 2018:4). Procedural equity, highlights institutions, governance, and participation to emphasise how decision-making, and a degree to which people and groups can influence these decisions, in essence, it also relates to political inequity (Leach et al., 2018:4). Furthermore, the “equity of what” comprises of but not limited to income, assets, social, cultural, spatial, knowledge, political and environmental aspects

gender issues, human right and access throughout our planning (Leach *et al.*, 2018; Wong *et al.*, 2019). In contrast “equity between whom” highlights how differences (including the what’s) are spread and felt between individuals and groups, accordance with differing magnitudes of difference. They include class, occupation, gender, identity, ethnicity, and geography. Since there is a lot of inequity in the global south mostly in wealth, resource distribution, and inclusion, we need to revisit the equity perspective to ensure justice for all.

The intersection of inequities does not just happen at a local level but also at the global scale as well whereby environmental and economic inequities may severely affect some countries more than others in terms of climate change and associated rises in sea levels (Leach *et al.*, 2018). We are already experiencing these effects due to inequities in the global south. Swilling and Annecke’s (2012) argument agree in essence that the poor will suffer from consequences of unsustainable use of resources first and the most because many livelihoods are intricately linked to, and dependent on, the environment.

Pavun, Vujasinović, and Matijević (2011) agree with this notion by arguing that poor people are most affected by the degradation of and destruction of ecosystems because they heavily rely on natural resources such as water, grazing land forest for survival. For this reason, consideration of an equity perspective may lead to the sustainable use of resources as communities will feel a collective responsibility for management given their reliance and connection to nature (Pavun et al. 2011).

The UNDP (2011:14) argues that equity and sustainability should not be seen as separate issues because they overlap each other on “normative and instrumental grounds”. In support of this notion, Pavun, Vujasinović, and Matijević (2011:7) argue that “the links between sustainability and equity are multi-dimensional and mutually reinforcing. Sustainability itself means justice to future generations. And it is impossible to imagine a situation where a case is made for inter-generational equity while underplaying intra-generational equity”. Additionally, sustainability has a component of justice as does equity, in essence, environmentalism links both justice, fairness to non-humans for humans, and equity. Pavun, Vujasinović, and Matijević (2011:7) therefore emphasize that attention must be paid to past inequities and discrimination such as the results of colonialism to bring about resource allocation as well as opportunities. They demand attention to historical inequities and discrimination, and as well as opportunities. Indeed, this can better be done through a change of social relations, redeployment of rights, resources, policy methods which deal with social, economic, and ecological concerns concurrently and holistically.

Leach et al (2018) further argue that although equity is mentioned in many SDGs, their implementation more often does not satisfy the perspective of equity. The lack of integrated data means that implementation agents and policymakers may interpret it differently, resulting in more of one of the aspects (equity or sustainability) or then the other. Thus there is a need to for a transformative agenda including new approaches to research with more integrated actions between

science and society (Leach *et al.*, 2018:10). A sustainable future must satisfy the needs of the communities through a UN's policy of 'leave no-one behind' which implies fairness and justice for all while caring for the environmental well-being so that we do not only improve livelihoods but also the environment.

2.6. Drivers of change

A driver of change is a natural or human-induced factor that directly or indirectly bring about a change in nature which in turn has impacts on human wellbeing and associated livelihood opportunities (Diaz *et al.*, 2015). There are direct and indirect drives of change. Direct drivers are those that cause changes directly on nature while indirect changes are those that change the level, direction, or rate of one or more direct drivers (Diaz *et al.*, 2015). It is important to understand and consider the drivers of change so that we can make the right interventions within a social-ecological systems, especially since a lot of the drivers interact themselves and it is not just climate change, but climate AND population and degradation.

2.6.1 Climate change

The Southern African region is acutely vulnerable to rainfall-related shocks with heavy dependence on agriculture. The Intergovernmental Panel on Climate Change (IPCC) has acknowledged the Southern African region as one of the most susceptible to expected climate change (IPCC, 2007). Namibia, located within the driest part of Southern Africa, where drought is prevalent and where great demand is placed upon natural resources, is considered to be particularly sensitive to the effects of climate change (MLR, 2015). It has been estimated that the temperature along the Kavango river (and the rest of Southern Africa) is will increase by over 4 to 6 °C in the near future CRIDF (2019:33), MLR (2015). They argue that the increase in temperature and rainfall variability are likely to upsurge the frequency of fire in places that are not normally fire prone and other extreme events will become more unpredictable.

A study found that this may have a negative impact on aquatic resource or resulting in insufficient water to support agriculture or fish farms, leading to food insecurity (CRIDF, 2019:33). This forecast is consistent with many climate models, which argue that Namibia will turn out to be drier in the future, rainfall inconsistency is expected to surge and extreme events such as famines and floods are likely to become more common and intense (CRIDF, 2019). Decreasing moisture in the soil means a reduced carrying capacity of the rangeland and "increasing the difficulties faced by rural people with the crop- and livestock-based livelihoods", creating a compounding effect on soil moisture and plant growth (CRIDF, 2019; MLR, 2015:54). These impacts on agricultural-related activities are expected to have far wide-reaching impacts on rural communities.

It is a well-known fact that agriculture is the largest employment sector in the SADC region, employing about 70 percent of the working class and sustaining the livelihoods of about 60 percent of people in the region, yet the sector mostly relies on rain for water (Mpandeli *et al.*, 2018). Reduced rain and drought imply that less food is produced, and less water is available for human and livestock consumption. It is also estimated that water and food demand will increase by 50 percent by 2050 globally, while energy demand is expected to double against scarce resources (Mpandeli *et al.*, 2018).

A combination of demand in the three essential sectors together with increasing population and reduced rainfall further increases water insecurity which threatens agricultural outputs. Also, it is believed that that annual rainfall figures will be reduced by as 10 percent in 2050 much as 20 to 30 percent by 2080 in the SADC region which can only increase socio-economic challenges, increasing resource scarcity, vulnerability and negatively affecting nutrition, health and human well-being (Mpandeli *et al.*, 2018). Despite these challenges and clear evidence that climate change is real and is already a threat to human well-being, a sizeable and influential section of the society remains in denial (Aboelnga *et al.*, 2018; Blewitt, 2018). Aboelnga *et al.* (2018) further emphasise that those who deny climate change are those who have vested benefits somewhere else and feel exposed by the fact that if they start abiding by the protocols of reducing global warming, by reducing their excessive consumption habits, their profits are threatened. Indeed, Swilling and Annecke (2012) support this notion by pointing out that fossil fuels, agricultural production, and deforestation are the main contributors to greenhouse gas emissions.

Indeed, climate change has become a serious concern that does not only threaten livelihoods of the most vulnerable people in the world but as well as leaders and policymakers (Blewitt, 2018). However, climate change impacts are felt more in the developing world, especially in rural areas as the majority of the poor people that live there are depending on subsistence farming (Blewitt, 2018). Imperatively, as Swilling and Annecke (2012) correctly put it, the poor will suffer first, and the most, because rich people and developed countries can at least delay the consequences due to resources at their disposal. The poor have the limited or/ weak infrastructure to protect them from such hazards and are likely to suffer harsh consequences (CRIDF, 2019). This is likely to be true for the people of the Kavango East Region because the region is one of the poorest in the country and faces serious food and water insecurity that are a result of climate change and related complex interactions. Infrastructures in the region are either not adequate or too weak to support their livelihoods. The region has a high rate of poverty, poor infrastructures, and low adaptation mechanisms which makes them vulnerable (NSA, 2014). Besides, the vulnerabilities of rural communities of Southern Africa (in particular Mayana and Uvhungu-vhungu) will even be more severe because they are heavily dependent on rain-fed agriculture, are faced with higher predicted temperatures and have weak and vulnerable economies (Hall *et al.*, 2017). What is even more worrying is that climate change will have

an extreme impact on those that are already on the economic peripherals, such as women and children.

Arora-Jonsson (2011) suggested that we must prioritize women and children because they are most exposed to climate change and are more likely to care for environmental wellbeing than men. However, not everybody agrees with the fact that women are more vulnerable to climate change than men. Ahmad and Chalk (1994) in Arora-Jonsson (2011) argue that climate change affects more men during natural calamities such as famine than women. They point out that men have a short life expectancy due to their sacrifice, which is why you mostly find more households headed by single women than men.

Rohr (2006) in Arora-Jonsson (2011) further agrees that men more often than women die during natural disasters than women because of their heroic nature, trying to save their families or trying to take on problems. The way they are raised makes them willing to take more risks than women. The argument in Arora-Jonsson (2011) gave an example of climate effects on Indian farmers that led to a lot of suicides by male farmers. It continued to say that there is a perception that women's vulnerabilities are just made-up stories without clear evidence. Similarly, Neumayer and Plumper (2007) in Arora-Jonsson (2011) tend to agree as they point to the fact that women are only more affected by natural disasters when they are socially disadvantaged.

However, the debate of Arora-Jonsson (2011) does not agree with the Namibian case whereby about 60 percent of rural households in Namibian context because majority of households are headed by women, (NSA, 2014). The NSA (2014) argues that most rural households are female-headed because men moved to urban areas in search of employment and a better life. This leaves women in charge of the households, work the land, and raise children. It is therefore imperative to assume that climate change impacts rural areas of the Kavango East Region are going to have serious negative impact on the livelihoods of women and children than men.

There is a need to collectively find solutions to climate change because the effects will be felt by everyone in the long run. The 2015 Paris Agreement calls for global nations to unanimously reduce the global temperature below before industrial levels below 2 degrees (Aboelnga *et al.*, 2018). However, this is not an easy task to achieve because climate change is a complex and cross-cutting problem that must be addressed through an integrated and transformative approach. In support of this notion, Mpandeli *et al.* (2018) argue that climate change is a wicked problem and the current approach from individual sectors is creating an unbalanced solution and slowing down sustainable development. It is therefore requires a transdisciplinary and cross-sectoral approach (Mpandeli *et al.*, 2018). Integrated approaches, like those that explore nexus issues can help in building resilient, integrated interventions and help surface trade-offs, therefore enhancing sustainability. Mpandeli *et al.* (2018) argue that using a multi- sectoral approach can help rural communities of Southern Africa to develop resilience which in turn will help with the attainment of SDG 1, 2, 3, 6, 7 and 13,

respectively. Indeed, this approach provides an essential supporting structure for controlling synergies and trade-offs with within WEF sectors from a perspective of emerging hindrance against sustainable development like climate change (Mpandeli *et al.*, 2018:2). It provides an opportunity to deal with climate change issues and adaptation which are complex in nature while at the same time creates an enabling environment for economic growth (Mpandeli *et al.*, 2018). The water, energy, and food (WEF) Nexus approach will further be explored in subsequent chapters.

Another solution to climate change is changing our ways of living which can help with reducing greenhouse gas emissions through changing the way we build infrastructure using public transport more often than private cars, and formulate national policies on climate change with respect to international agreements (Blewitt, 2018). CRIDF (2019:33) argues that there is also a need “to consider land use management practices, policies, and planning. However, this is challenging given the longstanding cultural-behavioural practices”. Rural communities may not partake in combating climate change because they often find themselves in a situation whereby they have to do business-as-usual to survive, such as using wood for building, diesel, paraffin, and firewood for fuel.

2.6.2. Population growth

The African population is expected to increase tremendously between now and 2050. It is estimated to reach 2.4 billion by 2050 from the current over 1.1 billion people (Hall *et al.*, 2017). Unfortunately, a quarter of Africans are facing food insecurity, and this is largely a result of the increasing population. Indeed, combating food insecurity has become even more complex due to climate change (Hall *et al.*, 2017). Whatever is being done to combat population growth may not be completely effective in the nearby future because the continent has the youngest population in the world with an average age of 18 many of which will start families. Other factors effecting population growth are cultural traditions, gender inequality, lack of infrastructure to facilitate family planning, improvement in health care, and reduced death rate due to increasing life expectancy. However, the increased population will make it hard to eradicate poverty, inequality, food insecurity, and malnutrition (Hall *et al.*, 2017). All these factors combined, make it difficult to curb population growth in most African countries soon. While growing populations are an issue, it is important to also look at how populations consume resources, while Africa might have the largest population in years to come, their consumption per capita will still be below that of regions in the global north.

Kavango East Region had a population of 153 255 in 2019 from a population of 136,823 people in 2014, whereby over 70 percent of the population lives in the rural areas (CRIDF, 2019; NSA, 2016; MLR, 2015; MLR, 2015). Population density of the Kavango East Region ranges from 3.7 to 6.7 persons per square km (Figure 2.3). This indicates that the region is one of densely populated from the Namibia perspective (this may not be the case if you compare to countries like South Africa). Arguably, these interpretations are also being problematic to the residents of the area because

politicians and policymakers sometimes refer to a large population as a reason of slow delivery of infrastructure and services.

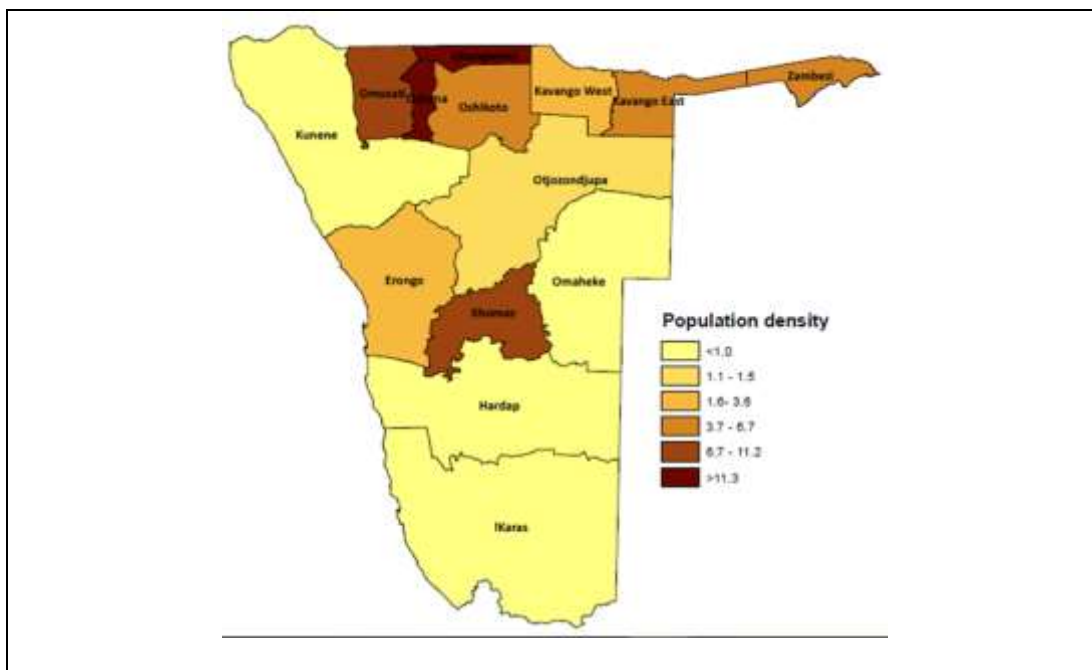


Figure 2.3: Population density by area (NSA, 2016:52)

The region is faced with multiple social issues ranging from poverty, inequality but more importantly population growth due to high birth rate and migration. The major causes of migration into Kavango East Regions (mostly by Angolan citizens) are the availability of better health facilities in comparison to the Angolan side, employment opportunities, and the maternal relationships between the Nyemba and Rukavango people (Likuwa, 2016). Another notable cause until the early 2000s was the intense civil war between UNITA and the Angolan government. Likuwa (2016) argues that the Nyemba people who already have relatives on the side of Namibia and came to visit ended up settling. Certainly, this has put a strain on available natural resources, and it is also a dilemma when it comes to planning and implementation.

Additionally, Likuwa (2016) argues that migration is a problem not only in Kavango East but also in most of the world. However, not everyone shares the same sentiment as Likuwa (2016). Migration may help with “poverty reduction, economic opportunities, address labour imbalances and increase the availability of new ideas and technology” (Hauser, 2015:2). Hauser's (2015) argue from the notion that someplace benefits from migration due to the lack of young population because it reduces mortality for the immigrants, improves fertility and address shortage of manpower for semi-skilled labour, etc. This is most common in developed countries such as western Europe, Canada, and Australia.

Besides, Hauser (2015) emphasise that this can also be a case even in developing countries because high population density makes it easy for infrastructure delivery per capita, removing pressure on ecosystems and other service delivery such as water and sanitation. Indeed, the

contradicting arguments of Hauser (2015) and Likuwa (2016) make sense depending on differing perspectives and political agendas. The movement of the Nyemba people from Angola into these villages can put a strain on the existing infrastructures and increase competition for employment opportunities and natural resources (ecosystem services), but can also bring with them new ideas, knowledge and practices that can build diversity and resilience. However, this remains a complex issue because of the political relationship between the two countries, shared river, and interrelations between the two tribes from both sides of the rivers.

Furthermore, population growth combined with high living standards and economic growth means increased energy need, water, and food, therefore, causing a depletion of natural resources in rural areas that heavily rely on fuelwood for energy. Consequently, the reliance of fuelwood for energy will create climate change issues and environmental degradation (Hall *et al.*, 2017; Hauser, 2015). Hence jeopardizing food security in the region. Also, food insecurity due to drought is expected to increase in the future. Increasing population growth further leaves residents without enough water supply, larger populations without access to infrastructure and services can also result in increases in water contamination, and waterborne diseases (CRIDF, 2019). Water insecurity has devastating effects on food production, human well-being, and sustainability of livelihoods. Unfortunately, finding a solution to population growth so that it does not hinder personal freedoms and the attainment of sustainable development is proving to be a challenge in developing countries. Pimentel *et al.* 2013 point out that humans are known to have a bad environmental management track record whereby everything is set up for self-benefits, consequently exploiting the environment. Balatsky, Balatsky and Borysov (2015) agree with this notion by arguing that natural resources are finite, and resources will only be able to support our livelihoods if we acknowledge our dependency on them, and develop measures to preserve the ecosystems that produce these resources.

In their recent study, Hall *et al.* (2017) used a modelling framework called FEEDME (Food Estimation and Export for Diet and Malnutrition Evaluation) to find solutions to the food shortage as a result of population growth. First, closing the yield gap by growing more cereal, fruits, and vegetables through sustainable intensification. Indeed, this needs major investment in technology, better-quality seed variations, fertilizers, irrigation schemes, and machinery to boost yields and ensure the nutrient adequacy of the food supply. Arguably the most important step in this process is the regeneration of soil fertility across the continent. Secondly, the importation of a food if the yield could not be increased to satisfy local nutritional needs. However, (Hall *et al.*, 2017:8) are warning us that importing food is problematic for developing countries because it will create an imbalance of payments. Food imports imply exporting jobs as well. Notably, Kavango East Region has one the most fertile land, an adequate supply of water from the Okavango River and it is also one the regions that receive more rain per annum, making it an ideal place for massive irrigation and livestock farming which if not done sustainably can degrade the ecosystems.

Solutions to population growth can in turn create new or more problems than solutions because of the failure to acknowledge the complexities of a growing population. In the past, decisions were made depending on current and isolated crises to protect or promote certain resources or a certain part of human well-being/ populations. In the context of the Anthropocene, this can no longer be the case, we must remain pro-active in our actions and address problems in a holistic manner (Pimentel *et al.*, 2013). We must also try to understand the changes in demography and whether they have negative or positive effects on sustainable development. Hauser (2015) emphasize that data management should be prioritised to strengthen evidence, development strategies, policies, and programs. They further suggest that as the population grows, governments must develop efficient transport and energy infrastructures, as well as water and waste management while engaging in information exchange with other countries in order to improve resource efficiency.

2.6.3 Land degradation

Exploitative land and resource usage causes land degradation which will have a direct impact on ecosystems and livelihoods. Pimentel *et al.* (2013) point out that as human activities increase, plant and animal species will be depleted which implies that the ecosystem services will become scarce. Land degradation is believed to affect over 3 billion people in the world and costing one-tenth of global gross domestic product (GDP) (IPBES, 2018; Hauser, 2015). Hence, unsustainable land use seems beneficial in the short-term but carries devastating effects in the long run.

Restoration of degraded land has 10 times the benefit in comparison to not doing anything about it (IPBES, 2018). The report further points out that such benefits are employment creation, gender inclusion, investment in education, and improved livelihood. Additionally, certain restoration practices can ensure equity, poverty eradication, reduce inequalities, promote sustainable consumption and protection of the environment (Hauser, 2015). Indeed, empowerment of women, both as an important goal in its own right is a key aspect of improving the quality of life for local communities.

Sand mining activities in Namibia, especially in the Kavango-East Region are mostly unregulated. The MLR (2015:102) document has argued that these activities if not monitored and regulated will cause environmental and social-economic problems. Such problems range from soil erosion, large open holes that fill up with water during the rainy seasons, endangering children and livestock lives. MLR (2015) further argues that sand mining is also likely to ruin the landscapes, becoming unattractive, and keeping tourists away. Sand mining issue is not unique to Kavango East Region. Indeed, this has been a problem around the country, whereby sand miners in search of sand for urban infrastructure exploit the nearby villages, without carrying out proper Social Impact Assessment (SIA) as well as Environmental Impact Assessment (EIA) (The Namibian, 2012). These are also the type of activities that creates inequity, environmental degradation, and are unsustainable in the long run.

2.6.4 Socio-economic activities

Socio-economic activities are necessary for enhancing livelihoods, but planning must be done to ensure that ecosystem services are intact against the growing population and demand for resources in rural areas. The fifth National Development Plan (NDP5) calls for integrated planning at all levels to kick off the rural economies (NPC, 2017). However, there are a couple of challenges that must be addressed to create an environment that enables economic growth in rural areas. Some of these challenges are poor roads, sanitation, energy accessibility, access to markets, poverty, lack of skills, and many others. By 2017, only 24 percent of the rural population have excess to energy compared to 75 percent in urban areas (NPC, 2017). In Kavango East Region, for example, almost 75 percent of households in the region depend on fuelwood (NSA, 2014). There is poor access with a degraded gravel road into the villages of Mayana and Uvhungu-vhungu, making it difficult to travel, mostly during the rainy season, and requires urgent government intervention. Furthermore, 70 percent of the country's 20 poorest constituencies are found in the two Kavango regions. These challenges alone already show how difficult it is to bring about a development that is sustainable, pro-enhancement of livelihoods, human well-being, and the environment.

Although over 60 percent of people aged 15 years and above are economically active, only 52 percent are employed, resulting in a 48 percent unemployment rate in the region. This makes the region the highest-ranked in unemployment in comparison to other regions in the country (CRIDF, 2019). Subsistence farming makes up 68 percent of households in rural areas. Similarly, agriculture and fishery employ 46 percent of the employed population (see table 2.1 below). This percentage is derived from direct and indirect employment that relates to agricultural and fishery activities in the region.

Table 2.1: The main occupation of employed person in Kavango East Region as per 2011 census (MLR, 2015).

The main occupation of employed population	Total	Percentage (%)
Skilled agriculture and fishery workers	10 832	45.95
Service workers	2 757	11.70
Professionals	2 634	11.17
Elementary occupations	1 909	8.10
Craft and related trade workers	1 509	6.40
Armed Forces	1 099	4.66
Technician and associated professionals	954	4.05
Clerks	897	3.81
Plant and machine operators and assemblers	543	2.30
Legislators, senior officials, and Managers	432	1.83
Do not Know	5	0.02

Extensive food production, in particular irrigation, consumes over 70 percent of water consumption in the two regions by 2008 (MLR, 2015). In contrast, the fishing sector consumed 4 percent in 2008 and projected to consume 0.5 percent by 2020 (MLR, 2015). Water consumption by all other water users in Table 2.2 is expected to remain relatively stable against total consumption except for irrigated agriculture. This does not imply a well-managed use of water but simply means that more and more water will be needed for food production as income and population growth. Indeed, this will put a strain on the environment and eventually create water insecurity.

Table 2.2: Water necessities for various water uses in Kavango West and Kavango East Regions (MLR, 2015:104 -107)

Water Users	Water Use (Mm ³) (2008)	Projected Water (2015)	Projected Water Uses 2020 (Mm ³)
Urban Domestic	7	8	9
Rural Domestic	2	3	3
Livestock Watering	3	4	7
Irrigated Agriculture	36	175	175
Fish Farming	2	1	1
Tourism Industry	1	2	2
Total	51	193	197

Furthermore, the total amount of water used in the Kavango East Region alone exceeds 22 million cubic meters (mm³) each year (MLR, 2015). The MLR (2015) underlines that this amount of water only equals to 0.3 percent of the total water flow into Botswana. This translates to the fact that water consumption in the Kavango East Region does not have a detrimental effect on the Motswana side for now.

Like any other part of the world, Kavango East Region must as well address gender issues. According to the Namibian Planning Commission (2007), a third of Namibian women between 15-49 years have experienced GBV of some kind (NPC, 2017). It is important to recognize that more women are raising children and working the land in the absence of men. Women's role in the growth and development of significant importance. "Their abilities to save and invest in their families is well documented. As the family's nutritional gatekeeper, women fight hunger and malnutrition" (The World Bank, 2003:71). Mies and Vandana (2014) elaborate that women will be at the forefront of the changes in attitude towards a better planet because they suffered a lot under patriarchal dominance. Feminism will open up the opportunity for inclusivity, love, and care. For this reason, there is a need for the incorporation of women's voices in socio-economic activities and planning (Blewitt, 2018). Their inclusion, in particular rural women, will help bridge the gap of inequity, inequality and reduce poverty through sustainable practices.

The inclusion of women from rural areas in socio-economic activities also implies that the standard of living in rural areas will only improve with the provision of basic services. This can allow for intensive rural entrepreneurship which creates employment, income, and reduces inequality. The National Planning Commission (NPC, 2017) calls for the integration of gender issues in the planning and support of informal businesses owned by women. Indeed, rural women are mostly involved in crafts, weaving, and food production, hence, their inclusion implies that they will have a chance to fully partake in economic activities and support their livelihoods and that of their families.

2.6.5 Technological Change

The effects of technology have both good and bad effects on social-ecological systems but are necessary to improve livelihoods. Technological changes such as an introduction of new and effective fishing tools may be good for fishing yields but at the same time may lead to the depletion of resources if not well managed. New pieces of machinery for farming will make it easy to plough and increase the crop yield. Telecommunication infrastructures are necessary to improve communication and the spread of information. Access to information helps small-scale farmers with proactive disaster risk reduction e.g., early warning for floods or drought forecasts. Also, regular monitoring and management of technological changes must be observed to make sure that they serve the purpose but as well not jeopardise the environmental well-being or exclude other groups within the community.

2.6.6 Socio-political factors

The period from independence from 1990 to 2002 has been characterised with instability in both Kavango East and West Regions due to civil war in Angola. Some UNITA bandits were crossing over to the Namibian side to steal food and livestock. This was one of the political challenges that threatened peace in the region, but after the 2002 ceasefire agreement between the ruling MPLA and UNITA, things have stabilised. Other notable disturbances in the region were perhaps the presence of unexploded landmines left over by Angolan civil war and the national liberation war against South African occupation.

The issue of Angolan and Namibian residents crossing the border does not just stem in cultural connections but as well in search competition for fish resources. Indeed, “there is a risk of political instability due to border-crossing and ‘entering others’ territory” (CRIDF, 2019:32). This issue is well known to both government and intergovernmental committees such as OKACOM who was established to help manage shared water resources between concerned countries.

Finally, a prolonged state of poverty, inequality, and inequity will pose a threat to the socio-political stability of the region if not treated with urgency. Solving poverty and inequality at the expense of the environment can equally pose socio-political instability in the future because people will be forced to compete for limited resources. Therefore, we shouldn’t just be worried about how the society takes care of its most vulnerable sections, but also how the land, its beauty, and all the creatures on it are managed (Blewitt, 2018). In essence, politicians are worried about economic growth, urban migration, and how they can feed the hungry. However, the environment must be a mainstay in the planning process as well, to mitigate land degradation, and recover lost biodiversity, especially in rural areas in order to enhance sustainable development for all.

Chapter 3: Research methodology

3.1 Introduction

This study used a mixed-methods strategy, embedded within a case study approach. By collecting both qualitative and quantitative data, a deeper understanding of the opportunities and challenges to enhance local livelihoods will be explored. Figure 3.1 outlines the research design and methods used.

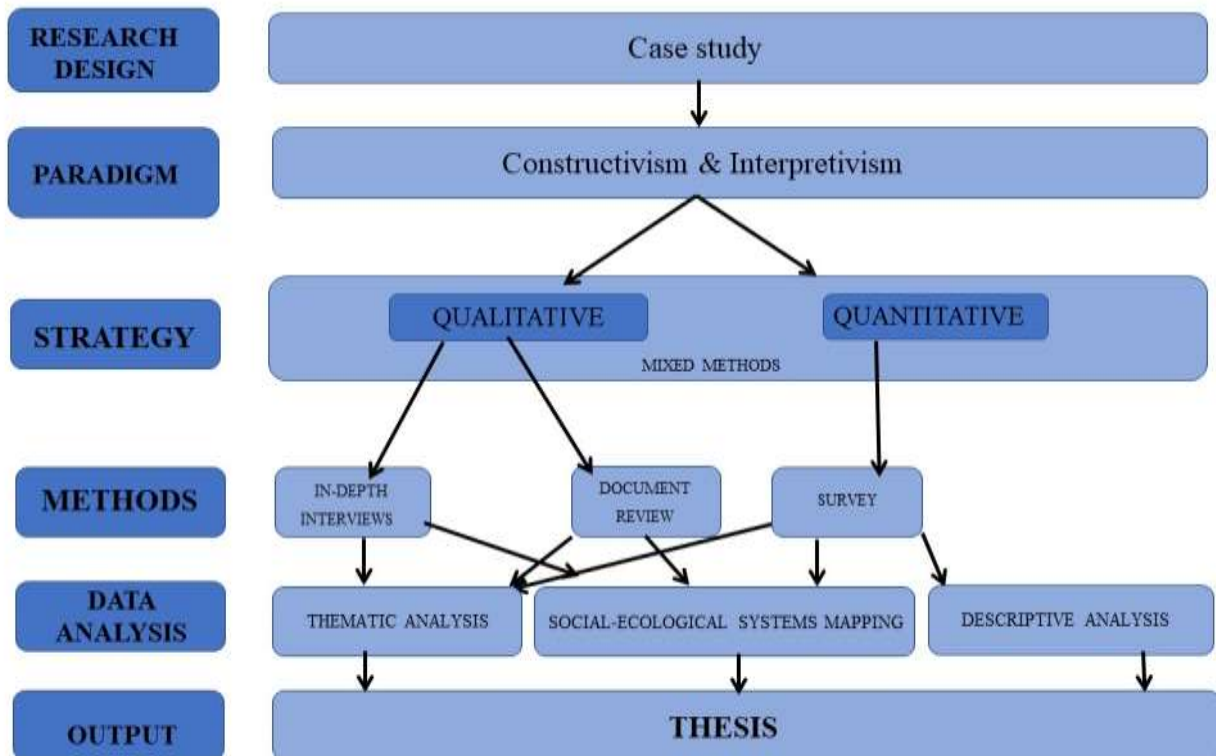


Figure 3.1: Methodological framework guiding the overarching research approach.

3.2 Research design

This study used a case study approach because it is a useful approach when there is a need to obtain an in-depth understanding of an issue, event, or phenomenon within a specific context (Yin, 2009). Two villages were selected as case study sites for further exploration and are outlined in section 3.2.1 that follows.

3.2.1 Case study description

The population of the Kavango East Region (Figure 3.2a) is estimated to have grown from 136 823 people in 2014 to 153 255 in 2019, whereby over 70 percent of the population live in rural areas (CRIDF, 2019; MLR, 2015; NSA, 2016). The CRIDF (2019) report estimates poverty to be at 43 percent

in the region, with less economic development happening in rural areas in comparison to urban areas like Rundu.

A multiple case study of two villages in the Kavango East Region in Rundu Rural Constituency was used to explore how a Nexus approach can help improve livelihoods without undermining the ecosystems on which people depend.

The two villages of Mayana and Uvhungu-vhungu (Figure 3.2b) were selected because: 1) they are within the scope of the funders' area of interests, which is the Cubango-Okavango River basin; 2) they are in ideal proximity to the Okavango River which provides many ecosystem services for local people which provides a good opportunity to explore a Nexus approach; 3) the researcher was able to work through a key informant, who lives in the area under study and could assist with participant selection and field work given the covid-19 restrictions.

Although Uvhungu-vhungu is a rural village, it is close to Rundu (which is 10 km away) and has a green scheme irrigation project which provides an interesting space for analysis. In contrast, Mayana is further east of Uvhungu-vhungu and is a hotspot for fishing. It has been in the news due to conflict between villagers and the on-going CRIDF water pipeline project, which provides a foundation for contrasting differences in social-ecological dynamics of the two villages (Republikein, 2020). Additionally, the fact that Mayana is further away from Rundu, makes it ideal to explore some of the differences in terms of how people access some basic services in comparison to Uvhungu-vhungu.

Mayana's population is almost twice that of Uvhungu-vhungu, this may perhaps be the reason why latest interventions in the area such as small-scale irrigation projects are mostly in Mayana over Uvhungu-vhungu (see Table 3.1). Both villages are under the Shambyu traditional authority and are riparian. However, the researcher assumes that factors around water and food provision are likely to provide both similar and contrasting livelihood opportunities in the two villages.

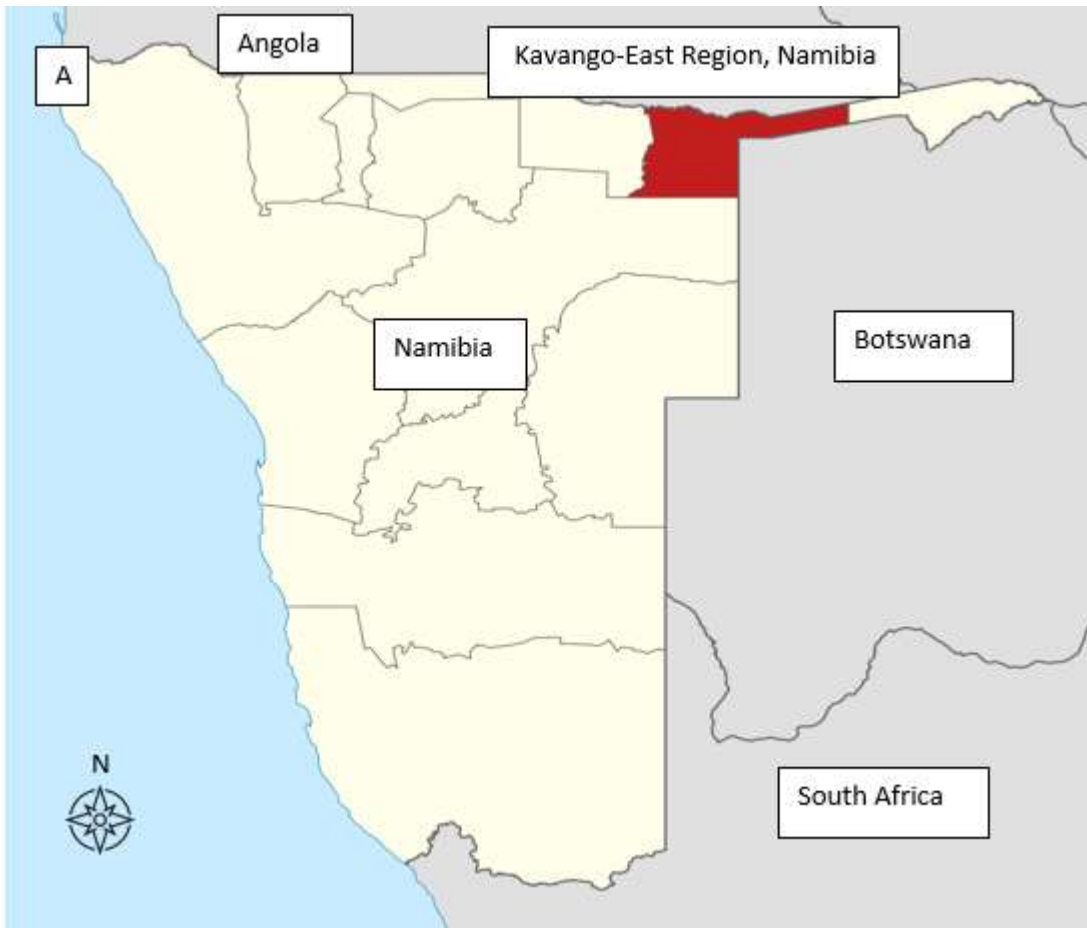


Figure 3.2: a) shows the map of Kavango East Region which is situated on the far east of Namibia, bordering both Angola (north) and Botswana (south). b) The location of the two case study villages (Uvungu-vhungu and Mayana). Credit: Google Maps and Romanus Kasino

Table 3.1: A comparison of challenges and demography between Mayana and Uvhungu-vhungu. Credit: Romanus Kasino and Key Informant

Category	Mayana	Uvhungu-vhungu
Population	1813	1006
Lodges	1	2
Large irrigation schemes	0	1
Water points (taps)	4 privately owned	2 public water points
Boreholes	0	1
Access to the River	Easy access	Restricted by UGSIP and Kaisosi River Lodge fences
Fishing potential	High (Natural ponds)	Low (sand and inaccessible)
Employment opportunities	Lodges	Lodges, UGSIP (1983)
New projects	CRIDF water pipeline, CRIDF small-scale irrigation project, and support	None
Electricity	Lodges, schools, a few well-off houses along the gravel road	Restricted to mostly UGSIP, school, and Lodges
Food access/production	Fishing, subsistence farming, limited small-scale irrigation, livestock breeding, and state drought relief	Limited fishing, subsistence farming, small-scale irrigation, UGSIP, livestock breeding, and state drought relief

Respondents who participated in the research either reside in one of the two the villages or work for institutions that are stakeholders in the area. Respondents were randomly selected, however no respondents below 18 years of age were included in this study. Gender, employment status, and level of education were not considered during the selection process. However, information on gender, employment status and other demographic information was collected during the survey and interviews. Assistance with participant recruitment and identification was enabled through the use of a key informant who lives in one of the villages and is involved with traditional leadership and a local community-based organisation (CBO) in the study site and facilitated contact with some of the respondents.

3.3 Research paradigm

A research paradigm represents a worldview of a researcher in the world, how the world operates, and relationships between social-ecological systems (Guba & Lincoln, 1994). A research paradigm is concerned with “a set of basic beliefs (or metaphysics) that deals with ultimate or first principles” (Guba & Lincoln, 1994:107). A research paradigm thus provides the direction of the research and informs the researcher of the appropriate research methodology to be employed.

In this study, the researcher used constructivism and interpretivist paradigms. Constructivism “views social phenomena and categories as socially constructed” (Bryman *et al.*, 2017:107). Hence constructivists argue “that the categories that people use to comprehend the natural and social world are social products. They do not have built-in essences or meanings; instead, meaning is constructed in and through interaction” (Bryman *et al.*, 2017:108). Constructivism implies that the research will help answer questions such as “what is there that can be known about”; a social phenomenon; identify the reality of how things work; pose questions relating to the moral importance of an issue and explore “matters of aesthetic” (Bryman *et al.*, 2017; Guba and Lincoln, 1994:108).

Interpretivism assumes that a research approach must differentiate between humans and other natural beings hence, “this approach involves the social scientist to grasp the subjective meaning of social action” (Bryman *et al.*, 2017:14). They point out that it attempts to understand human behaviours and also suggest that people should rather put their perceptions in brackets while carrying out the research, not necessarily to dismiss their initial views but to allow for novel data to emerge and be represented as well as not to be biased in the interpretation of the data based on apprehended assumptions of the researcher. Finally, from the epistemological perspective, the researcher and what is to be researched are actively interacting with each other, and “finding is created as the investigation proceeds” (Guba & Lincoln, 1994:111).

3.4 Research strategy

To explore the interactive components in the two sites for the case study, the researcher used a mixed method approach to investigate the interactions between water, energy, and food systems by looking at potential trade-offs and synergies between livelihood activities. The mixed-methods approach allows the researcher to combine quantitative and qualitative research within a single project (Bryman *et al.*, 2017). This approach was chosen, as neither a qualitative or quantitative strategy alone would have captured the richness and complexities of the phenomena under study. When combined, the strengths of the two strategies (qualitative and quantitative) enable a more holistic understanding of some of the issues under question (Bryman *et al.*, 2017).

Existing literature and government websites were used to gather both quantitative (including demographic information) and quantitative data, whereas online surveys and in-depth interviews

were used to gather qualitative and quantitative information (see research instruments listed in the Appendices: Appendix A and Surveys). Furthermore, in order to create a better understanding of the strategy, the researcher initially created a draft conceptual social ecological system map (Figure 4.1) using qualitative information obtained from existing literature and government websites, and through an expert workshop with ecosystem service experts familiar with the case study sites.

3.5 Research methods

The researcher used the following methods to collect data: document review, expert workshop, online survey, and in-depth interviews.

The review of available literature on livelihoods and ecosystem services in Namibia and Kavango East Region focused on how water, energy, and food resources interact, how they are allocated, used, and managed. The review also studied documentation that may explain who gained or lost from earlier decisions and interventions that impacted local livelihoods in the area. This literature included peer-reviewed publications, consultant reports and information contained in government documents. In order to find relevant documents, the researcher used keywords such as ecosystems, complex adaptive systems, complex systems, social-ecological systems, sustainable development, resilient systems, WEF security, WEF Nexus approach, Nexus analysis, Kavango East Region, Namibia, Mayana, Uvhungu-vhungu, energy, food, water, mixed-method approach, renewable resources, equity, and drivers of change. These keywords were used to look for relevant documents on search engines such as Google Scholar, OKACOM website, etc. The researcher also made use of course work from his previous studies towards a postgraduate diploma in sustainable development. Another source of literature was through snowballing, where expert knowledge and recommended documents by supervisors were used to add to the body of literature. Finally, the researcher searched through government and developmental organisations websites to identify data that are relevant to Kavango East Region. The main topics of literature review as already discussed under chapter 2 were social-ecological systems as complex adaptive systems; food, water, and energy nexus; ecosystem services and the link to livelihoods & human well-being; sustainability and equity; and drivers of change. All these documents were then synthesised to surface key information linked to the case study sites, and conceptual information linked to expected relationships between key social-ecological systems features. This information was then workshoped with 2 ecosystem service experts on the 19 May 2020 for 3 hours. This workshop was conducted online using Zoom software and a recording was made with permission for future reference and note taking. This workshop assisted with the development of a draft conceptual social-ecological systems map (see data analysis section below).

The online surveys with interest groups were primarily applied to collect information about households and their use of local resources and livelihood strategies. Appendix 1 contains a copy of

the survey that was implemented. Initially forty (40) respondents were targeted for the online survey. However, only twenty-three (23) respondents took part in the survey. As already discussed earlier, the survey targeted residents and those that work for stakeholder organisations and government institutions in the case study sites. Some respondents were identified and recommended by the key informant, while the researcher also sent out consent letters to stakeholders who allowed some of their employees to take part in the survey. The link to the survey, which was administered through the use of a Google Form, was shared by the researcher through mobile phone messages (WhatsApp and SMS) and via emails to the respondents. There were eighteen (18) main questions, which targeted livelihood strategies related to water, energy, and food. In addition, the question also probed information regarding current interventions, livelihood activities, equity, and gender roles in the two villages.

In-depth telephone interviews were carried out with key stakeholders who were purposively selected based on their roles within the system (e.g. resource users, decision-makers and NGO workers). Again, as discussed in the previous paragraphs, some respondents were identified by the researcher through the stakeholders' offices while some were recommended by the key informant. Although forty respondents were targeted, only nine agreed to a telephone interview. Due to time constraints, each respondent was interviewed once for an average duration of approximately one hour. Similar to the survey, there were eighteen main questions, which targeted livelihood strategies related to water, energy, and food, current interventions, livelihood activities in the two villages, equity and gender roles (see a semi-structured interview schedule was developed: Appendix A). However, respondents were allowed flexibility in order to give more details this time around, whereby the researcher asked follow up questions that led to clarity of issues that may not have been clearly explained or discussed in the online surveys. Additionally, the key informant interviews were conducted with one respondent to document key information (including demography) about the two villages due to his immense knowledge about the area. The key informant lives in one of the villages and is involved with traditional leadership and a local community-based organisation (CBO). Appendix 3 contains information on some of the questions that were asked of the key informant.

3.6 Data analysis

The researcher applied content and thematic analysis using deductive coding as part of the secondary data analysis to categorise emerging themes from the telephone interviews and online surveys. The researcher developed codes from the online survey and grouped them into themes. The interview data was likewise transcribed, coded and then analysed into themes together with data from online survey. Codes were created to group data with similarities in order to help identify answers to the main research questions. The codes were: challenges or negative factors on livelihoods, access to water and resources; types of water usage; river (reference to the river);

sanitation (and wellbeing); livelihoods (activities); interventions (to improve livelihoods); opportunities (for better livelihoods); infrastructures (that are in the two villages); energy (how often mentioned); food (how often mentioned); culture (how often mentioned); surprises (what surprised the researcher); recommendations (what respondents think can or must be done). These codes were consolidated into themes of water, energy, food, equity, ecosystem services, interventions, and recommendation and opportunities. Quantitative data (e.g., demographic information) from online surveys and telephone interviews were gathered using frequency tables and graphs, and then summarised using descriptive statistics. Social-ecological system dynamics and relationships were captured in a conceptual social-ecological system using SES mapping tools presented by the Wayfinder process (www.wayfinder.earth; Enfors-kautsky *et al.*, 2021; Enfors-kautsky *et al.*, 2018). SES mapping assisted with displaying the key interactions that are linked to food, water and energy. This analysis process was iterative – with the first social-ecological system map (Figure 4.1) being created based on a document review and expert workshop, and the second map (Figure 4.21) being updated once there was more understanding of key system components and livelihoods emerging from the interviews and online survey.

3.7 Research limitations

Ideally, the researcher planned to use focus groups and face-to-face interviews but changed strategies after the covid-19 restrictions and dangers it posed to respondents as well as the researcher's life. Most potential respondents are rural people who have little or no access to smartphones, while most of them cannot speak nor write proper English. It became difficult to communicate with every potential respondent through the phone or for respondents to answer survey questions that were accessible only through an internet link.

It took on average about one hour to interview a single respondent via a phone call, and it took almost two hours to interview respondents who needed a translator through the same process. Also, there were fewer respondents who agreed to take in-depth telephonic interviews than online surveys because they found it time consuming. However, in-depth telephonic interviews provided more information because respondents were allowed more time to clarify their answers.

Additionally, more funds were spent on logistics and on an intermediary (key informant) who spent extra funds calling potential respondents to try and convince them to participate in the survey and telephonic interviews. Although most respondents were given mobile data, some did not take part in the survey. Some potential respondents refused to take part in the interviews because they fear that information gathered may jeopardise their jobs, even when the consent letters were issued and explained to them. Two responses from the telephone interviews were withdrawn due to poor sound quality.

Limitation due to the covid-19 pandemic had serious implications on the research budget, time, methods, and accessibility to valuable data. This means that some data collection methods which may have been facilitated through i.e. focused group workshops, face-to-face interviews, and more in depth approaches proposed by the Wayfinder process were forgone. Furthermore, cultural beliefs, politics, and the fear of retaliation by some potential respondents meant that the data gathered were limited.

3.8. Research ethics

This research was approved by the Research Ethics Committee (REC) on Social, Behavioural and Education Research (SBER) committee on the 2nd of August 2020. The research was carried out as per stipulations of the REC. The expiry date of the research project is 1 August 2023. The project number is SPLSID-2020-14671.

Personal reflections of the research

It was a learning journey that enabled engagements with a diverse group of respondents, most of which are members of the communities of Mayana and Uvhungu-vhungu. It also helped the researcher create greater cultural awareness of the Shambyu people and further understand the disparities in standards of living, livelihood options, developmental and social issues in the area, in comparison to other area of Namibia that the researcher was already well acquainted with. The landscape, ecosystems, and local people have so much connection to the researcher because they resemble the area where the researcher grew up, except that here there is a river, richer and diverse ecosystems and good land for pastoral and agriculture production. The researcher's long-term interests have always been to learn and understand complex poverty traps that hinders progress within local communities and help find solutions. However, such interests also created bias on how the researcher perceived some issues in the area i.e. that woman were extremely excluded from decision-making; that local people were lazy; and that wild fruits and animals are within vicinity and accessible for human consumption. Also, that wood craft was one of the main livelihood activities in the villages and that the river and fishing were accessible to all.

Engaging in conversation with the respondents from the area, mostly women, was not easy as it became emotional at times. Sometimes, the conversation turned personal while most of the time respondents expressed how they felt helpless and left out, fearing that their livelihoods are insecure. Respondents who are residents of the two villages engaged in the conversation as if they are expecting interventions from the researcher and his sponsoring organisations. Some even asked if the researcher can convey the message to policymakers about their needs. This was the case more often, although the researcher and the key informant clearly explained that the data collected was for a research study towards a Masters degree.

In order to divert the conversation back to the research questions and objectives, the researcher made sure that at certain intervals he changed the topic or asked extra question that brought back the respondents within the topic of discussion. Sometimes the researcher had to remind respondents of how many more question were left to discuss in order to cut out personal stories. Having listened to people's personal stories and their hope for better livelihoods, the researcher wished this was more than just a data collection process for a research project.

Chapter 4: Results

This section provides an overview of the findings from the document review of information from the case study sites as well from information gained from speaking to experts that informed the development of a conceptual social-ecological systems diagram. It also presents the findings from the telephone interviews, and online survey.

4.1. First iteration of conceptual social-ecological systems map of the case study sites

The first system diagram (Figure 4.1) is informed by a review of existing documents about Kavango East Region, past visitation to the area and previous conversation with the key informant when the researcher was doing a scoping exercise during the development of the research proposal.

The resulting diagram demonstrates the expected ways in which the residents of the two villages are dependent on ecosystem services such as fish resources, wild meat and fruits, thatch grass and craft wood for their livelihoods and wellbeing. Residents of the two villages rely on the fertile land in the riparian and flood plains of the river which provides good pasture for livestock, land tourism, employment opportunities at lodges and irrigation projects, and there is sufficient food, as well as few concerns about drought because the region is known for good rainfall. Land tenure systems are gendered with mostly men owning land.

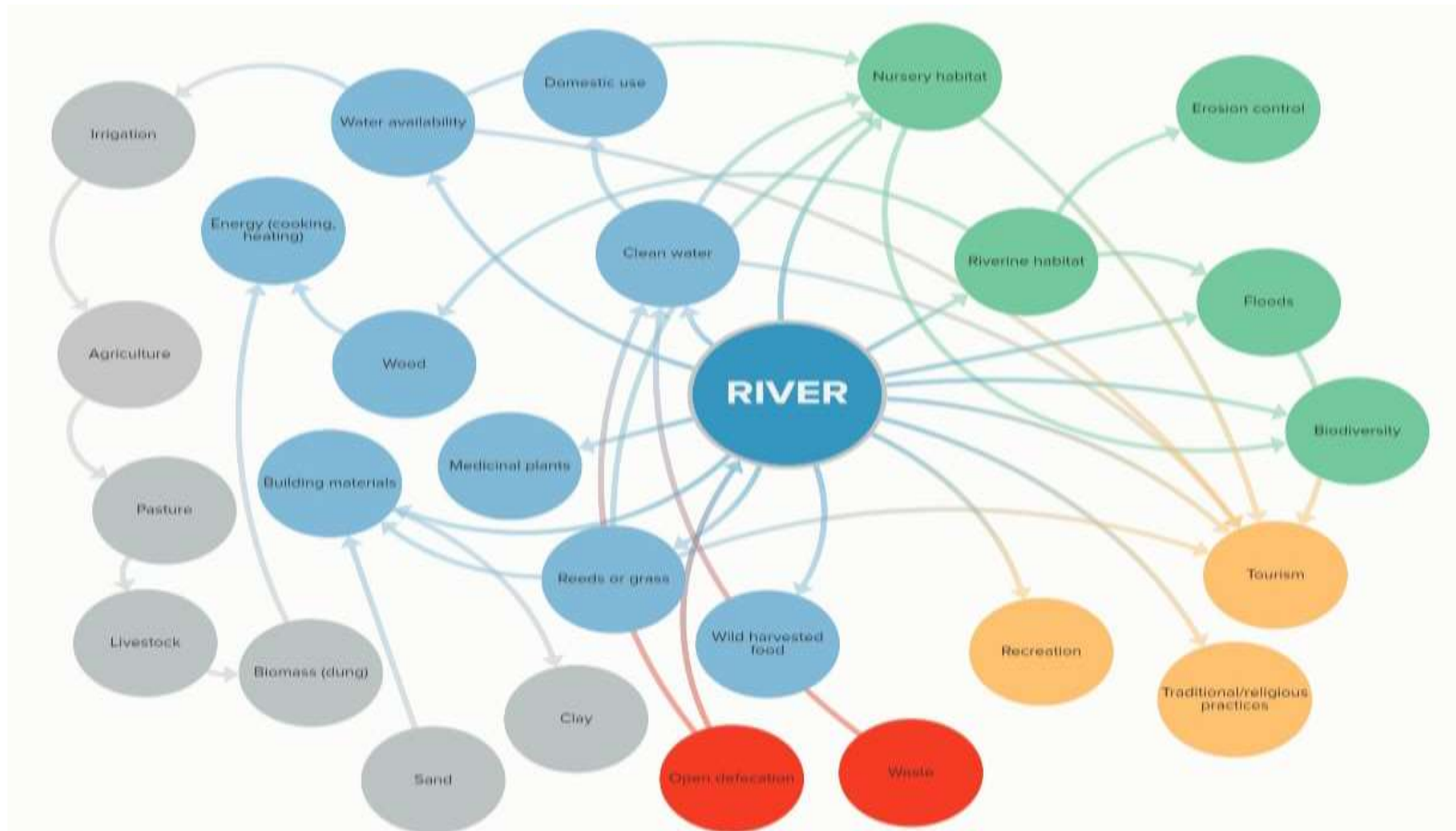


Figure 4.1: Initial conceptual social-ecological systems map illustrating key relationships and connections in the study sites. The river was assumed to be at the centre of major livelihoods activities, hence the blue arrows and components indicate how the river interacts with and supports major livelihood options. The green components are concerned with ecosystem services (including regulation, provisioning, and cultural ecosystem services) while the orange components are spinoffs that are as a result of a sustained and well managed system. Red colours indicate activities that are likely to affect human well-being in a negative way. The grey components are the existing livelihood activities (including traditional practices) and options that can still be further enhanced to improve local livelihoods and human well-being.

4.2 Survey and interviews

4.2.1 Profile of respondents

Twenty-three people responded to the online survey. Most of the survey respondents were male (n=17), while only six women responded to the survey. Fifteen respondents were between the age of thirty-five and fifty, six below the age of thirty-five, while two respondents were over the age of fifty, respectively.

There was a great diversity within this group when it comes to occupation. Eight respondents were subsistence farmers, five were teachers at local schools, two were water officers, with one fisherman, farm manager, business owner, regional planner, crop production officer, builder, secretary to the headman, and lodge owner each, respectively.

Nine respondents took part in the interview. Out of these nine respondents, seven were female, while two were male. All the respondents that took part in the interview were between the age of thirty-five and fifty. Six of these respondents are small-scale irrigation participants, one extension officer, one subsistence farmer, and one fisherwoman, respectively. Notably, all nine respondents are originally from the two villages. In total, thirty-two respondents took part in the telephone interview and online survey collectively. The majority of the respondents are subsistence farmers, followed by small-scale farmers and teachers.

4.2.2 Key findings

Overall, livelihoods are almost entirely reliant on the surrounding natural resources and healthy functioning ecosystems as indicated by the key informant and respondents who took part in the online surveys and telephonic interviews. These natural sources of livelihood options are comprised of land, water and other ecological factors that enable survival of the residents of Mayana and Uvhungu-vhungu. All respondents agreed that the main source of water for irrigation, household use, building, and livestock in the two villages is the Okavango River. Both water quality and water availability are issues for many of the respondents. There exists a huge challenge of poor sanitation with some respondents suggesting that the lodges may be disposing human waste into the river and also be blocking access to the river, resulting in residents having to travel long distances to fetch water.

Wood is the most used source of energy in the two villages, mostly for cooking, heating and lighting at night. However, wood is becoming a scarcer resource and is fetched from far afield. This is mostly an opinion of respondents who were interviewed telephonically and those who reside in the two villages. Electricity is only accessible to those that live alongside the gravel road. Electricity is mostly connected to wealthy households because the accessing electricity from the grid is expensive for poorest households.

All respondents confirmed that people from both villages are heavily reliant on subsistence agriculture and the fertile land for crop production. Small-scale farmers that were interviewed find it hard to source water from the river because they cannot afford pumps. Some of the respondents who took part in the online surveys are of the opinion that Uvhungu-vhungu Green Scheme Irrigation Project (UGSIP) does not directly

contribute to food security in the area but rather sells to bulk buyers such as grocery shops. All respondents agreed that fishing is one of the main sources of livelihoods, especially in Mayana. Fish, water spinach, and some birds from the river form a major part of nutrition.

There is a high level of poverty in the villages as indicated by most respondents. Most respondents attribute this to high school dropouts, economic exclusion, low literacy, and little state intervention. Women are left in the villages to work the land while men go to look for jobs in urban areas. While women are perceived to do the majority of subsistence farm labour, they do feel like they are only being included in some decision-making of new projects such as the water pipeline in Mayana. Finally, many of the residents use locally harvested natural resources such as wood, clay, and reeds to build their houses.

4.2.2.1. Livelihood options

- Water security

The majority of the respondents indicate that the river is the main source of water (Figure 4.2) in Mayana and Uvhungu-vhungu for a variety of different needs such as small-scale irrigation, large-green scheme irrigation, drinking, household uses, brewing *Tombo* (traditional sorghum beer), building, traditional rituals, livestock drinking, schools and school gardens and business (lodges). The three lodges in the two villages are also reliant on the river for consumable water and water to conduct their operations. The presence of Okavango River also serves as an attraction hotspot for water tourism, and recreational activities.

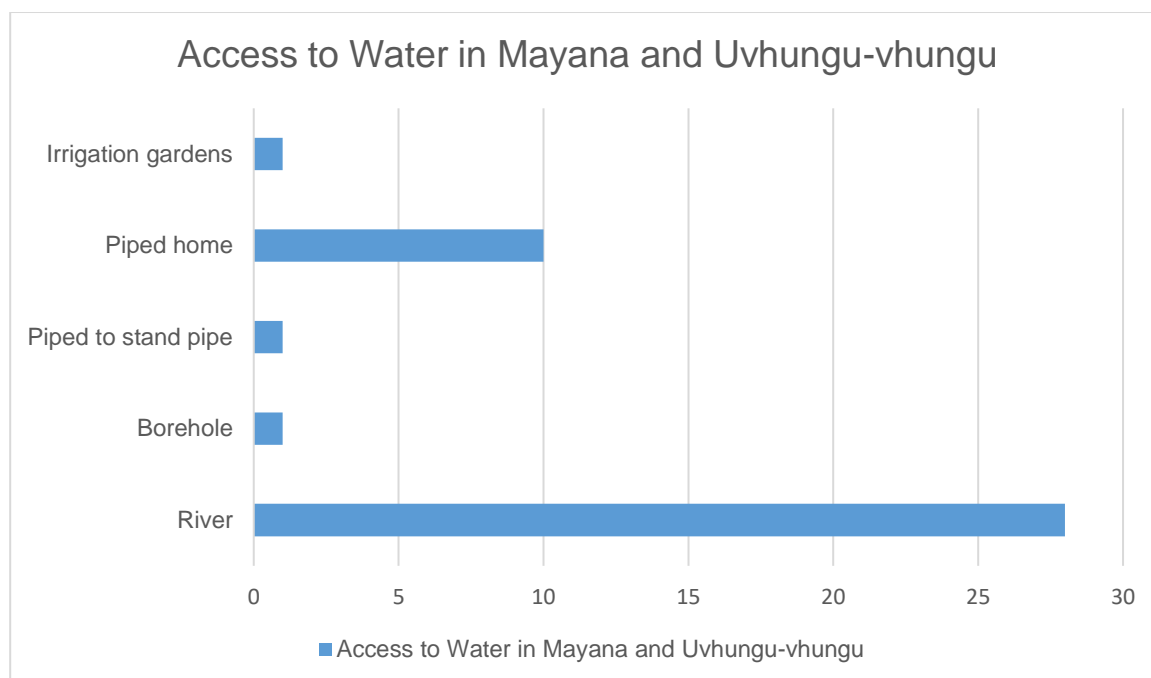


Figure 4.2: The bar chart illustrates the type of access to water in Mayana and Uvhungu-vhungu per number of times a type of access was mentioned.



Figure 4.3: Okavango River is the main source of water for the Mayana and Uvhungu-vhungu communities.



Figure 4.4: Water is used for small scale irrigation to produce food, mostly for household consumption.

Ten respondents from the online surveys indicated that every household has access to water, while seven respondents are of the opinion that only some households have access to water. Although most residents take water from the river, some have water delivered to their houses through a private pipeline, sourced from Namibia Water Corporation (Namwater) as highlighted by a respondent who said “those [well off

residents] *who can afford the pipelines are taking water from a Namwater tower in Kayengona*”, which is nearby the two villages. One respondent in particular indicated that there are four privately owned water points in Mayana and two public water points in Uvhungu-vhungu. According to some respondents, most people take water from the river, but some households collect water from small-scale irrigation gardens next to the Uvhungu-vhungu Green Scheme Irrigation Project. Twenty-seven (84 percent) respondents agreed that women and girls are the ones mostly responsible for collecting water. The Uvhungu-vhungu Green Scheme Irrigation Project (UGSIP) has erected water tanks next to the irrigation gardens for nearby residents (which are currently damaged), but this water is not treated for contaminants which was viewed as problematic.

Respondents said that the river provides food, water, aesthetic, and recreational opportunities for locals and visitors. The river also supports biodiversity alongside its shore which makes it ideal for lodge owners and guesthouses to set up their businesses. Three respondents indicated that the river provides reeds, clay and sand for building. There are small irrigation projects (community projects) alongside the river, which are mostly found in Mayana. Residents indicated that it is easy to set up small-scale irrigation projects in Mayana because there are more natural ponds alongside the bank of the river, which makes it easy to carry water by bucket (some use pumps and pipes) to the gardens. It is also easier to access the river in Mayana than in Uvhungu-vhungu because the area along the river is not fenced off.

- *Adequate sanitation*

All the respondents said that the residents of Mayana and Uvhungu-vhungu face several challenges such as having to use impure water directly from the river for drinking and cooking. Respondents pointed out that they are concerned about their health because of poor sanitation which they see as a serious matter and needs urgent attention. Most households have no toilets, therefore use the nearby bushes when nature calls as said by one respondent: “So far people are using bushes as a means of relieving themselves and this hinders their health” says one respondent. Additionally, most households collect water directly from the river for household use. Local people are also worried about lodges in Mayana because they do not know where this lodges dispose faeces and wastes. Respondents further pointed out that some residents still wash their clothes in the river.



Figure 4.5: Small-scale gardens (Figure 4.5b, c and d) in Mayana provide a livelihood to locals, in particular women. It is easy to set up small-scale irrigation in Mayana because there are more natural ponds than in Uvhungu-vhungu. Natural ponds (Figure 4.5a) make it easy to collect water than doing so directly from the river using buckets and pipes

- Food security

All the respondents have indicated that subsistence farming (Figure 4.6) is one of the main sources of livelihood options in the area, with ten respondents specifically mentioning crop farming. Uvhungu-vhungu Green Scheme Irrigation Project (UGSIP) (Figure 4.7) sells part of their produce to local people that can afford to buy. However, majority of the residents either produce their food, get drought relief food from the state, or harvest it from nature e.g., fishing, wild fruits, and hunting animals. Ten respondents cited small-scale irrigation farming as a source of food and income at household level in Mayana, including the CRIDF funded small-scale pilot projects in Mayana.

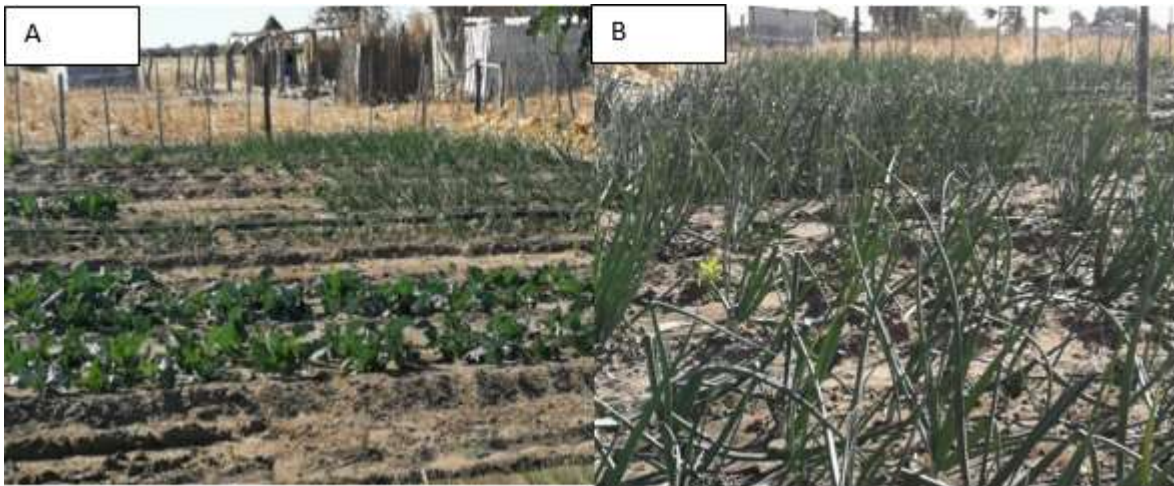


Figure 4.6: These gardens (in picture A and B) are set up right next to the Mahangu (millet) and maize fields which are the main source of food in the area. Mahangu and maize are rain-fed while horticulture gardens use water drawn from the river.

All thirty-two respondents stated that fish (see Figure 4.8 and Figure 4.9) is one of the main sources of food taken from the river. Respondents suggested that fish is more accessible in Mayana because of natural ponds along riverbanks which makes it easy to catch fish.



Figure 4.7: The UGSIP employs locals and people from other areas. It provides food which is marketed countrywide and it was set up before independence (in 1990) as a means of ensuring food security.



Figure 4.8: Fish is the main source of food from the Okavango River. It is mostly caught in Mayana due to the presence of natural ponds in the area (also see Figure 4.5a).

Apart from fish, *Namayara* (water spinach) were the most mentioned by respondents. *Mashwa* (lily roots), birds, otters, rats, hippopotamus, tortoise, snails, *Engangu* (plant), *Ehunguhungu* (plant), *Namahwa* (plant), *Xaba* (plant), *Khola* (plant), and *Lingangu* (plant) are other popular sources of food found in water (see Figure 4.9). It was further found that some food like snails, tortoise, and hippopotamus are not popular because most people either discontinued eating them and there are also taboos around their consumption. This is the same with catfish which is seen as a tool for ritual as is highlighted in the following sections.

Maize and millet (*Mahangu*) are the popular dry crop in the two villages (see Figure 4.10). Most respondents mentioned maize and millet which are seen as mainstays not only on a daily meal but as well as culture and lifestyle of Shambyu people (who live in both villages), particularly for residents who do not have gardens in their backyards or means of income to afford food and other basic needs. Wheat, livestock, beans, gourd calabash, and groundnuts are other supplementary food grown through subsistence farming. Other types of food grown in gardens, small-scale projects, and at the UGSIP are pumpkins, wild melons, cabbage, carrots, green pepper, tomatoes, butternuts, watermelons, and onions as discussed by respondents. Respondents also mentioned mutate (wild spinach which is either grown or found in the forest) and wild fruits as sources of food in the area.

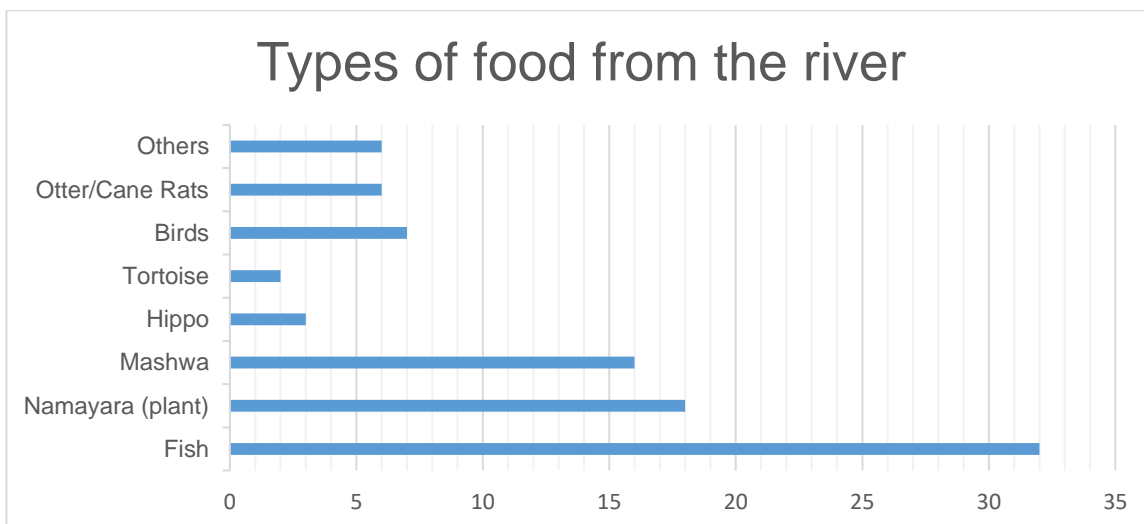


Figure 4.9: Popular food from the Okavango River found in Mayana and Uvhungu-vhungu as per the number of mentions by respondents. Other edible plants include *Engangu*, *Ehunguhungu*, *Xaba*, *Namahwa* and *Khola*.

Twenty-six respondents said that food is for both household consumption and for sale. Therefore, people mostly sell excess harvest, however, four respondents said it is for home consumption only. From the interaction with respondents, it is clear that most of their food is sourced from the river and fertile land adjacent to the rivers. However, the state also gives drought relief to households in the form of food during drought seasons when the harvest is low, and those in need through the constituency office.

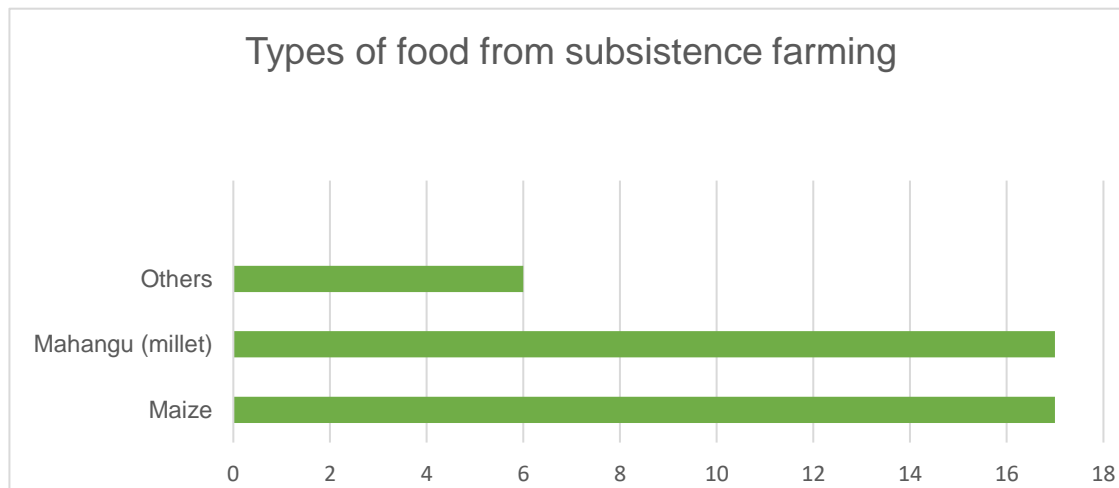


Figure 4.10: Popular food from subsistence farming and small-scale irrigation found in Mayana and Uvhungu-vhungu as per the number of mentions by respondents. Mahangu (Millet) and maize are the most popular dry crops in the two villages. Others include pumpkins, cabbage, beans, carrots, gourd, melons, Mutete etc.

- Energy Security

All respondents mentioned that fuelwood is the main source of energy in the two villages as illustrated in Figure 4.11. However, there is an exception of a few households (mostly those alongside the gravel road), private lodges, government infrastructures like schools, and the UGSIP who have access to electricity from the central grid. Wood is mostly used for cooking, heating, and lighting, with twenty-two respondents mentioning cooking while nine mentioning heating and lighting, respectively. Respondents are however worried that wood has become scarce of late as highlighted by a respondent who said “wood is collected from far fields”. Twenty-four respondents said that wood is mostly collected by women and girls.

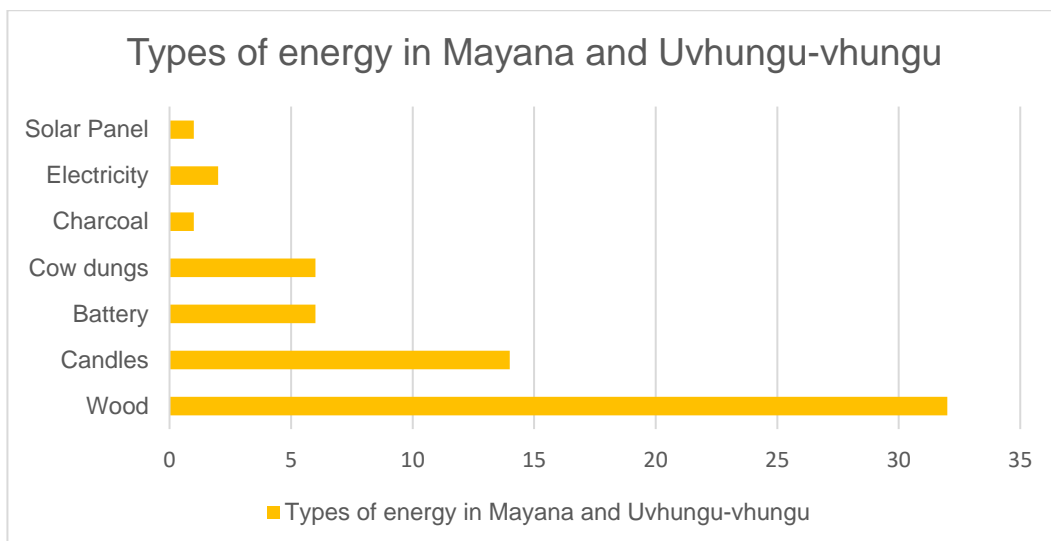


Figure 4:11: Sources of energy in Mayana and Uvhungu-vhungu. Fuelwood is the most popular source of energy in the two villages. Wood is the most common source of energy for most households.

Residents also use cow dung for heating and battery torches for lighting as acknowledged by six respondents. Fourteen respondents said that candles are commonly used in households, mostly for lighting purposes at night. Only one respondent acknowledged charcoal as a source of energy.

Only two respondents directly mentioned electricity as a source of energy. Respondents in general said that only a few residents have access to electricity and gas stoves (all thirty-two respondents agreed) for example one respondent said: “Electricity is only accessible to those that live alongside the gravel road”. Respondents further pointed out that electricity is more accessible in Mayana as highlighted by a respondent who said “in Uvhungu-vhungu, people are pushed far away from the gravel road due to the UGSIP and Kaisosi River Lodge”, who emerged as the main beneficiaries of electricity from the grid. Respondents further indicated that even if one wants to get electricity from the grid, it will be difficult because transformers needed to bring electricity at homesteads are very expensive, unless people form cooperatives and share costs which is not common.

Solar panels as a source of energy were only mentioned once by a respondent who tried to explain how an NGO-funded small-scale project pumps the water from the river. From the interaction with some respondents, small photovoltaic panels are used across households in the area to charge phones and radios. Residents in the area also use petrol for transportation (cars) but more commonly, diesel in tractors at UGSIP and by subsistence farmers during the cultivation period. Some respondents also cited oxen as a source of energy as they are used to cultivate the land by most residents who still cannot afford to make use of subsidised tractor.

- *Nature's Contributions to Livelihoods.*

The Okavango River is source of most building materials used to construct traditional houses such as grass, reeds, clay, sand, and water which also used during construction. Additionally, respondents indicated that the river is a source a variety source of food as indicated in the earlier sections, which provide income to fishermen, in Mayana. The village of Mayana has a lot of pans, hence its name 'Mayana or Mazana' in Shambyu, which means pans. The pans serve as natural routes for flood water to divert away from highlands into the river, eventually preventing flooding. Natural ponds alongside the river in Mayana enable residents to easily catch fish and collect water for small-scale irrigation activities. Indeed, the presence of the river attracts land and water tourists. These tourists use three local lodges in the area for accommodation, which in turn employ local people.

Villagers use the river for socialising (swimming, hosting parties and cooling off). Shambyu people also bury their kings and queens on the riverbanks as a form of respect for their statuses. The river is also used for ritual practices such as cleansing and communication with ancestors. During the interaction with one of the residents, the researcher has learned that Tilapia fish are favoured over Catfish unlike in other parts of Namibia as Catfish are used for witchcraft to cleanse ugly spirits from cursed and sick people. The Catfish is then thrown back into the river alive after being used in rituals signifying an important cultural practice.

During fishing, women tell stories and share news that matter in the villages. Women do not just get to engage in conversation when fishing, but it is also an opportunity to socialise and build important social capital and get away from house chores that awaits many of them at home. It was also found that residents of the two villages collect food such as Mutete from the nearby forests. Fortunately, residents also came to learn how to cultivate Mutete which now being part of the home-grown vegetables during the rainfall seasons. The nearby forests provide wood for building, fuelwood, and also wood for carving. Wood crafters produce wooden plates, cups, chairs, wooden replica of animals that are sold to tourists, wood handles (*mupini*) for hoes, axes, and wooden pieces for pounding Mahangu (called *Muhwi* and *Sini* in Shambyu).

Sufficient ground water in the area enabled a secondary school in Mayana to depend entirely on a borehole for its water needs. It was also found that the fertile land in the area makes the two villages favourable for food production. The nearby forest is not just a source of wood, but it is also a grazing ground for livestock.

Livestock drink from the river which makes it easy for villagers to breed healthy livestock. Residents are also heavily reliant on biomass (cow dungs and wood) for energy. Cattle also provide income for residents while equally contributing to food production (oxen) and meat for the household. Also, cattle serve as an important part of the local people's culture as it is used to compensate the bride's family, while bulls are slaughtered during weddings and funerals to feed attendants. The livestock skin (such as that of goats and cattle) is useful in many ways from making clothes, blankets to being turned into a delicious meal. As part of the Shambyu culture, men own livestock, sometimes symbolically because they are the head of the household.

- Income

Residents of the two villages get their income from selling their produce from subsistence farming, fish, livestock, and craft. Some residents work and earn an income from UGSIP (Figure 4.12a and Figure 4.12b), small-scale irrigation projects, and other residents earn salaries by working at the lodges. Some households receive income from family members and relatives who live and work in urban areas, since most residents do not have an income at all. The job opportunities that are available in the area such as employment at UGSIP are casual for most people and they only work during the harvest season. It is common to find shebeens (informal bars where alcohol is sold) in many corners around the villages. At shebeens, residents sell *Tombo* (Sorghum beer) for income. Gathering at shebeens is regarded as a form of recreation for many people in the two villages.

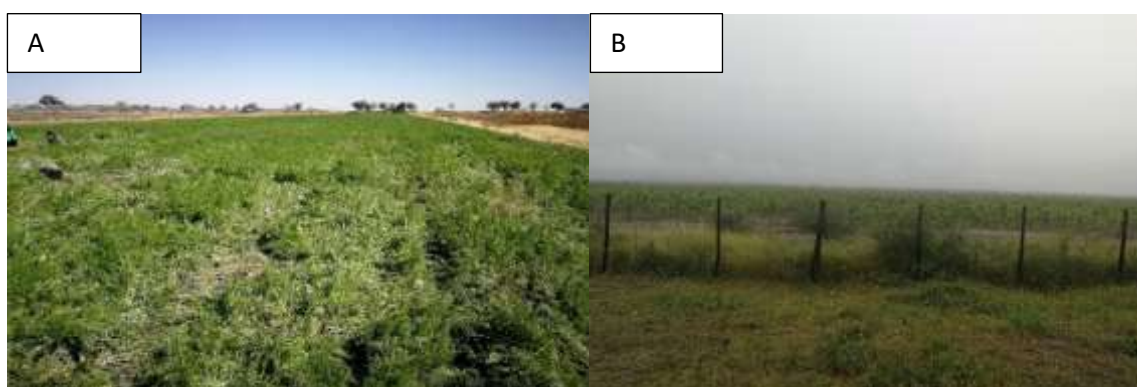


Figure 4.12a: The UGSIP uses seasonal workers for the harvest of their produces. This provides an additional income for residents of Uvhungu-vhungu. Figure 4.12b: The UGSIP provides employment. A part of the farm is divided into 50 plots measuring 1ha for small-scale farmers.

- Potential Livelihood Options

Respondents stated that the two villages hold a high potential for food production (crops, vegetables, and meat), water supply, and employment creation due to the presence of the river and a rich biodiversity. Notably, respondents mentioned that these potentials can only be unlocked if there is improvement in infrastructure such as water pumps and pipelines, desalination, sanitation, rainwater harvesting, boreholes, education, and enhanced access/connection to energy. They believe that this will help kick off economic activities for local people. There are further potentials for women empowerment through intensified small-scale irrigation projects and urban farming, consequently, also earning them an income as highlighted by one respondent who said “If we can produce more from our gardens then we can sell to others, and we are looking forward to the completion of the water pipeline project by CRIDF. We want to make change and create jobs opportunities mostly through agriculture for the grade 12 dropouts”.

Respondents highlighted that most learners who dropped out of school can be trained to acquire vocational skills in sustainable farming methods, and entrepreneurship in order to help them contribute to their communities. Other potential activities that respondents believe can enhance livelihood options in the area

are the establishment and construction of recreational activities for local people and visitors. Some respondents believe that further research on livelihood in the area will help create a better picture of what is needed there, which can be used to take appropriate action for social upliftment.

4.2.2.2. Livelihood interventions

Most respondents are concerned that there are few-tangible livelihood interventions to help alleviate poverty and ecological degradation in the two villages. However, there are schools in both villages, a gravel road, and an electricity line along the gravel road. There are three lodges (two in Mayana and one in Uvhungu-vhungu) one large-scale irrigation project (UGSIP) and a 50-ha small scale irrigation project in Uvhungu-vhungu. There are privately owned small-scale irrigation projects in Mayana, and two NGOs funded small scale projects that are intended to support women with climate resilient farming methods such as conservation agriculture. There is a water pipeline project under construction funded by CRIDF, which is intended to use solar renewable energy to pump water from the river. The pipeline will deliver water to residents in Mayana and the small-scale irrigation projects funded by CRIDF in the village. This will supplement the only borehole installed at a secondary school in Mayana. Respondents also indicated that there are school feeding programs to help with supplementary nutrition and social grants for the elderly, those deemed vulnerable, and those living with disabilities.

Findings indicated that social grants significantly sustain livelihoods for poor rural children, old people, and people living with disabilities as articulated by one respondent who said: "Social grants are helping in a big way, they should be continued". The state also provides drought relief food to those that qualify during drought seasons. In addition, farmers are given seeds by NGOs and from the constituency offices while they are also allowed to hire government tractors at a subsidised price.

The UGSIP (see Figure 4.12a and Figure 4.12b) which was set up pre-independence and actively supported by the government as a means of ensuring food security and employment for local people, seems to be run by people from other regions in Namibia as reported by some respondents, adding to a sense of exclusion. This was attributed to a perceived lack of skills and capacity and limited adult education amongst locals.

Table 4.1: A comparison of existing interventions between Mayana and Uvhungu-vhungu. Latest interventions in the area that are mostly focused in Mayana such as small-scale irrigation projects (CRIDF, 2019; NSA, 2014).

Interventions	Villages	
	Mayana	Uvhungu-vhungu
Lodges	1	2
Large irrigation schemes	0	1
Water points (taps)	4 privately owned	2 public water points
Boreholes	0	1
Employment opportunities	Lodges	Lodges, UGSIP and small-scale irrigation plots feeding from the main project (1983)
New projects	CRIDF water pipeline , CRIDF small-scale irrigation project, and support (2019)	None
Electricity	Lodges, schools, a few well-off houses along the gravel road	Restricted to mostly UGSIP, school, and Lodges
Food access/production	Fishing, subsistence farming, limited small-scale irrigation, livestock breeding, and state drought relief. Seeds and tractors subsidies	Limited fishing, subsistence farming, small-scale irrigation, UGSIP, livestock breeding, and state drought relief. Seeds and tractors subsidies
School feeding programmes	Available	Available

Next to the UGSIP is a small-scale irrigation project that was established by the Namibia Development Corporation (NDC) and now under Ministry of Agriculture, Water and Forestry (MAWF) in Uvhungu-vhungu. Respondents said that this project focuses on horticulture and it draws water from the main irrigation farm's pipeline. The project is on a 50ha land, run by about 50 local farmers (figure 4.13b) and most of these plots are mostly run by women. Respondents said that the 50 ha small scale projects are effective and those that are fortunate to be allocated the plots are benefiting from the project. Other major interventions in the area as discussed in the first paragraph of this section, are the initiatives of NGOs. Six respondents said that there is a small-scale irrigation project funded by the United States Agency for International Development (USAID) through a Sustainable Agriculture Research and Education Program (SAREP), the Development Assistance from People to People (DAPP Namibia), European Union (EU), U-landshjälp från Folk till Folk i Finland sr (UFF-Finland), and Namibia Nature Conservation (NNF) (Figures 4.13a, 4.13b and 4.14).



Figure 4.13a: A board at a SAREP small-scale project displaying the names of donor organisations. Figure 4.13b: The SAREP small scale irrigation funded by DAPP Namibia, European Union, UFF-Finland, and Namibia Nature Conservation to help train small-scale farmers on CA in Mayana. Most participants are women.

The project draws water directly from the Okavango River using a solar pump. Through this project, local women are also trained on conservation agriculture (CA), provided with climate resilient seeds, and establishment of food gardens. One of the respondents from Mayana mentioned that “conservation agriculture, a new farming method that helps us cope with climate change is one of the climate adaptation options and is improving harvests for people who are using these mechanisms”. Respondents also referred to the CRIDF water pipeline project (Figure 4.15) in Mayana which is intended to deliver water to the community of Mayana.



Figure 4.14: A CA project in Mayana that is set up to help communities adapt and learn new climate-resilient methods such as growing legumes and millet in the same field to maximise the yield.



Figure 4.15: A CRIDF funded water pipeline in Mayana is intended to supply water to small-scale farmers in Mayana.

Respondents are also concerned that adult education has been discontinued (in Uvhungu-vhungu). Additionally, all respondents pointed to a lack of capacity building, access to information on farming techniques, training, and equipment for SMEs and agricultural activities. It was further found that high school learners walk long distances to school – “education is not well covered; some learners walk up to 10km” to school, says one respondent. Another issue raised by a respondent is lack of enough classrooms, “overcrowded schools and classrooms and lack of Primary Healthcare facilities (clinics) is a problem”. There are no clinics in either of the two villages except in the Kayengona village which is situated between Mayana and Uvhungu-vhungu.

4.2.2.3. Equity

Different dimensions of equity emerged from this research, these dimensions relate to issues of distribution and recognitional issues.

- Distributional Equity

It is evident from the interaction with respondents that the presence of UGSIP in Uvhungu-vhungu creates an imbalance of opportunities in comparison to those living in Mayana. “Electricity is only accessible to those that live alongside the gravel road”, it is more accessible in Mayana because “in Uvhungu-vhungu, people are pushed far away from the gravel road due to the irrigation farm”, says respondents. The study found that those who are fortunate to benefit from small-scale irrigation funding and plots are reaping the benefit of sustained nutrition and income as the UGSIP provides an opportunity for employment in the village. Although some small-scale farmers benefit from UGSIP through water provision, respondents said that some private (self-funded) small-scale farmers who did not receive funding from the government and donor

organisations (see Figure 4.13a), collect water using buckets on their heads to water their gardens. Respondents said that this is the case with some small-scale farmers who are situated far from UGSIP because they cannot tap into the UGSIP pipeline or afford neither solar nor diesel pumps.

It was also found that the lodges in the two villages are not owned by people from the area, but rather by people from other regions. The Kaisosi River Lodge and the UGSIP additionally “block a large part of access to the river” with their fences, says a respondent which is a sentiment shared by another respondent. The fences also pushed residents far away from the river. Also, the UGSIP is set up on both side of the gravel road and electricity line which has blocked off the road that leads to Rundu. The presence of the fence implies that most homesteads in Uvhungu-vhungu are now located far from the electricity line. Respondents say that this is one of the reasons that fishing in Uvhungu-vhungu is almost impossible, making Mayana the most accessible for fishing between the two villages. Consequently, they argue that it is equally easier to collect sand, clay, and harvest reeds and grass in Mayana than in Uvhungu-vhungu. However, respondents have also indicated that fishing in Mayana is not just accessible because residents can easily access the river, because they have natural ponds alongside the river which act as fish catchment, as well as less sand.

One respondent in Uvhungu-vhungu indicated that the government fishing and forest regulations restrict their normal use of resources. Additionally, a respondent indicated that the establishment of Green scheme projects and lodges that cover a big area of land restrict access of the villagers to be able to cultivate crops and raise livestock, and use the spaces for grazing areas. However, some respondents in Mayana did not share the same sentiment, they argued that there is no, or insufficient restriction on fishing (amount or size of catch).

- Recognitional Equity

It was found that there is inconsistency in the inclusion of local people in decision-making. Nine respondents said that people are consulted before any project in the area, eleven said consultation happens only sometimes. Respondents in Uvhungu-vhungu said that the 50ha small-scale irrigation scheme plots next to the UGSIP were expanded without proper consultation. However, some respondents from Mayana said that there was a lack of consultation on an ongoing water pipeline project. They gave an example of a recent community protest over a water pipeline in Mayana because residents said that their crop fields are being destroyed by the project because they were not properly consulted and there was no compensation offered (Figure 4.15).

When asked whether women are being included in decision making, most women respondents answered that women are involved in decision-making. When it comes to household responsibilities, men and boys tend for livestock while women collect wood and water. During the rainy season, men plough while women sow. Weeding is a combined responsibility, but women are said to have more responsibilities during that period. Men were found to mostly own livestock; sometimes symbolically because they are the heads of the

household. Respondents said that even if the livestock belongs to a woman, it must be seen as belonging to the man.

4.2.2.4. Other challenges

Some respondents commented that fishing tools of local fishermen and fisherwomen are sometimes stolen by Angolans. Twelve respondents have mentioned drought or climate change as a challenging factor. They indicated that drought affects their ability to catch fish, birds and *Makanda*, because the catch goes down when the water level is low. It was found that there are frequent floods in Mayana, and sometimes the river overflows into the villages during good rainy seasons. Respondents further spoke about a lack of market for their produce such as millet, tomatoes, cabbage, and onions as well as a lack of infrastructure and services, lack of tangible development, and a lack of sufficient support for small-scale irrigation projects, such as overbooked government tractors.

Other factors that affect livelihoods in the two villages as indicated by respondents include lack of unity amongst villagers. Eight respondents also spoke about the high level of alcohol abuse as a challenge towards, education, agricultural productivity and performing activities that brings in income. Teenage pregnancy was rarely mentioned, with only six respondents referring to it as a challenge although this did emerge as a challenge mentioned in policy documents. Other challenges are that craftsmen and women are forced to travel and do their wood work in Rundu where there is a workshop with equipment instead of working within their villages.

Table 4.2: A comparison of livelihood challenges between Mayana and Uvhungu-vhungu.

Livelihood challenge/factors	Quotes from Respondents	Place of concern
Sanitation (impure water and lack of ablution facilities)	"... so far people are using bushes as a mean of relieving themselves and this hinders their health..."	Mayana and Uvhungu-vhungu
Long-distance walk to the river in order to collect water	"...Some villagers walk long distance to the river to fetch water..."	Mayana and Uvhungu-vhungu
Unemployment	"High youth unemployment..."	Mayana and Uvhungu-vhungu
Lack of training and capacity (in agriculture and employment creating vocational courses)	"Lack of good training... Yes, people need a great support to be educated on how they can develop skills to understand the idea of sustaining themselves."	Mayana and Uvhungu-vhungu
Need for a clinic or Primary Health Care Facilities	"overcrowded schools and classrooms and lack of Primary Healthcare facilities (Clinics)"	Mayana and Uvhungu-vhungu
Walking long-distance to school	"...some learners walk up to 10km"	Mayana and Uvhungu-vhungu

Fishing limitation	"...Government fishing regulations in place...limit people's use of the resources."	Uvhungu-vhungu
Forest regulation	"... Government's forest regulations laws also limit how much wood resources is harvested."	Mayana
Limited access to the River due to the presence of lodges and irrigation projects	"Establishment of Green scheme projects and lodges that cover a big area of land whereby the villagers could not cultivate crops and raise livestock...."	Uvhungu-vhungu
Drought	"Lack of rainfall in some years...drought sometimes"	Mayana and Uvhungu-vhungu
Flooding	"Yes, when it rains heavily, there is flood in Mayana..."	Mayana
Difficult access to the market	"Craftsmen and women operate from Rundu because there are equipment and an operating place there..."	Mayana and Uvhungu-vhungu
Inadequate or lack infrastructure	"...electricity is only accessible to those that live alongside the gravel road", it is more accessible in Mayana because "in Uvhungu-vhungu, people are pushed far away from the gravel road due to the irrigation farm..."	Mayana and Uvhungu-vhungu
Lack of unity	There is no unity in the community...Community leaders could be educated on how to unite their members and come up with community building projects or activities..."	Mayana and Uvhungu-vhungu
High level of alcohol abuse	"...alcohol consumption by villagers because they have nothing else to do."	Mayana and Uvhungu-vhungu
Fenced off communal land for commercial purpose	"...in Uvhungu-vhungu, people are pushed far away from the gravel road due to the irrigation project"	Uvhungu-vhungu

4.3. Updated conceptual social-ecological systems map of the study sites

After carrying out the online surveys and in-depth telephonic interviews with respondents, the system diagram Figure 4.16 was updated based on information obtained by the researcher from data provided by the key informant and respondents who are stakeholders in the villages of Mayana and Uvhungu-vhungu and additional literature. Poverty and unemployment remain high in the two villages, and the dependency on ecosystem services leaves people from the two villages vulnerable to climate change. Most of the initial findings from document reviews such as culture, and ecosystem services (livelihood options) from the

respondents confirm many of the relationships and interdependencies. Other changes on the system are depleting fuelwood, access to the river and increasing drought.

Central to this social-ecological system map is the Okavango River which is linked to various interacting elements including livelihoods, and ecosystem services, as well as other actors. The map highlights how actors, ecosystems, livelihood activities and options interact with each other. Actors and livelihood activities have a positive (blue line) impact or add to one another (Figure 4.16). Similarly, some actors and livelihood options have a negative (red) impact or subtract from one another. For example, population growth influences the availability of clean water while availability of energy can reinforce accessibility of water to the population. Many of the relationships are underpinned by the availability of water from the Okavango River. The inseparable relationship between agricultural activities and water is also dependent on access to energy. Most small-scale irrigation projects and commercial agriculture activities such as UGSIP rely on pumps powered by electricity from the grid while some small-scale projects use solar pumps and diesel pumps to pump water from the river. Electricity is also vital in cooling food products at the UGSIP and lodges. Diesel and petrol are essential for human mobility in the area but as well as in food production. Perhaps the most used source of energy is wood which is sourced from forests. Wood is used for cooking and lighting, while candles are essential for providing light at night.

The heavy reliance of rural communities on ecosystems in these two villages implies that there is an urgent need to ensure that biodiversity remains intact and ecosystems are protected. A high level of poverty and slow socio-economic development implies that people are more reliant on ecosystems for their livelihoods and wellbeing and resource use can become unsustainable. There might be a danger of weakening regulating, provisioning, cultural and supporting ecosystem services which are integral for sustainable development. The lack of adequate development interventions and state led support imply that the growing population remain heavily dependent on ecosystem services which will eventually cripple their ability to recover. Understanding how the system interacts and affect social-ecological systems in the two villages can help inform policy, interventions and behaviour change through advocacy which can contribute towards more sustainable and just outcomes.

Regulating ecosystem services are often “hidden” parts of complex social-ecological systems, playing an important role in mitigating floods, ensuring sufficient water quantity and quality, carbon sequestration, erosion prevention and pollination. Tourism, which is either water or land based, relies mostly on the river and rich ecosystem services (biodiversity) in the area. It also directly interacts with infrastructure, food, and availability of energy in the two villages. Tourism potential ensures the establishment and continuity of lodges.

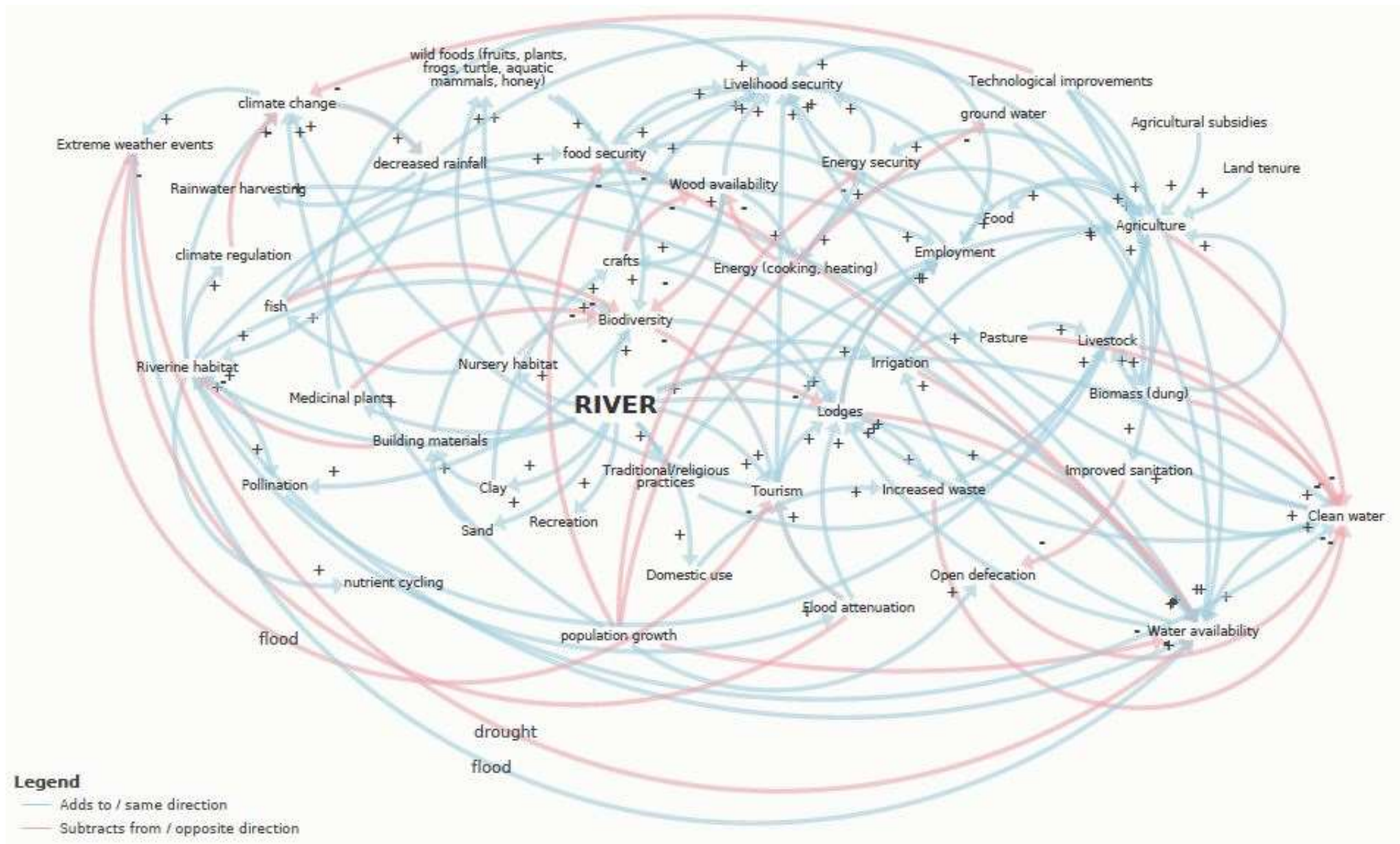


Figure 4.16: An updated social-ecological system diagram of different elements and systems that are interacting in and around Mayana and Uvhungu-vhungu villages of the Kavango East Region. This diagram is updated after conducting interviews and getting a better view of the connections in the two villages

The future resilience of the two communities on the Okavango River is also subject to what happens to the river water on the Angolan side and decisions taken by the OKACOM. Indeed, interactions of different systems in the area are complex and affect livelihood in different ways. Infrastructures such as roads, basic services, and electricity are necessary for socio-economic development, but their inadequacy hinders progress in the three sectors making up the WEF nexus.

Potential drivers of livelihoods in the area, some of which were identified in were identified under chapter 2.6 and others under chapter 4.1 to chapter 4.2 are population growth, technology change, culture, climate change, land tenure, and other economic activities such as fishing, etc. These drivers either have a positive or negative impact on a livelihood, depending on how their emergence interacts with the system. Policy enhancement, education, infrastructure development, state subsidies for agronomic activities and small and medium (SME) enterprises development, employment creation activities, inclusion, as well as good management of water and land ecosystems can help improve livelihoods and human well-being in the area significantly. This is also likely to contribute to the attainment of many sustainable development goals and targets.

While this conceptual social-ecological systems map is still inadequate in capturing all of the important linkages in the system, it provides a useful tool for mapping out some of the key interrelationships with the WEF nexus and can allow for future research into some of the changes that might be necessary to enhance more sustainable outcomes for both people and the ecosystems that they rely on. Importantly it provides an illustration of the system that allows for dominant relationships to be visualised and highlights the importance of the Okavango River for many livelihood options for people living adjacent to it. It is also useful for further discussions with stakeholders to stimulate discussions on what they perceive important relationships to be.

Chapter 5: Discussion

5.1 Overview

The objective of this research was to understand existing and potential livelihood options for the communities of Mayana and Uvhungu-vhungu villages of Kavango East Region, by exploring the interactions and interconnections between water, energy, and food to co-develop recommendations and response options for enhancing livelihoods.

It is clear from the interaction with respondents that the communities of the two villages are heavily reliant on natural resources for their livelihood options. It is also clear that the river and fertile land are at the centre of the provisioning of the ecosystem services in the area. Not only does the river provide water, building materials, and food but there is an inseparable attachment between the river and local culture (Figure 4.16). Land ecosystem services are equally essential to the local peoples' livelihoods because they provide fuelwood, building materials, and space for food production. It was also found that there is a high level of poverty, lack of infrastructure, poor sanitation, and lower literacy. This is in agreement with much of the issues discussed in the literature review under chapter two of this thesis (Diaz *et al.*, 2018; IPBES, 2018; Guerry *et al.*, 2015; Speranza, Wiesmann and Rist, 2014; Scoones, 1998). The following sections discuss livelihood options related to water, food, and energy and how nature contribute to these, livelihood interventions by various actors, as well as equity and other challenges.

5.2. Livelihood Options

The results of this thesis show that livelihoods options, especially those that are necessary to meet basic human needs linked to food, water and energy are dependent on a healthy, functioning river, and associated riparian zone (Figure 4.16). Moreover, local food security- either through farming, fishing or rearing livestock is dependent on the sufficient availability of, and access to water from the Okavango River. This is consistent with findings of ecosystem service assessments and how they contribute to livelihoods in Africa (IPBES, 2018). The availability, access to, and quality of the water is in turn being impacted by particular land-use activities linked to commercial farming (through restricted access to land and irrigated water) and tourism activities (lodges blocking access to water or sewerage pollution). This blockage of access has knock on impacts for local food and water security- especially for the majority of residents who still harvest water directly from the river. However, commercial farming and lodges also provide potential income sources for people, through direct employment, which can supplement subsistence farming and harvesting of natural products for consumption and use.

Population growth in the region is predicted to increase to 153 255 in 2019 from 136 823 people in 2014 (CRIDF, 2019; NSA, 2016; MLR, 2015; MLR, 2015) which will exacerbate demand for water, food and energy.

Water insecurity has devastating effects on food production, human well-being, and the sustainability of livelihoods. Additionally, climate change is predicted to reduce the availability of water for drinking, growing food, maintaining sufficient ecological reserves and increasing energy needs (Bizikova and Swanson, 2013:4). In addition to current livelihood options, there are other livelihood potentials in the two villages (figure 4.16) as discussed by respondents. However, these potentials can only be realised through investment in ecosystems and human capitals in order to generate benefits for human well-being and the environment. Equally, women have a higher participation in food production, hence their empowerment through funding of small-scale projects and trainings (as discussed in section 4), will ensure an equitable sustainable development which has been found in other examples such as the funding of small scale irrigation projects in Mayana and Uvhungu-vhungu. This is in agreement with the World Bank (2003) report which argued that women are willing to invest in their families' nutritional needs, they will be at the forefront of change because they suffered for long (Mies & Vandana, 2014), while at the same time, the inclusion of rural women will aid in reducing inequity, inequality and poverty (Blewitt, 2018).

5.2.1 Water security

The reliance of the two villages on the river for household water use, and lack of infrastructure indicates that there are issues of water security in the two villages because water is not readily available or good enough for household and human consumption. Residents also travel long distances, as far as 5km to get water in the nearby Kayengona village, implying that the region faces economic water scarcity in which there is little or no investment in water resources technology and infrastructure, (Ho *et al.*, 2014; Vidyasagar, 2007). This is a reality facing many people living in rural areas in the global south, in particular the two villages under study, and it is often women and girls who carry out this work (UNEP, 2016), of fetching water by walking long distances.

The Ministry of Lands and Resettlement (MLR) report of 2015 estimated that water consumption for rural domestic, livestock watering, and irrigated agriculture activities in the Kavango East and West regions will increase from 41 million m³ in 2008 to 185 million m³ in 2020. The MLR (2015) and Namibia Statistic Agency (NSA) (2015) reports further shows that over 70 percent of water use in the area is for agriculture and irrigation and expected to increase to 89 percent by 2020. These reports further underscore the importance of maintaining the health of the river ecosystem. Although the river has sufficient water throughout the year, the possibilities of contamination, and exclusion of villagers through blockages of access, or competition for water with other projects (e.g., irrigation projects), will likely cause other problems such as further economic water scarcity and extinction of

aquatic resources and species. The imperative is therefore setting up adequate policy that considers a multisectoral approach (Krchnack 2011).

5.2.2 Food security

Although the presence of the UGSIP seems to be a solution to food security in the area, such projects have more detrimental effects on the environment than on food security and the focus should rather be on smaller irrigation schemes (Kawana, 2016). This sentiment is also supported by respondents who stated that the 50 ha small-scale projects alongside the UGSIP are more beneficial to the farmers and local people than the UGSIP. In part because of this lack of access, the two villages rely heavily on drought relief for nutrition (NSA, 2016).

Villagers have settled near the river on small plots, making it difficult to cultivate sufficient food for the whole family. This has created trade-offs between increased food insecurity against the availability water which is needed for both food production and household use (Kawana, 2016). Another reason for settling near the river is to be able to access water for household use, and avoid walking long distances during dry seasons. There is a need for supportive policies and interventions to be implemented that can provide piped access to water for those that wish to increase agricultural productivity in larger areas (Mwoombola, 2017; Kawana, 2016).

Drought is posing a threat to the production of staple crops such as Mahangu (millet) and maize; hence they are cultivated only during rainy seasons at subsistence level (although the UGSIP is also producing maize for commercial purpose). According to Mwoombola (2017:87), the region of Kavango East Region requires climate-smart initiatives like quality, drought resistant seeds, new farming methods, and social protection programs for the vulnerable communities. Practices such as closing the yield gap by growing more cereal, fruits, and vegetables through sustainable intensification as discussed by Hall *et al.* (2017) can also be useful for the residents of the two villages. However, Hall *et al.* (2017) argue that such practices need major investment in technology, better-quality seed variations, fertilizers, irrigation schemes, and machinery to boost yields and ensure the nutrient adequacy of the food supply. Indeed, such investment will need proper management because they could have impacts on other systems such as agricultural runoff, exploitation of natural resources such as the fertile land, and pollution from machinery

Livestock are kept for a multiplicity of reasons such as for sale, cultivation of crops, dung for manure and meat as is common in many agrarian landscapes as discussed by respondents. The use of livestock for food production in rural area is another proof that rural communities rely on ecosystem services for their livelihood, and the interconnections between various livelihood options. The continued use of livestock for food production requires protecting the grazing area, ensuring water availability for livestock, and safeguarding surrounding ecosystems. However, careful management grazing activities needs to take place to ensure that intensive grazing does not lead to land degradation (IPBES, 2018; Hauser, 2015; MLR, 2015).

5.2.3 Energy security

Fuelwood is the most commonly used source of energy in the two villages. This finding is in line with the Ministry of Lands and Rehabilitations (MLR, 2015) which reported that almost 83 percent of households in the Kavango East Region depend on fuelwood, while only 12 percent use electricity to cook. However, some respondents said that wood is getting scarce, and are therefore being collected from far afield. This is also similar to the views of Carpenter *et al.* (2005) and Folke *et al.* (2011) who argue that significant changes in ecosystem services around the world are due to a growing population whereby people need more timber and fuel, consequently altering ecosystems' ability to support livelihood. Loss of biodiversity through deforestation for fuelwood will not only negatively affect the availability of ecosystem services for the people of the two villages, it is also contributing to climate change and other social-ecological issues such as poverty (Giurge *et al.*, 2020; Hyde *et al.*, 2020).

The dependency of the two communities on wood, cow dungs, oxen for land cultivation, dietary energy, and in some instances solar panels for energy use equally imply that these communities are heavily reliant on ecosystem services for their energy needs. However, a dependency on green infrastructures (see definition under chapter 5.2.4) is not reliable if the investment in built infrastructure does not complement green infrastructure (Gruetzmacher *et al.*, 2020; Krchnak *et al.*, 2011). According to IPBES (2018), burning fuelwood degrades the environment if not well managed by causing a loss of biodiversity, and it releases carbon into the atmosphere. Firewood burning is causing indoor air pollution, which has significant health impacts on communities using this form of energy (Langbein, 2017).

Electricity is extensively used by the UGSIP to draw water from the river, operate machinery, and power lighting, and cooling systems. Grid electricity is available at the three lodges in the two villages. However, this is not the case with Mayana and Uvhungu-vhungu residents because electricity is only reachable to those that live along the gravel road, which is the main road passing through the villages. In addition, transformers are unaffordable to residents who are mostly poor (NSA, 2014). Notably, the pace of electrification has been slow and mostly restricted to government assets in rural areas (ASECAP, 2016).

It was found that there is a use of diesel for machinery at the UGSIP and tractors that are used to plough irrigation fields. This type of fuel has direct and indirect effects on the biodiversity because they emit a huge amount of carbon into the atmosphere. There was not enough evidence from respondents related to the use of diesel for fuel at household level (such as electricity generation etc). However, it was found that residents also use battery torches and candles for lighting and heating, while charcoal was also found not to be a popular choice for sources of energy in the two

villages because it was rarely discussed. Solar energy was found not to be popular in the area as it is only found to be used and installed by an NGO at a small-scale irrigation project in Mayana. Indeed, the use of solar panels in Mayana for pumping water directly complements the targets of SDG goal 7 which aims for clean and affordable energy. Although photovoltaic cells' prices are falling (DEA, 2016), their prices are not affordable in Mayana and Uvhungu-vhungu as per conversations with respondents. If availed to residents at an affordable price, they will help in pumping water for household and irrigation and consequently improving lives. As noted by Swilling and Annecke (2012), energy transition and decarbonisation are necessary steps toward a green economy and reduced carbon emissions. The reduction and supply of affordable energy will ensure energy security in the region while helping drive economic development.

5.2.4 Livelihood interventions

Although several livelihood interventions have taken place in the two villages (see Table 4.1), many of these may not be adequate to lift people out of poverty. Lade et al. (2017:5) argue that "In a conventional single-dimensional, multiple-equilibrium poverty trap, asset inputs such as cash, technology, artificial fertilizer, or pesticides (which they call type I interventions, see Table 5.1) succeed once the input is sufficiently strong." They gave three examples of "poverty alleviation pathways":

- Type 1: push over the barrier (bringing in infrastructure or capital to move the system over the barrier);
- Type 2: lower the barrier (changing how things are done to level the playing field);
- Type 3: transform the system (modify or overhaul the system fundamentally).

Of these three pathways, most of the interventions in the study sites have fallen under the first pathway (push over the barrier) and a few in the second pathway. Interventions do not seem to be enough because it is evident from interviews with respondents that poverty is still rife in the two villages. This supports the argument of Lade *et al.* (2017) that a new approaches, underpinned by systems thinking are necessary (in their example, a resilience-based approach) which can assist with finding solutions that are better suited to the needs of people in the two villages. It is therefore imperative to shift the system from Type 1 interventions, which are commonly used but proved to be of less success, to Type 2 & 3 such as small-scale irrigation projects implemented in consultation with local community members by using tools such as the Wayfinder process (Enfors-kautsky, E. *et al.* 2021). This way, consultation is a holistic approach where members of the stakeholders co-create knowledge and solutions pathways (Aboelnga *et al.*, 2018; McNamara *et al.*, 2018).

Table 5.1: Poverty alleviation pathways as adopted from Lade et al (2011:3). The intervention in Mayana and Uvhungu-vhungu are not enough to balance the playing field nor for poor people to move over the social barrier for better livelihoods.

Poverty alleviation pathways		
Examples of Type 1 interventions: Pushover the barrier	Examples of Type 2 interventions: Lower the barrier	Examples of Type 3 interventions: Transform the barrier
Subsidised tractors hours Seeds Social grants Water pipelines Irrigation projects/gardens Solar-powered pumps Gravel roads etc. Gravel road Drought relief Electricity grid Lodges Fishing tools	Conservative Agriculture Year-round farming Use of technology in farming Irrigation practice Change of building materials Fishing methods etc.	Small-scale irrigation project for women in Mayana

The system is unlikely to move to the intended direction of poverty alleviation because the inputs are one-dimensional. Most of the interventions are directed to food production and extraction of water for food production and issues regarding the safeguarding of the ecosystems are less mentioned by respondents nor visible in the area. Scoones (1998), Pavun, Vujasinović, and Matijević (2011), Speranza, Wiesmann and Rist (2014) warns us that too much reliance of rural (mostly poor people) communities on ecosystem services creates uncertainty and exposes exploited ecosystems to droughts, flooding, or other natural hazards, making it hard to separate livelihood from ecosystem services. Therefore, achieving better livelihoods cannot be isolated from environmental management. The imperative of integrated resource management through a WEF nexus approaches is therefore a viable solution for understanding what opportunities exist for transforming some of the conventional barriers trapping people in cycles of poverty (Aboelnga *et al*, 2018; Mohtar, 2013)

5.3 Equity issues

Most of the issues mentioned by respondents that are affecting residents of the two villages such as limited access to the river in Uvhungu-vhungu or people walking long distances to access water, poor sanitation, poverty, lack of capacity, lack of consultation, unaffordability of electricity, and

exclusion of women, show that there is poverty, inequity, and lack of development in the region. Inequity directly affects progress in sustainable development while causing negative trade-offs in the WEF sectors.

5.3.1 Distributional equity

Residents of Uvhungu-vhungu have restricted access to both river water and fishing due to the presence of UGSIP and Kaisosi River Lodge which are fenced off, hence blocking human and livestock pathway to the river. This has the potential to cause conflicts in future if not solved. It is also likely to keep villagers on the periphery of development if again, left unaddressed. This goes against distributive justice that is at the intersection of equity and sustainability as discussed in the UNDP (2011) report. The capabilities of people to be able to access water resources and road infrastructure will likely push these communities further into poverty and marginalisation and these intersecting inequities can lead to further issues of limited capacity (Leach et al 2018).

Additionally, the lodges in the two villages are owned by people from outside Kavango East Region, who are previously advantaged. This is an economic inequity (and exclusion of resources due to historical inequities). For an individual to set up such infrastructure, they need certain capabilities such as education, finances, and collateral which is lacking for the majority of people living in these communities.

The region is also experiencing inequity of infrastructure distribution, such as a lack of roads and electricity infrastructure in the two villages. There is also inequity between the two villages, whereby Uvhungu-vhungu has a large-scale irrigation project which provides jobs, and two public water taps while Mayana has no water taps, while the small-scale irrigation projects in the villages have a small capacity to provide real employment. It was also found that although Mayana has the only borehole between the two villages under study, the borehole is at school and it is not for public use. The UNDP (2011:19) argues that to enhance equity through equality, we must look at inequalities between and amongst the poor, but also other categorisations are equally imperative: poor and underprivileged groups, together with people with mental or disabilities, require access to public goods and services to attain “equality of capabilities”.

Although there are two public taps in Uvhungu-vhungu, they are not accessible to everyone because of the distance from some households. High income households in Mayana are able to access piped water from a Namibia Water Corporation (Namwater) storage tank, which is 5 km away in a nearby village of Kayengona. This also exposes the existing inequity between the poor and the rich in terms of accessing resources. Although there is an electricity line running along the gravel road, the majority of the households in the two villages cannot afford to buy a transformer, while some are very far from the road, making it even expensive acquire. This leaves the communities in the two villages to remain heavily reliant on fuelwood as a source of energy, which is unsustainable. Pavun,

Vujasinović, and Matijević (2011) argue that poor people will be most affected by the degradation and destruction of ecosystems because of their inseparable reliance on them. Indeed, inequities in accessing water and energy resources are already having negative impacts on water, food, and energy security.

5.3.2 Recognitional equity

Communities were excluded from decisions related to infrastructural development in the two villages. The construction of the CRIDF funded pipeline affected 100 households (*Republikein*, 2020:3) and residents of Mayana felt that they were not properly consulted which led to demonstrations. Respondents highlighted how residents of Uvhungu-vhungu felt left out on the construction of the UGSIP's and Kaisosi River Lodge's fence and the allocation of irrigation plots alongside the UGSIP. Leach *et al.* (2018) argue that equitable development is likely to be delayed if there is an exclusion in decision making because communities will reject and try to sabotage the project. Similarly, the SDSN (2012:2) argues that sustainable development's framework encompasses social inclusion (including equity), economic development, environmental sustainability, and good governance. Equity and inclusion should therefore be a mainstay in promoting sustainable development and projects implementation should involve villagers to ensure sustainability of these projects.

It was also found that there was a high rate of unemployment in the two villages, despite the presence of lodges and the UGSIP. Unemployment was attributed to a lack of training, capacity, and funds to help start or expand existing projects like those of small-scale irrigations. According to Mwoombola (2017), the communities in the Kavango East Region lack appropriate financial institutions and support that would sensitize them on the economic benefits of dry crops like Mahangu and other agricultural activities.

Although the research found inconsistencies among respondents on whether women felt included in decision-making, most ongoing irrigation projects and funding in the area are mostly focused on women empowerment. This may be the reason of inconsistency in the responses, also for the fact that most men left their houses in search for jobs in urban areas (Likuwa, 2016). The NPC (2017) argues that women should be supported through empowerment because they raise children and work the land in the absence of men. Women's role in the growth and development is significant. The CRIDF pipeline and irrigation project under implementation in Mayana aims to bring water near women small-scale farmers, who are at the same time being trained in conservation agriculture. Despite this, some cultural practices hinder women's empowerment. For example, men who do not own livestock will be regarded as the symbolic owners of the livestock in the family. This patriarchal order excludes women from decision-making and empowerment. According to NPC (2017), women lag behind their male counterparts in resource distribution, economic, and political participation due to education and cultural practices. This is despite efforts by governments to develop gender policy

documents such as Namibia's National Gender Policy (NGP), the National Gender Plan of Action (NGPA) and the Customary Law Bill all of which promote gender equity.

- *Gender roles in food production*

It was found that the responsibilities for food production are shared between men and women, with each gender having its unique role, although according to some respondents, it is mostly women who are left in the villages to look after the whole food production process alone and to after children. This is in agreement with Mwoombola's (2017:85) observation that women are more involved in food production because they hardly find formal employment to earn an income. The statistic that 60 percent of Namibian rural households are female headed because men moved to urban areas in search of employment and a better life also attest to this (Mwoombola 2017; NSA 2014). Some projects such as CRIDF's project in Mayana, has strong signs that equity and women issues are being addressed to a certain extent.

5.4 Other challenges

Agronomic activities and increasing population in the two Kavango regions imply that the application of fertilisers, pesticides, and sedimentation is likely, which may result in the deterioration of water quality and loss of biodiversity (IPBES, 2018; Pimentel *et al.*, 2013).

Several additional challenges were raised by the respondents. Sanitation was found to be a major issue in the two villages and residents do not have clean potable water and toilets which has been found to be a challenge in other rural settings in Southern Africa (CRIDF, 2019). The lodges that are built on the bank of the river are also posing a threat to water security because the respondents are worried of where they dispose human excreta. If, as suspected by respondents, the lodges dispose human excreta into the river, this is a serious health challenge to humans, animals, and the environment. Because the region's inhabitants derive livelihood from the river (Figure 4.3), poor water quality as a result of lack of infrastructure for sanitation will negatively affect livelihoods. Indeed, a thorough study of water quality concerning human activities is imperative to examine the effect of human activities on biodiversity in the two villages.

The study also found that there is a lack of infrastructures in the two villages such as tarred roads, water infrastructure, and clinics while schools are said to be overcrowded, forcing learners to walk long distances to school. A lack of infrastructure and services make residents of the two villages vulnerable to environmental shocks and stress. Indeed, the communities of Mayana and Uvhungu-vhungu currently lack resilience due to multiple unaddressed challenges that they are currently facing (CRIDF, 2019; MLR, 2015; NSA, 2014) as discussed under chapter 2.6.

According to respondents, there is a lack of unity among villagers which may hamper collaboration in community initiatives as well as projects such as the conservation agriculture that are being funded by CRIDF and OKACOM. Lack of communication, differing goals, unwillingness to cooperate and create trust, differing goals and agenda, uneven sharing of power and knowledge amongst stakeholders is one of the main challenge of a Nexus approach (Aboelnga 2018:9-10). This notion should not just be reduced to a Nexus approach but rather must be seen as tool for a holistic approach that will aid in advancing sustainable development.

Alcohol abuse is likely to be the main contributing factor to Gender-Based Violence (GBV), teenage pregnancy, and poor performance in school. Surprisingly GBV was not discussed as an issue in the two villages. The issue of teenage pregnancy was also rarely discussed by respondents during the study. This is surprising given that between 2017 and 2018; about 3500 pupils fell pregnant in Namibia (Namibian, 2019). Of that number, 545 pupils, the highest per region, fell pregnant in Kavango East Region. In 2020, the number has gone up to a record 3600 pupils, of which 520 of those pupils who fell pregnant are from Kavango East Region (Namibian, 2021). This makes Kavango East Region to have the third highest number of teenage pregnancies in 2020, with only Ohangwena Region (562) and Kavango West Region (522) ahead of it. This newspaper report argued that some of the major causes of teenage pregnancies are socio-economic challenges, including unemployment and poverty, are among the contributing factors to the high rate of teenage pregnancy. Other causes were community hostels, unprotected sex among teenagers, the social structure (family set-up), cultural and religious beliefs, and a lack of parental guidance, drug, and alcohol abuse, peer pressure, amongst other things.

Indeed, it is likely that the 2020 statistics are mostly influenced by the lockdown restriction which means that parents had to leave their children home and unsupervised, however the number of 2017 to 2018 is enough to cause alarm and call for social change.

If there is no appropriate intervention in the system, the villagers' coping strategies will be weak going into the future. With the current minimal investment intervention in basic infrastructure and services, the resilience of social-ecological systems will be eroded over time, mostly due to increasing demand and over- exploitation of ecosystem services. Walker (2020) and Green, Cosens, and Garmestani (2013) emphasize that communities can develop better adaptation mechanisms that will help them deal with climate change and environmental shocks by ensuring equitable and sustainable governance of the river and associated biodiversity protection, with a specific focus on managing sedimentation from the floodplains which regulates productivity. Since adaption is a major component of resilience, adaptive management for ecosystems can be developed through continuous learning, revising of management action, monitoring, and attempting to understand the system through sustained stakeholder engagement.

5.5 Bringing nature into the Nexus

Healthy and functioning ecosystems form a strong foundation for improving livelihood options in the two villages. Most of the livelihood generating infrastructures in the two villages (irrigation projects and lodges) were entirely set up due to the presence of the Okavango River. The Okavango River is a very important source of water, food, and building material for local people in the two villages. It is also a source of regulating, supporting, and cultural ecosystem services for these communities. Land biodiversity equally has a strong link to the presence of the river in the area and their use is related to the use of aquatic resources that the river provides. For example, land use for agricultural activities and fuelwood are the results of people settling closer to the river to access water and aquatic resources.

Indeed, natural infrastructures such as natural ponds, pans, underground aquifers, and the river itself are sometimes overlooked without a nexus perspective, and this has costs, especially for the poor (Krchnack *et al.*, 2011). Also, the fact that residents still rely on wood for energy (NSA, 2014) means that the ecosystem are being exploited unsustainably (Hall *et al.*, 2017; Hauser, 2015). Managing ecosystems to improve livelihood is unlikely to be achieved without a nexus approach while isolating the management of social-ecological system elements will hinder progress in attaining the SDGs (Krchnack *et al.*, 2011).

Synthesis

The current investment in agricultural infrastructure in the two villages implies that more water and energy are being channelled to food production while households continue to face economic water scarcity and energy insecurity. However, the use of water and energy resources for food production has implications on the availability of water for household consumption because water is only pumped to the irrigation sites but not necessarily availed to households. The same can be said about energy. There are therefore challenges on achieving resilient social-ecological systems and improved livelihoods due to current silo-ed planning that ignores a nexus approach. Agricultural policy favoring intensification, agronomic activities and drought are likely to increase water demand (Figure 5.1). Agricultural activities are also likely to increase the demand for energy. Increased availability of energy at lower prices makes it easy to use more water in agronomic activities, which may put pressure on water resources. Equally, energy is necessary for pumping water, but it is imperative to recognise that energy policy also affects the demand, supply, and quality of water. Indeed, there are potential trade-offs when one sector becomes neglected, or attention is paid to one sector more than the other two sectors. However, when a Nexus approach is employed, it will easily help identify trade-offs, consequently, help decision-makers to manage and mitigate the impacts on both livelihoods and the environment. This can then direct investment into ecosystem restoration activities so that nature can continue to provide ecosystem services, so that people

harvest these resources from nature responsibly - therefore relieving the pressure on the environment.

Equally, the lack of sanitation infrastructure means that human waste ends up in the water, consequently contaminating them, hence, posing a threat to human well-being and aquatic species. The production of food at the UGSIP project is not solving food shortages in the area because it is intended for commercial purposes. Small-scale irrigation is not adequate to provide employment and food either. This issue, coupled with drivers of change in the area, are likely to lead to unnecessary trade-offs. Therefore, a Nexus approach in the three-sectors, especially acknowledging the role of nature in the nexus can help to understand what interventions might be necessary to improve livelihoods.

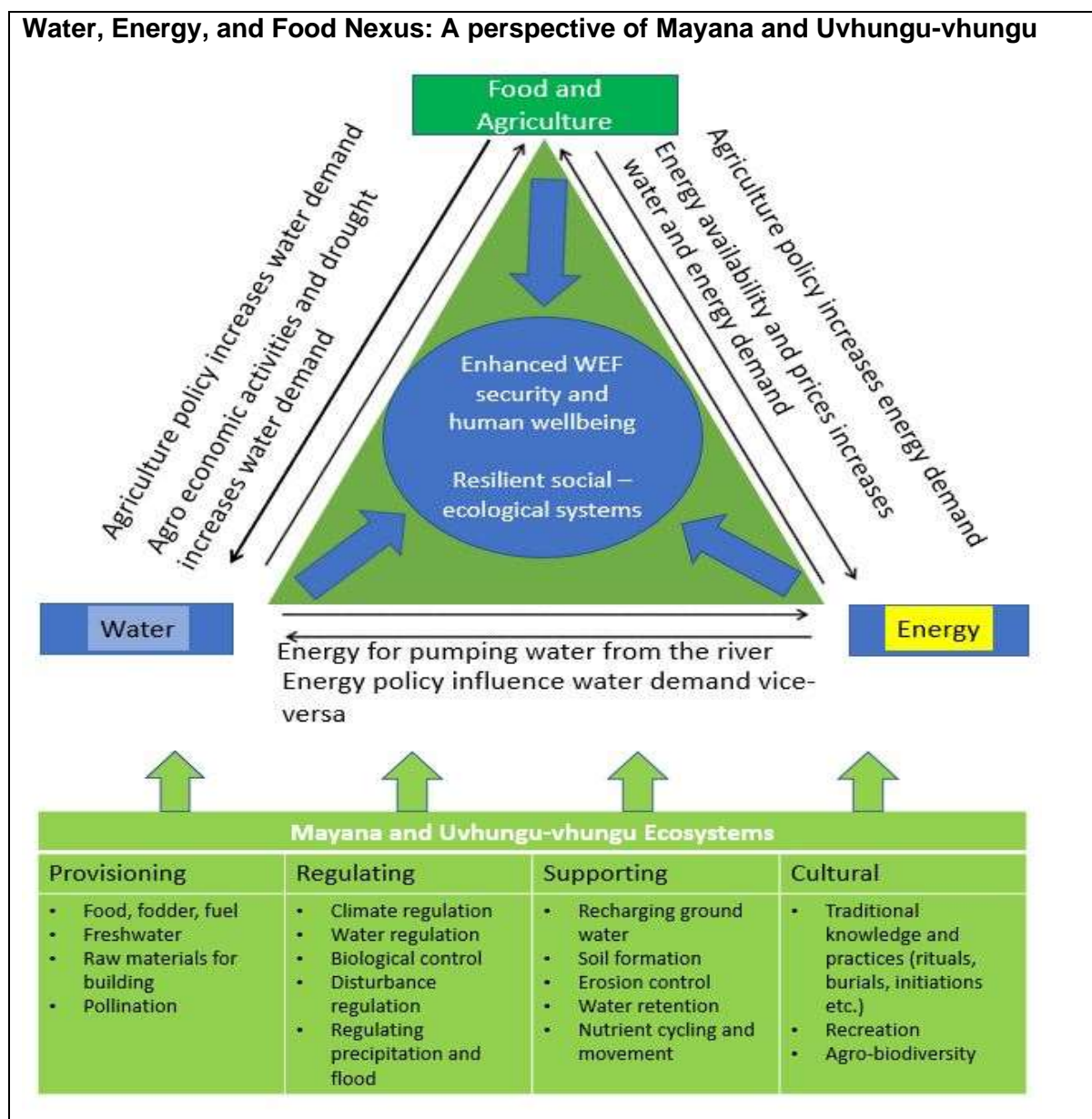


Figure 5.1: An illustration of the interconnections within the WEF nexus in Rundu Rural Constituency in Mayana and Uvhungu-vhungu. A nexus approach ensures that there is a balance in WEF policy,

while ensuring that the trade-offs due to demand in one of the three sectors are carefully managed to attain WEF security and resilient social-ecological systems. Adapted from Rasul (2014:38)

Nature's contribution to livelihoods

Indeed, this thesis has demonstrated an inseparable reliance of the two communities on the local ecosystem, and particularly on the river which provides a suite of ecosystem services and a wide range of livelihood options which are important for the well-being of the of people in the two villages. This finding is reflected in other studies which argue that rural communities are heavily dependent on ecosystem services for their livelihoods options (Carpenter *et al.* 2005; Guerry *et al.* 2015; Krchnak *et al.* 2011).

The village of Mayana has a lot of natural pans which divert flood water away from households into the river, eventually minimising floods. Existence of these natural ponds regulates floods and ensure human well-being, making these ecosystems integral in improving and maintaining the quality of life in Mayana and Uvhungu-vhungu (IPBES, 2018). It is therefore imperative to understand that the communities of Mayana and Uvhungu-vhungu need supportive environmental and governance mechanisms to ensure that ecosystems are not over exploited but are rather generative. Such support may come in the form of agricultural machineries and tools, financial capital, training, and capacity building (CRIDF, 2019; IPBES, 2018; Mpandeli *et al.*, 2018; Hall *et al.*, 2017).

It is hard to separate ecosystem services in the rural case like Mayana and Uvhungu-vhungu from culture because most of the services are regarded as culture (Schneegg, Rieprich & Pröpper (2014). Collecting fuelwood, which was found to be the most popular source of energy in the two villages, can be seen as part of the cultural ecosystem services for the Shambyu people. This activity is also considered an ecosystem service under the provisioning services category. Therefore, the two must be seen as inseparable and intertwined and need to be governed through integrated informal and formal mechanisms to be sustainable.

Chapter 6: Conclusion and Recommendations

6.1 Final remarks

This study aimed to explore the livelihood options in the two villages of Mayana and Uvhungu-vhungu of the Rundu rural constituency to understand their connection and interdependency to water, energy, and food as well as how they interact with each other. The study aimed to create an understanding of these connections and interdependencies between food, water, and energy systems using a nexus approach, to help with understanding what interventions can be developed that will address complex and interconnected challenges, especially under conditions of change. This was done by engaging key stakeholders in the region, in particular the residents of Mayana and Uvhungu-vhungu villages.

The community of Mayana and Uvhungu-vhungu are heavily dependent on local ecosystems. Livelihoods are supplemented by small-scale irrigation projects in the area but they are not impactful enough to supply adequate nutrition, and support human well-being for all in the two villages. Even with the minimal support from stakeholders, the small-scale irrigation schemes do not seem sufficient in their current form.

As a result, there is an urgent need for more interventions to support small scale farmers that can help them cope with predicted changes – such as assisting with climate-resilient seeds, technology, renewable energy, and water infrastructure (i.e. solar powered-pumps), market access, storage, training, and capacity building. Moreover, any intervention done to improve livelihoods must be done parallel to conserving the ecosystems and in turn the flows of ecosystem services in the two villages. The most notable types of livelihood options in the area are fishing, livestock rearing, small-scale irrigation, and subsistence farming. State grants is additionally an enabling factor ensuring that vulnerable people (children, people with disabilities, and old people) have means to survive during difficult times and equally safeguarding their wellbeing.

The current interventions in the two villages are focused mainly on food production. This is arguably a one-dimensional (siloes) intervention that is focusing more on food while neglecting the other two sectors, as well as the important role that the environment plays in the availability of the ecosystem services. This is also evidenced by the fact that there is clearly economic water scarcity in the two villages while villagers rely on fuelwood for their energy need- which is unsustainable going into the future. In addition, the social capital is weak and cannot support necessary interventions that are needed in the area due to a lack of education and skills. This problem of silo-ed and one-dimensional interventions to enhancing livelihoods is also echoed by CRIDF (2018) when they argued that water

and energy security are affected by food production therefore a need for an integrated intervention, such as investment in the WEF sectors.

Another problem in the two villages is the fact that more water is directed to irrigation, lodges, and government buildings the less is available for household use. This is an indication that there is distributional equity issues which need to be addressed in order to realise the goals of the SDGs of leaving no-one behind. Although a lot is being done to address inequity and inequalities, inequity between genders and communities must be integrated in the current interventions to make sure that no one is left behind.

Although fertilisers are used in commercial irrigation projects, the impacts of the fertiliser are not yet known, therefore there is a need for an urgent assessment on aquatic life and water quality in the Okavango River. The river holds a potential for economic development and WEF security for the two villages and must be managed in an integrated way that easily identify and mitigates potential trade-offs that could potentially erode livelihood opportunities.

Food production in the two villages depends on the river for horticulture and irrigation projects, while subsistence farming is dependent on rainwater. Mwoombola (2017) has raised concerns about the culture of farming in the region because in some instance subsistence farmers settle far away from their fields (close to the river), consequently exposing their yield to pests and wild animals because they are not fenced off. This requires further investigation to determine what support subsistence farmers might need in order to improve their farming methods. In this regard, agro ecological or permaculture farming methods could be useful (Pereira et al. 2018) as well as investigating novel ways to reduce human wildlife conflicts (Mwoombola, 2017; Le Bel *et al.* 2011).

There is support for small-scale irrigation farmers (mostly women) in Mayana and Uvhungu-vhungu. However, the scales of support and its pace are not sufficient to solve current livelihood problems. United Nations Environmental Programme (UNEP), therefore, calls for rigorous support (technology and technical) and climate-resilient agriculture for rural communities (Mwoombola, 2017). It is also worth mentioning that although there are livestock farming activities in the two villages, this can further be intensified to generate greater economic benefits from by products such as milk and milk products. The restarting of livestock herding at UGSIP which has been discontinued for years will help add economic benefits and jobs for the residents. However, livestock herding would still need to be managed to not erode local landscapes and more livestock might mean more human wildlife conflict.

The heavy reliance on fuelwood and its depletion is harmful to the local ecosystems. Wood is already scarce and being collected from far afield. This therefore serves as a good reminder to stakeholders that there is a need for a thoughtful nexus approach that embeds energy security in any sustainable development interventions. The use of diesel in water accessibility and food production is contributing to carbon emission and stakeholders must find alternatives. Although the use of

renewable energy is not at massive scale in the two villages, Swilling and Annecke (2012) argue that decarbonisation and a quick transition to green energy will be the major driver of the 4th industrial revolution. The use of renewable energy will also help uplift the residents of the two villages from poverty while advancing the other SDGs. Unfortunately, respondents who use buckets to collect water from the river for their gardens have indicated that solar panels and pumps are unaffordable to them. Some possible solutions to energy access for irrigation and household use are the formation of community corporative where funds are sourced and channelled to create solar plant for the members of the community, wind technologies and biofuels from cow dung.

There is a serious concern with sanitation, education, and training, as well as affordable energy for operating machinery. Notably, lodges in the two villages must apply transparency in their operations, to make sure that waste is discharged safely and not in the river as residents assumes is the case. Drought and climate change are threatening the WEF security because the temperature around the Okavango River is expected to rise by between 4 and 6 °C in the near future (CRIDF, 2019; MLR, 2015). This is also a matter of concern by respondents and urgent attention in addition to current intervention is necessary to ensure that the communities of the two villages are able to develop resilience and adapt to changes. Social issues such as teenage pregnancy and alcohol abuse are threatening livelihoods and wellbeing in the two villages and need to be addressed accordingly.

Local culture in the two villages is hard to differentiate from other ecosystem service categories because sometimes what is regarded as a type of one ecosystem service also falls under the cultural practice category, e.g., food is both a provisioning service, but is also deeply rooted to culture and cultural practices and rituals. Schnegg *et al.* (2014) argue that culture forms the identity of local people, it is inseparable from ecosystem services. Additionally, communal land tenure implies that communal farmers cannot receive loans from the banks to finance their irrigation projects (Mwoombola, 2017; OKACOM, 2009).

Equity is a very important component of sustainable development (Leech *et al.*, 2018). There are serious inequities in the two villages, and this needs strong intervention from stakeholders. Some of these inequities that need urgent attention are health inequity (access to adequate sanitation and clinics); gender inequality and the need for empowerment; unequitable opportunities for education and training; economic inequity such as access to financial capitals, technology, and farming equipment; and inequitable distribution of development between Mayana and Uvhungu-vhungu. Lodges expose the existence of resource inequity because they are owned and operated by people from previously advantaged communities. Additionally, it was clear that residents were not consulted in the past when these infrastructures were set-up hence their pathway to the river is blocked by large fences in Uvhungu-vhungu.

Women still perform more house chores, raise children, fetch water, cultivate the land, yet, when it comes to ownership of livestock (and the house), these belong to the man (sometimes symbolically)

because a man is regarded as the head of the house even in his absence. Those with means can source piped water to their homes from the river or from the Namibia Power Corporation pipeline, but poor, old, and disabled people are not able to do the same. To enhance equity through equality, we should look at inequalities between and the poor, but also other categorisations are equally imperative: poor and underprivileged groups, together with people with mental or disabilities, require access to public goods and services to ensure “*equality of capabilities*” (UNDP, 2011:19). Additionally, UNEP encourages the empowerment of women through climate-resilient agriculture (Mwoombola, 2017).

Finally, the water ecosystem management, water for household use, consideration of interconnected ecosystem services and energy for households are almost completely neglected in many of the current interventions. Therefore, such interventions are not enough to enhance resilience by moving the system over the barriers discussed by Lade *et al* (2017) such as irrigation gardens, subsidised tractors, electricity grid, social grant etc. because they come in limited capacity. The over exploitation of both land and water ecosystems are eminent. The disparities in WEF sectoral interventions are holding back progress in each of the three sectors. The nexus approach can help solve equity issues, if implemented in such ways that are sensitive to gender, equitable, encourage learning, capacity building, and infrastructural development.

6.2 Recommendations

The following recommendations are made after reflecting on the findings:

- Ensure coordinated and integrated WEF Nexus approach that will help in building interventions and help minimise trade-offs, therefore enhance sustainability. This can provide an opportunity to deal with economic water scarcity issues and finding a balance between water for food or commercial purpose and water for household consumption, at the same time creates an enabling environment for sustainable economic growth. The WEF integration is best done through a coordinated planning by involved players such as Namibia Water Corporation, Namibia Power Corporation (Nampower), Agricultural Business Development (Agribusdev) and the line ministries that are responsible for water, energy, food, environment, infrastructure etc. It will be good if a working committee from all the WEF sectoral players is created and meet regularly to strategies and monitor each other’s progress.
- Ensure that in every planning and implementation process, nature is made integral in order to safeguard ecosystem services because they are the main source of livelihood for most residents of the two villages. One way to do this is to include residents in the future decision-making, and to make sure that they benefit equally from new investment that are brought about by the presence of strong ecosystem services such as land and water tourism initiatives, small-scale irrigation, wood craft etc. Conducting an ecosystem service

assessment could help articulate the bundles of ecosystem services and who the beneficiaries are of those services, at what scales and linked to particular decision-making contexts.

- The government and stakeholders must continue to support efficient and resilient agricultural and fisheries systems that help promote sustainable livelihoods. One such practice is conservation agriculture (CA), which is being funded by donor organisations in the Mayana, should be continued and expanded to include more residents in order to help protect biodiversity, improve nutrition, and resilience.
- Improve water, sanitation, and hygiene (WASH) by building toilets by using local materials (clays, sand, and thatch) which are cheap and readily available. Provide clean water for household use to the residents of Mayana and Uvhungu-vhungu. Educate people about personal hygiene and the importance of clean environment. Encourage efficient water irrigation techniques such as drip irrigation to save water.
- Subsidise transformers, renewable energy, and grid electrify for the two villages to avoid further reliance on fuelwood. One way is to form community cooperatives whereby residents can either buy one large transformer as a group or set-up a subsidised solar plant for their irrigation and household needs. Also avail solar pumps to small-scale farmers and household in order to encourage the use of renewable energy. This will help create a WEF resources security, create employment opportunities, and income for the residents.
- To remain within the principle of *'leave no-one behind'*, encourage men to participate in small-scale farming with their families. The current focus on women as beneficiaries of small projects is justifiable by the fact that many men have left for urban areas but men that have remained in the villages must equally benefit from interventions. Deliver infrastructure near Mahangu fields such as water pipelines and electricity in the forest to encourage communal farmers to relocate near their fields.
- Empower women by offering them incentives to take up literacy classes, attend agro-farming training, and providing technology. Respondents have unanimously indicated that a lack of skills and training, education, and technology is hindering development in the two villages. However these opportunities should also provide opportunities for child-care and not come at an extra cost or burden to those participating.
- Create a market for communal and small-scale irrigation farmers as well as craftsmen and women in the villages and encourage them to employ others by subsidising the price of inputs as a form of incentives.

- The government must closely work together with concerned stakeholders to co-develop an investment strategy that ensures WEF security of the Okavango basin through OKACOM and others and ensure appropriate communication. This should include:
 - ✓ Assessment of the Okavango River basin's socio-economic history. Carry out a study to investigate the quality of water in the river and possible effects by agronomic activities.
 - ✓ Participatory engagement of the rural communities (Mayana and Uvhungu-vhungu) should be continued to develop agricultural production that does not compromise ecosystem services.
 - ✓ Identify financial and instrumental partners for future investment and support for small-scale farmers.
 - ✓ Monitor performance by community members who got funding for small-scale projects and apply adaptive management to invest in the area while remaining proactive.
- Formulate policies that transform the management of commons resources so that we can protect commons resources from privatisation. For Example: making sure that lodges and irrigation projects in the Uvhungu-vhungu only fence off sufficient land while making appropriate provision for people that are displaced or whose access to the river is blocked to easily access resources in the river. This can also be done through a strong component of corporate social responsibility.
- Encourage the use of alternative building materials such as bricks to help combat the destruction of ecosystems. Residents of Mayana and Uvhungu-vhungu are too dependent of natural resources such as wood, reeds, glass, sand, and clay for building which is unattainable as the population continues to grow.
- Start community-led and run food for work programs to encourage and attract community members to participate in community work such as paving of roads, laying of water pipelines, and setting up of community gardens. This is a holistic approach which will make community members take ownership and safeguards infrastructure in their villages.

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Appendices

Appendix A: Survey and Interview Questionnaires

Semi-structured interview schedule

Due to covid-19 global pandemic, this interview will entirely be online. Participants will be asked to take part in telephonic, Skype or Zoom interviews and a letter of informed consent will be completed prior to each interview.

The following details will be recorded before each interview:

Date and time of interview:

Method of interview: Telephone/Online platform

Interviewee code [linked to informed consent form and recording]:

Occupation:

Sex: M/F/Unknown

Approximate age: (above or below 35)

Prior to the interview, I will reiterate the aims of the research project and established that there is informed consent to proceed with the interview. I will also inform the interviewee that I will be recording the interview and explain to them how I will store the data and ensure confidentiality.

Good morning/afternoon. Thank you for agreeing to participate in this research. I am going to ask you a number of questions, please answer to the best of your ability and stop me if you are unsure of anything. These questions relate to Uvhungu-vhungu and Mayana in the East Kavango Region. The interview should take between 45 minutes to one hour to complete.

1. Does everyone in this area have access to water? If no, who does not?
2. What type of access to water do they have? (River, pipes, well, borehole, combination)
3. Who else, apart from the local people, uses the same source of water as the people of the village(s)?
 - a. What do they use the water for?

4. In your opinion, what can be done to improve the water supply, sanitation, and accessibility in the village(s)?
5. What are the main sources of food in [insert name of village(s)]?
6. Which crops and vegetables are mostly grown in the region?
7. Do people have livestock?
 - a. If yes, is this livestock for sale/subsistence/other?
8. What do people use for energy?
9. If wood is mentioned, where is this wood from?
10. Is this energy for cooking/ lighting/heat/other?
11. Other than what you have said already, what are the main livelihood activities in [village name(s) will be inserted] Mayana and Uvhungu-vhungu villages?
12. Which negative factors affect livelihoods activities in these villages?
13. Linked to [insert negative factor] how do people cope with this?
 - a. How does this factor impact, food, water, or energy use?
14. Apart from what you have mentioned already, how else do people in the region benefit from the river?
15. Are you aware of any existing project/responses/interventions that have happened in the region to improve the livelihoods of people?
 - a. If yes, please elaborate on who led this intervention (government department, NGO, private sector), who benefitted from this intervention, and who might have been left out
16. What do you think could be done to improve the livelihoods of people in the region?
17. Are people included in decision-making processes linked to their livelihoods?
 - a. If yes, how
 - b. If no, how could this be changed?
18. Is there anything else you would like to tell me?

Thank you very much

Questionnaire (Survey)

Due to the covid-19 global pandemic, this questionnaire will be conducted online, through an online form or via email if respondents are not familiar with using online forms and would be more comfortable completing the questionnaire in their own time. A letter of informed consent will be completed prior to the questionnaire being sent. The questionnaire is estimated to take 20-30 minutes to complete.

Instructions for participants:

You are asked to participate in a research study conducted by Romanus Kasino from the School of Public Leadership at Stellenbosch University. The results of this research will contribute towards an MPhil degree in Sustainable Development from Stellenbosch University. Please take some time to read the information presented here, which will explain the details of this project. Please feel free to ask the researcher, Mr Romanus Kasino any questions about any part of this project that you do not fully understand either by sending an email to kasinor@yahoo.com or contacting him on 081 3559756. It is very important that you are fully satisfied that you clearly understand what this research entails and how you could be involved.

You were selected as a possible participant in this study because you are regarded as one of the main stakeholders linked to water use, and how it links to food and energy security.

PURPOSE OF THE STUDY

The purpose of this study is to understand the existing and potential livelihood options for communities in the Kavango East Region of Namibia by exploring the interactions and interconnections of water, energy, and food in order to co-develop recommendations and response options for enhancing equitable and sustainable development. This research is part of the five-year broader USAID-funded project called the Resilient Waters Programme which aims to build a more resilient and water secure Southern African communities and ecosystems in the Okavango and Limpopo River Basins

Participation in this survey is voluntary and by participating in this survey, you give consent for the results to be used for degree purposes, however, you may request for your comments to be removed from the study at any time. Removing yourself from the study will not affect you negatively in any way whatsoever. All data will be stored in a password protected filing system that only the researcher has access to.

You will remain anonymous however, should you wish to be informed of the outcomes of the study, please leave your contact details at the end of the survey.

This study has been approved by the Research Ethics Committee at Stellenbosch University and will be conducted according to the ethical guidelines and principles of the University.

The survey should take approximately 20-30 minutes to complete.

Thank you very much in advance for your participation.

Date:

Occupation:

Sex: M/F/I'd rather not say/Other

Age: above/below 35

Questions

1. Does everyone in this area have access to water? If no, who does not?
2. What type of access to water do they have? (River, pipes, well, borehole, combination)
3. Who else, apart from the local people, uses the same source of water as the people of the village(s)?
 - a. What do they use the water for?
4. In your opinion, what can be done to improve the water supply, sanitation, and accessibility in the village(s)?
5. What are the main sources of food in [insert name of village(s)]?
6. Which crops and vegetables are mostly grown in the region?
7. Do people have livestock?
 - a. If yes, is this livestock for sale/subsistence/other?
8. What do people use for energy?
9. If wood is mentioned, where is this wood from?
10. Is this energy for cooking/ lighting/heat/other?
11. Other than what you have said already, what are the main livelihood activities in [village name(s) will be inserted] Mayana and Uvhungu-vhungu villages?
12. Which negative factors affect livelihoods activities in these villages?
13. Linked to [insert negative factor] how do people cope with this?
 - a. How does this factor impact, food, water, or energy use?
14. Apart from what you have mentioned already, how else do people in the region benefit from the river?

15. Are you aware of any existing project/responses/interventions that have happened in the region to improve the livelihoods of people?

- a. If yes, please elaborate on who led this intervention (government department, NGO, private sector), who benefitted from this intervention, and who might have been left out

16. What do you think could be done to improve the livelihoods of people in the region?

17. Are people included in decision-making processes linked to their livelihoods?

- a. If yes, how
- b. If no, how could this be changed?

18. Is there anything else you would like to tell me?

Thank you very much

Appendix B: Consent to participate in research



UNIVERSITEIT • STELLENBOSCH • UNIVERSITY
Jou kennisvenoot • your knowledge partner

STELLENBOSCH UNIVERSITY

CONSENT TO PARTICIPATE IN RESEARCH

Exploring interdependencies and relationships in the water, energy, and food (WEF) nexus to improve local livelihoods: A case study of the Kavango East Region in Namibia.

My name is Romanus Kasino. I am a student at Stellenbosch University studying for an MPhil degree. I would like to invite you to participate in a research study I am conducting to understand the importance of nature in providing livelihoods and other benefits to people in two case studies in Namibia. You were selected as a possible participant in this study because you are regarded as one of the main stakeholders linked to livelihood related decisions on water, energy and food and can therefore provide meaningful insight into enhancing the understanding of the interdependencies between water, energy, and food in the Kavango East Region of Namibia.

Your participation in this research is voluntary and at any stage during the conversation, you are free to stop and exit the process if you no longer wish to be part.

1. PURPOSE OF THE STUDY

The purpose of this study is to understand the existing and potential nature-based livelihood options for communities in the Kavango East Region of Namibia, which are linked to water, energy, and food. Nature provides a suite of benefits for people. For example, a river can be a source of livelihood (fishing, reeds for basket weaving), a source of water for human consumption and agriculture, and habitat for aquatic species. My research will look into the different benefits that are currently derived from nature in two case studies. This research is part of the five-year broader USAID-funded project called the Resilient Water Programme which aims to build more resilient and water secure Southern African communities and ecosystems in the Okavango and Limpopo River Basins. For more information on the USAID RWP programme please contact nmahlangu@resilientwaters.com. For more information on this specific research project, please see the accompanying research outline.

2. PROCEDURES

Individual interactions

I will reach out to you through telephone, an online platform (e.g., Zoom or Skype) or send a questionnaire via an online link to a form or via email depending on the circumstances surrounding the covid-19 development. The telephone interview will be recorded via an external voice recording device, connected to the mobile phone. A telephone interview is estimated to last no longer than one hour, while the online survey/questionnaire will range between 20 – 30minutes (depending on the respondent's typing speed). You will have access to your recordings and responses should you request them.

3. POTENTIAL RISKS AND DISCOMFORTS

There are no foreseen risks or discomforts associated with taking part in this research. Participants will be provided with sufficient information (either written, or verbal should the respondent request it) on the background, objectives and aims of the project. Participants are free to refrain from answering any questions they feel uncomfortable responding to without consequence and the researcher will protect the identify of all respondents.

4. POTENTIAL BENEFITS TO SUBJECTS AND/OR TO SOCIETY

This research aims to understand how nature benefits people and hopes to raise awareness about the multiple dimensions in which nature affects various aspects of people's lives. It does not however have direct immediate benefits, but I hope will add to the conversation about resources management in the northern parts of Namibia. More broadly, it will feed into the work of the Resilient Waters Programme which is working to improve natural resources governance in the region.

5. PAYMENT FOR PARTICIPATION

You will not be paid to take part in the study, and there will be no costs involved for you other than the data used to connect online. As stated, at the end of this letter, please indicate whether you have reliable access to the internet, or whether you require a data top up. Should you need data to participate, you will be supplied with N\$ 65 as a once-off donation for participation.

6. CONFIDENTIALITY

Any information that is obtained in connection with this study and that can be used to identify you will remain confidential and will not be disclosed to anyone unless with your permission or as required by law. Confidentiality will be maintained as per ethical guidelines and principles of the **Stellenbosch University**. More information on Stellenbosch University's ethics policy can be found at: <http://www.eng.sun.ac.za/media/sites/7/Template-1-Written-Consent.docx>

7. PARTICIPATION AND WITHDRAWAL

If you volunteer to be in this study, you may withdraw at any time without consequences of any kind. You may also refuse to answer any questions you do not want to answer and remain in the study. You may also request for your responses to be removed from the study at any time and be destroyed without any consequences of any kind.

8. IDENTIFICATION OF INVESTIGATORS

If you have any questions or concerns about the research, please feel free to contact Romanus Kasino at 081 355 9756, e-mail: kasinor@yahoo.com or Dr. Nadia Sitas at +27 21 808 9607, e-mail: nadiasitas@sun.ac.za or Dr. Odirilwe Selomane at +27 21 808 9607, e-mail: odirilwes@sun.ac.za or Amanda October at +27 21 808 9607, e-mail: aaoctober@sun.ac.za

9. RIGHTS OF RESEARCH SUBJECTS

You may withdraw your consent at any time and discontinue participation without penalty. You are not waiving any legal claims, rights, or remedies because of your participation in this research study. If you have questions regarding your rights as a research subject, contact Ms. Maléne Fouché [mfouche@sun.ac.za; 021 808 4622] at the Division for Research Development.

10. Availability and Access to internet

Circle **Y** for YES and **N** for NO where necessary.

- a. I have access and good connectivity to internet **Y/N**.
- b. I will need data top-up to successfully participate in the interview, focus group discussions or questionnaire **Y/N**.
- c. I am available midweek between _____ and _____ hours respectively (kindly indicate the time slot)
- d. I am available over the weekend between _____ and _____ hours respectively (kindly indicate the time slot).
- e.

SIGNATURE OF RESEARCH SUBJECT OR LEGAL REPRESENTATIVE

The information above was described to [me/the subject/the participant] by [name of relevant person] in [Afrikaans/English/Xhosa/other] and [I am/the subject is/the participant is] in command of this language or it was satisfactorily translated to [me/him/her]. [I/the participant/the subject] was given the opportunity to ask questions and these questions were answered to [my/his/her] satisfaction.

[I hereby consent voluntarily to participate in this study/I hereby consent that the subject/participant may participate in this study.] I have been given a copy of this form

Name of Subject/Participant

Name of Legal Representative (if applicable)

Signature of Subject/Participant or Legal Representative

Date

SIGNATURE OF INVESTIGATOR

I declare that I explained the information given in this document to _____ [*name of the subject/participant*] and/or [his/her] representative _____ [*name of the representative*]. [*He/she*] was encouraged and given ample time to ask me any questions. This conversation was conducted in *English/Rukavango/Shambyu* and *this conversation was translated into Rukavango/Shambyu* by Mr. Joseph Mbamba].

—

Signature of Investigator

Date

Appendix C Key Readings

Key words and Documents

Key Words <i>(in no particular order)</i>
WEF Nexus (water, energy, food)
Ecosystem services and biodiversity (Nature)
Resilience
Data Analysis
Adaptation
Social ecological systems as complex adaptive systems
Sustainable Livelihood
Sustainable Development
Kavango East Region
Namibia Statistics Agency
Ministry of Agriculture, Water and Forestry
Namibia Water Corporation
Namibia Power Corporation
Ministry of Lands Resettlement and Rehabilitation
Equity
Sustainability
Namibia
Key Documents <i>(in no particular order)</i>
Prospects for Improving Irrigated Agriculture in Southern Africa: Linking Water, Energy and Food
The IPBES Conceptual Framework — connecting nature and people
An investigation into the role of leadership in water technology innovations in enhancing job creation in Kavango East Region in Namibia (Kawana, 2016)
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