BUILDING SOCIAL AGENCY AND LOCAL CAPACITY FOR SUSTAINABLE AND EQUITABLE COMMUNITY RESOURCE MANAGEMENT:

A Framework for Co-Learning, Adaptive Planning, and Participatory Mapping of Land Uses and Ecosystem Services

Report to the
Water Research Commission

by

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EXECUTIVE SUMMARY

BACKGROUND

Smallholder communities in the uKhahlamba Drakensberg Mountain, KwaZulu-Natal, depend on the natural resource base of their lands to sustain agriculture, water resources and ecosystem services for their livelihoods and well-being. Climate change, poverty and degraded landscapes call for urgent need to implement sustainable management strategies for securing these resources. Conventional approaches to natural resource management have typically involved technical and top-down strategies, which are rarely successful due to the varying and contextual nature of resource-dependent rural communities. The context-specifics in such communities include historical, institutional, and social-cultural settings, which shape the land management decisions made by community members and leaders. Increasingly, it has been suggested that increased participation by community members, integration of knowledge systems and co-design of resource management plans positively influence the implementation and long-lasting impacts of natural resource management strategies.

This project took place in two agricultural communities, Costone and Ezibomvini, located in the uKhahlamba Drakensberg Mountains, downstream from a protected area that encompasses transboundary national parks, wilderness areas, and includes declaration of both Ramsar wetland importance and UNESCO World Heritage Site. These areas are home to rich biodiversity of endemic and threatened species and habitats, and also host long-term research on water, grassland management, soil conservation, and fire regimes. Further, the uKhahlamba Drakensberg is a strategic water source area in South Africa, and provides water to Gauteng and KwaZulu-Natal. It is of national priority to manage and protect this water source to sustain supply to the end users, which does not include the residents of the rural villages within these water source areas. Due to a lack of resources and other factors, these communities have received little to no support related to water services in their villages, relying instead on very old infrastructure (pre-1994) and undeveloped water sources (springs and small streams) for their household water needs. There has been no focus on agricultural and landscape-based water resource management despite the area being severely impacted by erosion and low productivity of croplands and grazing areas. Climate change mitigation and adaptation processes have been limited to training and awareness within municipal structures, to enable development of environmental management plans. This project brings together experts from various scientific disciplines (hydrology, ecology, sustainability science, environmental sciences, agricultural engineering and social sciences), community development practitioners and local communities, using a transdisciplinary, participatory approach in order to:

1) enhance the knowledge base towards a shared understanding of the natural resource base, climate variability, community needs and priorities, and governance decision-making and power dynamics, and

2) co-learn for stimulating action, building social agency and improved decision-making and governance outcomes.

AIMS

The following were the aims of the project:

1. To assess and quantify changes in rainfall patterns and water quantity over time to inform communities' decision-making.
2. To develop a transdisciplinary social-ecological GIS support tool for decision-making and management of water and natural resources and link land uses with ecosystem services and livelihoods.
3. To survey ecosystem health and functioning including biodiversity of community land based on the needs of the communities for their ecosystem services and livelihoods.
4. To improve the understanding of local decision-making and resource use and management and identify the social-cultural factors that influence decisions.
5. To design and test a framework for supporting innovation and decision-making for sustainable resource use management and improved livelihood opportunities.

METHODOLOGY

A transdisciplinary mixed-method approach was employed, with the methods being applied in an integrated and iterative manner across the five aims. The integrative science-action approach involved methods such as historical and current monitoring of climatic and hydrological observations, hydrological modelling, landscape mapping, veld assessment, citizen science water quality tests, participatory mapping workshops, village walks, co-learning workshops, focus group discussions, in-depth interviews, participant observations and facilitated management plan development. These methods were occurring in parallel with various community-led

activities for spring protection, water reticulation, grazing management, erosion regulation and restoration, river clean-up and alien clearing.

RESULTS AND DISCUSSION

The changes in rainfall patterns and water quantity were assessed and quantified over time to inform communities' decision-making (Aim 1). The temperatures in the area are higher than in the past, with 2019 and 2015 being the hottest years. The rainfall is highly variable, which results in variable streamflow from the catchments. 2018/2019 had the lowest rainfall and lowest streamflow on record. A drought period stretched from 2013 until 2020, followed by an unusually wet period, with the summer of 2022 being much wetter than average.

A transdisciplinary social-ecological GIS support tool was developed for decision making and management of water and natural resources, and locally defined land uses were linked with ecosystem services and livelihoods (Aim 2). The communities have a rich and detailed understanding of their landscape and describe a diverse utilization of, and appreciation for, the various land uses and their benefits. A wide variety of ecosystem services are associated with specific land uses and places in the landscape, although many of the ecosystem services were perceived as having declined by the participants. A series of map layers were produced for each of the communities, with spatial information about the community landscapes, co-generated between the project team and the communities. The map reading literacy and ability to interpret spatial information was significantly improved during the course of the project, which enables the communities to use the printed maps for continued decisions around community resources and management strategies.

Ecosystem health and functioning of community land, including biodiversity was surveyed based on the needs of the communities for their ecosystem services and livelihoods (Aim 3). The communal rangelands in both villages are moderately degraded and dominated by grass species with an average palatability and low grazing value. Land degradation linked to overgrazing and severe erosion are evident in both villages. Large gullies have formed in areas related to cattle paths and subsequent water movement down these paths.

The understanding of local decision-making and resource use and management was improved, and social-cultural factors that influence decisions were identified (Aim 4). Overall, decision-making processes in these communities involve a combination of collective discussions among some selected groups of community members, individual autonomy in certain areas, and the involvement of the local chief and councillor in resolving disputes and managing resources. While there is a focus on community participation and preserving natural resources, there are also challenges and tensions in the relationship between the community and certain governance structures. The concept of ownership has emerged, where individuals claim resources such as land, water sources, and trees as their own. Thus, public access to resources has diminished.

A framework for supporting innovation and decision-making for sustainable resource use management and improved livelihood opportunities was designed and tested (Aim 5). Co-learning between the project team and community participants about the climate, the environment, and the communities' needs, priorities and decision-making structures enabled the development of participatory community resource management plans that are community-led and expert guided. The process particularly empowered the Costone community to plan, innovate and take action towards management of their resources and to build social agency. Ezibomvini did not see the same rate of success and require more support. Community resource innovations were co-developed between community participants and the project team. An engineer assisted with co-designing an innovation for spring protection and reticulation in Costone. Along with the efforts of a youth group, the "EcoChamps", community members in Costone initiated a number of restoration actions derived from the community resource management plans. Such actions include grazing management alterations, alien clearing, river cleaning and erosion control activities using check dams with stone and brush packs and re-seeding of grass species on bare soil.

CONCLUSIONS

These findings and outcomes were co-developed, discussed and reflected on in a series of engagements, co-learning workshops and cross-visits in the communities. This project highlights the importance in creating a shared understanding of the communities' resource base between scientists, practitioners and community members, the communities' dependency and management of their landscape, governance and decision-making structures and mechanisms for social learning, generation of agency and action, and assuring long-lasting and fair impact. This project has led to improved governance within the communities by establishing new community-based structures and improved rules and logistics within these structures. Traditional authority structures have been brought on board and

strengthened. Enhanced participatory decision-making generated through this project has supported sustainable and fair implementation and innovation, and ensured coherent collaboration within the communities, and with other stakeholders and collaborating partners.

This project contributes with new knowledge and enhanced understanding of the mechanisms and processes required to stimulate action, build social agency and improve decision-making for sustainable and equitable management of community resources. Lessons learnt from this project include 1) the importance of genuine, caring and intentional presence in the community for building trust, 2) experienced and skilled facilitation, continuously within and outside of structured workshops, as well as, 3) the significance of livelihood support for participants to enable effective, collective engagement in broader community matters. These aspects of transdisciplinary science-action research requires funding support for longer term engagement, significant funds for meaningful facilitation of community engagements, and larger proportions of funds that directly benefit communities to support their livelihoods. The learnings from this project can be used to inform the design, implementation and funding of similarly aimed projects and programs.

Although there is evidence that both social and environmental shifts towards sustainability and equity have occurred in both communities during the duration of the project, the communities require continued, long-term support to remain within this positive trajectory. Further research is recommended to assess and analyse the mechanisms and factors contributing to successful mobilization of agency and action that was initiated in this project, and what is required to assure long-lasting and fair impact.

RECOMMENDATIONS

- Sustainable management of water and natural resources is a complex and context dependent issue and needs to be addressed with co-created knowledge from scientific experts, facilitation practitioners and community members jointly
- Restoration activities in these communities are urgently required to address the erosion linked to overgrazing and to, at a minimum, slow the rate of erosion with the intention ultimately to restore the landscape
- Rangeland management requires an integrated approach including well informed and controlled fire management strategies with resting periods and controlled grazing to avoid further degradation and loss of productivity
- Mapping and assessment of landscape resources requires a participatory approach to build a shared understanding of the landscape's capacity, use and benefits including ecosystem services
- Enhanced understanding of climate patterns, ecosystem health and functioning, and consequences of management practices enables better-informed and climate-resilient community resource decisions
- Enhanced understanding about the community governance structures, decision-making processes, and community needs and priorities enables better guidance from project experts towards equitable and sustainable management of natural and water resources
- Addressing power imbalances and promoting transparency, accountability, and meaningful participation are essential for equitable and sustainable management of natural and water resources
- Co-learning processes involves experienced and skilled facilitation, continuously within and outside of structured workshops
- A carefully designed, expert guided and community led co-development of adaptive community resource management plans enables social agency, stimulates action, and improves decision-making and governance outcomes
- Collaboration with mandated government structures providing communities with an innovation platform for trying out and integrating locally relevant ideas have the potential for long-lasting impact
- Supporting participants' livelihoods opportunities prior to, or in parallel with, community engagement activities enables collaborative commitment and engagement that is not hindered by individual poverty struggles
- Building trust through genuine, caring and intentional presence in the community is essential to stimulate commitment and collaboration between the project team and community participants

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The following members of the Reference Group are acknowledged for their valuable contributions and guidance:

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ACRONYMS & ABBREVIATIONS

ARUA Water CoE	African Research Universities Association Water Centre of Excellence
CA	Conservation Agriculture
CMA	Catchment Management Agency
CPNR	Cathedral Peak Nature Reserve
CRA	Climate Resilient Agriculture
CWRR	Centre for Water Resources Research
DALRRD	Department of Agriculture, Land Reform and Rural Development
DoA	Department of Agriculture
DSD	Department of Social Development
DWS	Department of Water and Sanitation
EFTEON	Expanded Freshwater and Terrestrial Environmental Observation Network
INR	Institute of Natural Resources
IWRM	Integrated Water Resources Management
KZNDARD	KwaZulu-Natal Department of Agriculture and Rural Development
LLA	Locally Led Adaptation
MDF	Mahlathini Development Foundation
NDC	The Northern Drakensberg Collaborative
NWA	National Water Act
OLM	Okhahlamba Local Municipality
SAEON	South African Environmental Observation Network
SANBI	South African National Biodiversity Institute
SAWS	South African Weather Services
TA	Traditional Authority/ies
UKZN	University of KwaZulu-Natal
UTDM	The uThukela District Municipality
VCA	Veld Condition Assessments
WRC	Water Research Commission
WRM	Water Resource Management
WSA	Water Services Act
WSP	Water Service Provider
WUA	Water User Association

CHAPTER 1: INTRODUCTION AND BACKGROUND

1.1 INTRODUCTION

Sustainable land management for water, food and ecosystem services is crucial, and particularly challenging, in degraded, water scarce and natural resources dependent communities, such as the agricultural villages in the Drakensberg, KwaZulu-Natal. These communities are often disproportionately impacted by socio-economic hardships, as well as climate variability and weather-related hazards. Such communities have evolved to deal with environmental and socio-economic disturbances that have shaped livelihood strategies over generations (Ostrom 1990). Despite decades of initiatives to improve livelihoods and long-term sustainability of different rural and indigenous communities globally, the successes of implementation are disparate and seemingly highly context-dependent. Scholars have set out to investigate success factors in the implementation of these innovations. Increased participation by stakeholders and community members, co-management and integration of knowledge systems have been suggested to positively impact the implementation of natural resource management strategies (Reed et al., 2009, Tengö et al., 2014). It has been found that factors such as power imbalances, poor income distribution and gender inequities, as well as external and internal disturbances undermine sustainability, and thus, impede the potential of successful outcomes of community-based natural resource management strategies (Delgado-Serrano et al., 2018). Repeated evidence that the success of such innovations are greatly context-dependent, suggests that there is a gap in the understanding of how the factors that make these smallholder communities contextually different influences the land management decisions. These communities are largely characterized by their cultural and historical legacies that shape human-nature relationships within specific cultural and institutional contexts, which in turn influence collaboration around these resources (Cockburn et al., 2020). Accounting for the diversity of social-cultural values, attitudes and understanding of human-nature relationships increases the context-sensitivity in decision-making processes such as land and natural resource management, but is often overlooked in both science and policy (Muhar et al., 2018). Motivations behind decisions are rooted in different social-cultural concepts such as worldviews, collective traditions and experiences, beliefs and values, and play out both in individual and collective decision-making processes. While conventional approaches to natural resource management have taken on technical problem solving processes, many scholars have recently argued that when drawing on theories and methods from social sciences, the human dimensions of natural resource management and environmental conservation can be better understood (Charnley et al., 2017). Decisions on natural resources are linked to the property regime of the land being managed and are commonly categorized into four basic regimes: open access, private property, communal property and state property (Feeny et al., 1990). This categorization is useful for theoretical analysis but reality is often more complex with combinations of these regimes; overlapping or conflicting. Communal property, or common-property, is usually the dominant property regime of smallholder communities such as those in focus in this project. Common-property regimes are however often not equitable and sustainable in practice. In the South African context, traditional authorities were established post-Apartheid to govern the communities' land and natural resources. Rapid socio-economic and political change has led to inequitable power structures in communities, where powerful actors have an advantage over the impoverished and women (Benjaminsen et al., 2006, Cousins, 2009). The combination of traditional authority over communal land, and national legislation and policy adds further complexity to the issues of decision-making of natural resources. Unpacking the community resource governance as well as the multifaceted dynamics between individual and collective decisions around these resources is thus crucial towards equity, long-term sustainability and resilience in communal land management.

1.2 LOCAL CONTEXT TO THE STUDY AREA

The uKhahlamba Drakensberg mountains, KwaZulu-Natal, is a protected area that encompasses transboundary national parks, game reserves, wilderness areas, and includes declaration of both Ramsar wetland importance and UNESCO World Heritage Site. These areas are home to rich biodiversity of endemic and threatened species and habitats, and also host long-term research on grassland management, soil conservation, and fire regimes. There are distinct fence line effects between the protected areas and the nearby communities, but the dynamics between the two sides of the fence in terms of benefits or threats, are not scientifically explored. Further, the uKhahlamba Drakensberg is a strategic water source area in South Africa, and provides water to Gauteng and KwaZulu-Natal. It is of national priority to manage and protect this water source to sustain supply to the end users. Within the uKhahlamba Drakensberg are the long-term Cathedral Peak research catchments where extensive, interdisciplinary monitoring and observation is

ongoing focused on the impacts of global environmental change, water, carbon, biodiversity and energy. Research has shown the rainfall in the Cathedral Peak catchments to be declining, with greater declines evident in the streamflow. Changes have been shown in the fire regime overtime as well. Beyond this, the research in the catchments is improving our understanding of hydrological processes. The knowledge that has been generated about the hydrology/hydro-meteorology of the Cathedral Peak nature reserve (CPNR) has benefited the management of the reserve, regional and national water planning but has not been of direct benefit to the impoverished, water insecure community downstream of the reserve who have a fundamental right to access the resource. These communities, whose livelihoods largely depend on natural resources and the land they are managing, receive only small pockets of ad hoc support from provincial Government Departments such as KwaZulu-Natal Department of Agriculture and Rural Development (KZNDARD) and Department of Social Development (DSD) and civil society organizations. The uThukela District Municipality (UTDM) (11 326.12 sq km in extent with a population of approximately 724 000 people) oversees and coordinates social and economic development as well as water and health services for the three local municipalities under its jurisdiction (Okhahlamba, Alfred Duma and Inkosi Langalibalele local municipalities). Due to lack of resources and other factors, the communities in this area have received little to no support related to water services in their villages, relying instead on very old infrastructure (pre-1994) and undeveloped water sources (springs and small streams) for their household water needs. There is no focus at all on agricultural and landscape-based water resource management. Climate change mitigation and adaptation processes have been limited to training and awareness within municipal structures, to enable development of environmental management plans. Could the research and monitoring in the CPNR be of direct benefit and be used in the communities decision-making to lessen their water insecurity? Further, could an understanding of the multiple benefits of high-quality water result in opportunities where the community could be compensated for ensuring that the quality of the water does not significantly decline as it moves downstream? Research into the dynamic interrelationships between and within the water-ecosystem-society domains will help explore answers to these questions.

Smallholder farmers in these communities rely heavily on their natural resource base to support their non-commercial to semi-commercial maize and livestock-based farming systems. Irrigation infrastructure is virtually non-existent although some individuals use local sources for vegetable production at household level. Grazing management systems are managed by the traditional authorities and for the most part is limited to setting annual dates for the cycles of livestock being moved into the mountain grazing areas (summer) and being allowed back into the village confines (winter). Within this context, it is imperative for the local communities to understand and to start grappling with their resource management issues and to garner as much support for these processes as they can. Given the very high levels of poverty in the area, these communities cannot be expected to implement these processes on their own, but they can go a long way towards jointly setting their priorities of action and undertaking joint and collaborative activities within their ambit of influence.

1.3 CONNECTION TO EXISTING PROJECTS

Mahlathini Development Foundation (MDF) is a small NGO working in pro-poor agricultural innovation systems who have been supporting smallholders in 20 villages (~550 direct participants, ~3000 beneficiaries) in the Okhahlamba Local Municipality. Local understanding, planning and implementation of climate smart agroecological practices, linked to local value chains and economic development can increase people's adaptive capacity and resilience in the face of further change. To this end, MDF and their partners have been working with two processes: i) Creating awareness and appropriate models for implementation of Conservation Agriculture in conjunction with Grain SA in KwaZulu-Natal and the Eastern Cape (2013-2019) and ii) Designing and implementation of a decision support system for smallholder farmer in implementation of a locally appropriate basket of climate smart agriculture practices in conjunction with the Water Research Commission (WRC) (2017-2020). The importance of also including broader natural resource and water management concerns into these processes have already been noted and initial steps have been taken with the learning groups involved to focus on these issues; primarily fodder flow and grazing management for livestock and access to and management of water resources for micro-scale irrigation. These processes have provided a strong entry point into these communities for the exploration and adaptive planning related to integrated water resource management (IWRM) and ecosystem services that this project undertakes.

This research builds on knowledge gained through several projects involving the lead and collaborating organizations, including the Mahlathini led WRC funded project "Collaborative knowledge creation and mediation strategies for the dissemination of Water and soil conservation practices and Climate Smart Agriculture in smallholder farming systems (K5/2719/4), and the project "Establishment of a More Robust Observation Network to Improve Understanding of Global Change in the Sensitive and Critical Water Supply Area of

the Drakensberg" (K5/2236), led by the Centre for Water Resources Research (CWRR), University of KwaZulu-Natal (UKZN) (Toucher et al., 2016). The research in this project further relates to other projects implemented through CWRR and the South African Environmental Observation Network (SAEON), the Expanded Freshwater and Terrestrial Environmental Observation Network (EFTEON), as well as outreach activities by Ezemvelo KZN Wildlife.

The study area of this project falls within the South African National Biodiversity Institute (SANBI) Thukela Catchment Living Catchment Project under which collaboration and co-learning is taking place within a multi-stakeholder engagement process. Recently, the Institute of Natural Resources (INR), MDF, and CWRR-UKZN have entered into a collaboration with WWF-SA to establish a Strategic Water Source Partnership (SWSP) for the Northern Drakensberg with particular focus on the upper uThukela. The Northern Drakensberg Collaborative (NDC, formerly the Upper uThukela Catchment Partnership) will implement work related to climate resilience agriculture and the control of alien invasive plants as well as supporting stakeholder engagement. Furthermore, UKZN, through the CWRR, forms part of the African Research Universities Association Water Centre of Excellence (ARUA Water CoE) along with several other South African and African Universities. The NDC including this project, has been included in the Water CoE research collaborations as a learning site in applying transdisciplinary social-ecological systems research into participatory water governance.

1.4 METHODOLOGICAL AND CONCEPTUAL APPROACH

Scientific advancement in the field of natural resource management is increasingly being created using sustainability science, social-ecological systems and resilience thinking approaches. Sustainability science is inherently transdisciplinary, and participatory multi-method approaches are often required to address the complex human-nature interactions that occur within social-ecological systems (Binder et al., 2013, Pacheco-Romero et al., 2020). Fundamental to the theory of social-ecological systems is the notion that feedback between social and ecological systems are interdependent and interact at various spatial and temporal scales (Guerrero et al., 2018). Although water forms part of a social-ecological system, its integrating and fundamental characteristics calls for additional emphasis in water focused research and management. This project uses a novel conceptual framework where the water domain obtains explicit attention within a social-ecological systems approach (Figure 1-1). This novel approach includes assessments of components therein, and the feedbacks between, the coupled systems of water, ecosystems and society. This three-domain framework encompasses and draws on concepts and methods from the dominating disciplines within each of the domains separately, as well as the interfaces between the domains as follows: Water-Society: Sustainable management and use of water resources is the focus of IWRM, which fundamentally draws on the scientific understanding of the process-based modelling and the dynamic interactions and feedbacks in coupled human-water systems (socio-hydrology). Ecosystem-Water: There are also interlinkages between the hydrological processes and the ecosystem functions (two-way dependencies), which is studied within the field of eco-hydrology. Ecosystem-Society: Societies' dependency on ecosystems for their well-being and livelihoods is commonly assessed through the concept of ecosystem services, typically studied using a social-ecological systems theory.

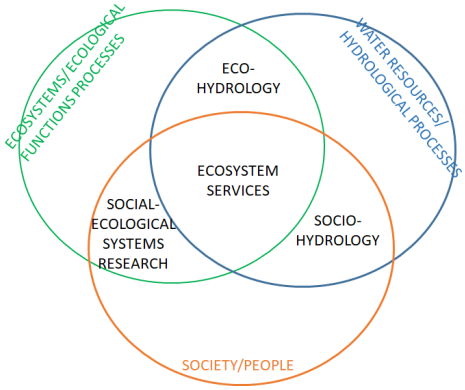


Figure 1-1 Conceptual framework: coupled water-ecosystem-society systems assessment

The research conducted in this project includes assessment of all the components: water resources and hydrological processes, ecosystem functions and ecological processes, and people's and societies' resource use, management and dependence, as well as cross-domain dynamics. This research has obtained a comprehensive understanding of not only the natural resource base, but also

the socio-economic benefits the communities obtain from natural resources such as water and ecosystems, within the communities and in the protected areas nearby. In addition, the social learning approach provided for more informed decision-making about appropriate adaptive measures to ameliorate negative impacts and synergise for positive re-enforcements in the social-ecological system. This transdisciplinary research sought to generate novel scientific knowledge to guide sustainable management of water resources and promote equitable development.

This project brings together experts from various scientific disciplines (hydrology, ecology, sustainability science, environmental sciences, agricultural engineering and social sciences), community development practitioners and local communities, using a transdisciplinary, participatory approach in order to 1) Enhance the knowledge base towards a shared understanding of the natural resource base, climate variability, community needs and priorities, and governance and power dynamics, and 2) co-learn for stimulating action, building social agency and improve decision-making and governance outcomes. Figure 1-2 provides an overview of how the report is structured.

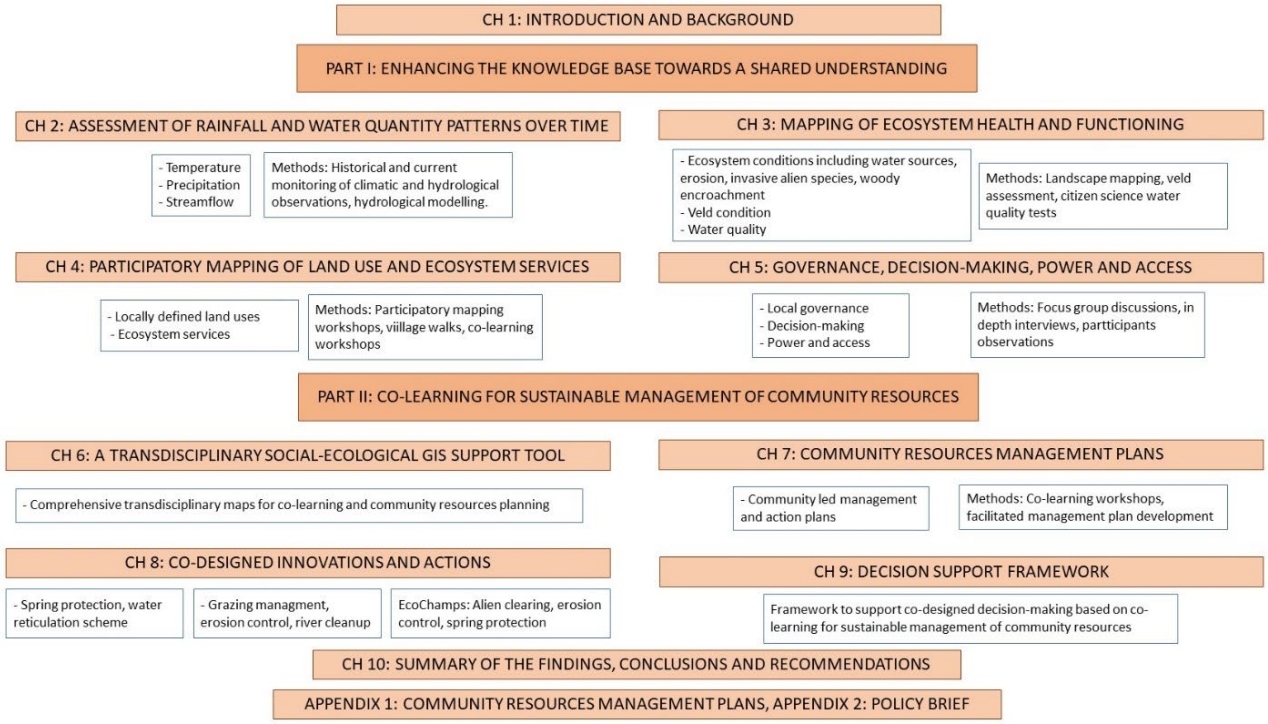


Figure 1-2 Overview of the report structure

1.5 PROJECT AIMS

The following were the aims of the project:

1. To assess and quantify changes in rainfall patterns and water quantity over time to inform communities' decision-making.
2. To develop a transdisciplinary social-ecological GIS support tool for decision-making and management of water and natural resources and link land uses with ecosystem services and livelihoods.
3. To survey ecosystem health and functioning including biodiversity of community land based on the needs of the communities for their ecosystem services and livelihoods.
4. To improve the understanding of local decision-making and resource use and management and identify the social-cultural factors that influence decisions.
5. To design and test a framework for supporting innovation and decision-making for sustainable resource use management and improved livelihood opportunities.

PART I: ENHANCING THE KNOWLEDGE BASE TOWARDS A SHARED UNDERSTANDING

CHAPTER 2: ASSESSMENT OF RAINFALL AND WATER QUANTITY PATTERNS OVER TIME

2.1 INTRODUCTION

The first aim of this project was to assess and quantify changes in rainfall patterns and water quantity over time to inform communities' decision-making. The outcome of this aim is a shared understanding of the community water resources (changes of water quality, quantity, streamflow, recharge potential, sediment load). To achieve this aim, the hydroclimatological data from the Cathedral Peak research catchments was assessed to determine any patterns and changes over time that have occurred.

The Cathedral Peak Research catchments were established in 1945 for the purpose of investigating the influence of different land management treatments on streamflow response. The catchments were highly influential in informing water policy in South Africa, particularly as it relates to afforestation. In 1995 (and earlier at some stations), due to a lack of funding, monitoring ceased in the Cathedral Peak catchments. Recognising the value of the historical data from the catchments for assessing long term change, the SAEON Grasslands-Forests-Wetlands node became actively involved in the landscape in 2011, and over time intensified the monitoring of the catchments and formally registering the Cathedral Peak research catchments as a Long Term Ecological Research site.

An assessment of the hydroclimatological data is presented in the sub-sections which follow. The long term data including the historical period is presented, and qualitative comparisons drawn at this stage. Given the gap in the records no trend tests have been applied to determine quantitative trends.

2.2 TEMPERATURE PATTERNS

The Mike's Pass weather station was, and is currently, the primary weather station at the Cathedral Peak research catchments. The initial weather station was installed in 1948 and remained operational with high quality data for temperature until 1991. The Mike's Pass weather station was the first equipment that SAEON installed in the catchments in August of 2012. The mean annual temperature at the Mike's Pass weather station since monitoring resumed in 2012 has been above the historical (1951-1980) mean average temperature, and has been greater than the mean by more than 0.5°C each year with 2015 and 2019 being more than 1.5°C warmer than the historical mean average temperature (Figure 2-1).

The monthly mean temperature anomaly for the current period is shown in Figure 2-2. The monthly mean temperature has generally been greater than the historical mean of the monthly average temperature, especially during the winter months. During the dry period of 2015 the mean monthly temperature was, for some months, more than 3°C warmer than the historical mean of that month's average temperate. Interestingly, the month of October in the current period has often been colder than the historical mean for October (Figure 2-2).

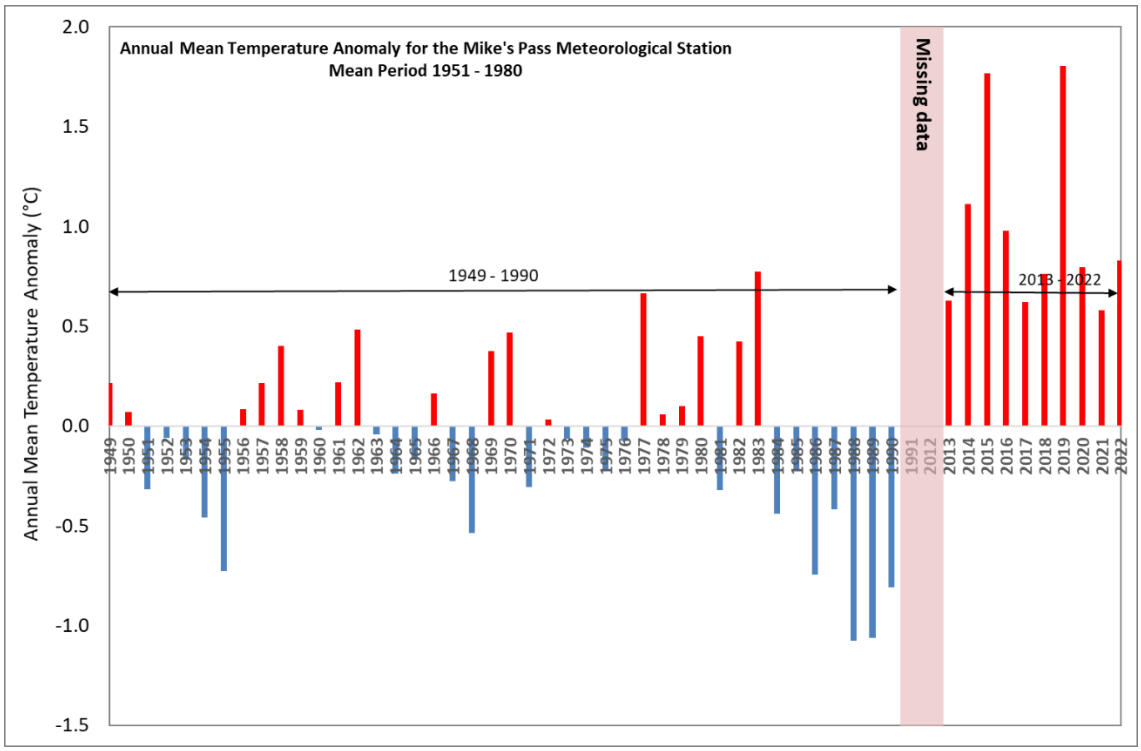


Figure 2-1 Annual mean temperature anomaly for the Mike's Pass meteorological station

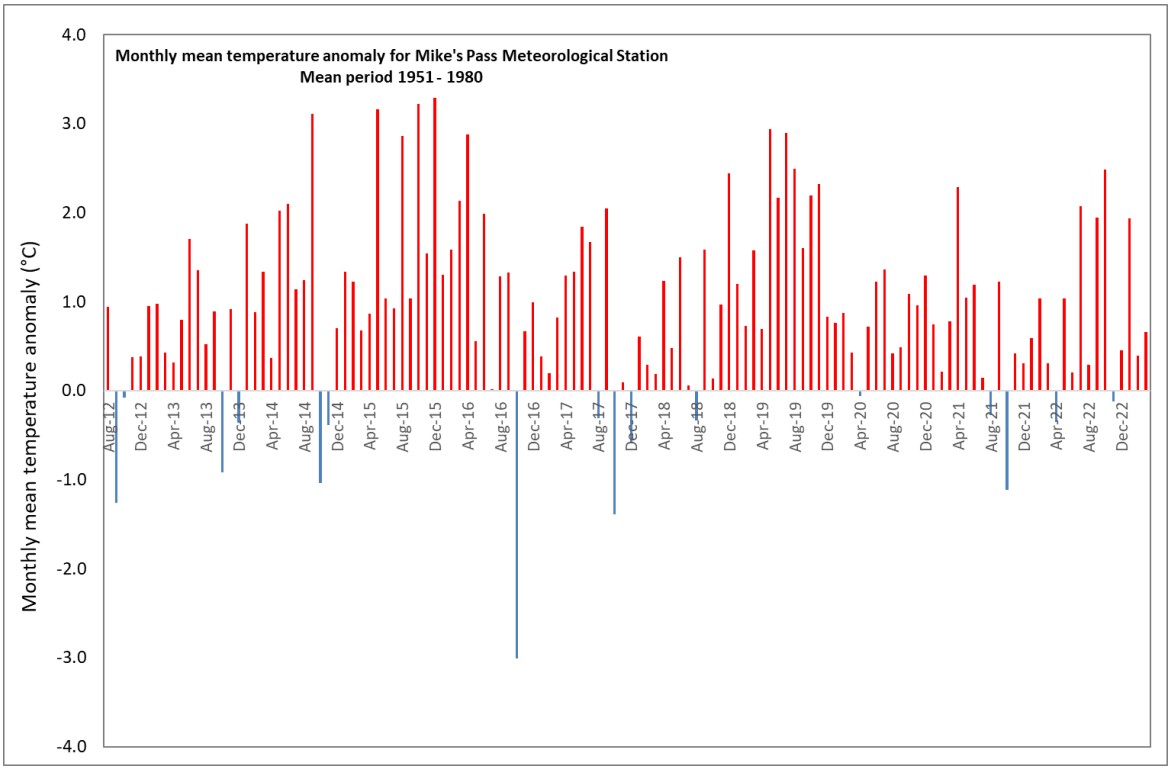


Figure 2-2 Monthly mean temperature anomaly for the Mike's Pass meteorological station

Given the warmer temperatures seen in the current period of data relative to the historical records, changes in the nature of heat waves over time were investigated. To determine the number of heat waves over time, the South African Weather Services (SAWS) definition of a heat wave was used. SAWS defines a heat wave as three consecutive days where the maximum air temperature is at least 5°C

warmer than the mean maximum temperature of the hottest month of the year. The warmest month in the historical temperature record for the Mike's Pass weather station was January with a mean maximum temperature of 21.4°C (1951-1980 mean).

The number of heat waves being experienced at the Mike's Pass weather station appears to be greater than what was experienced historically (Figure 2-3). In the historical record available for the station, the greatest number of heat waves experienced in one year was five in 1968. Some years no heat waves were experienced, and the majority of years experienced one heat wave. During the current period of monitoring, nine heat waves occurred during 2019, seven heat waves in both 2013 and 2018 and six heat waves in 2015. All years in the current period have experienced at least two heat waves, even 2023 where only three months of data is included. Interestingly, the hottest day on record for the Mike Pass weather station was recorded in 1970, 36.5°C. However, the next four hottest days were recorded in 2016, 2015, 2018 and 2019 recording 35.16, 34.65, 32.92 and 32.67°C respectively.

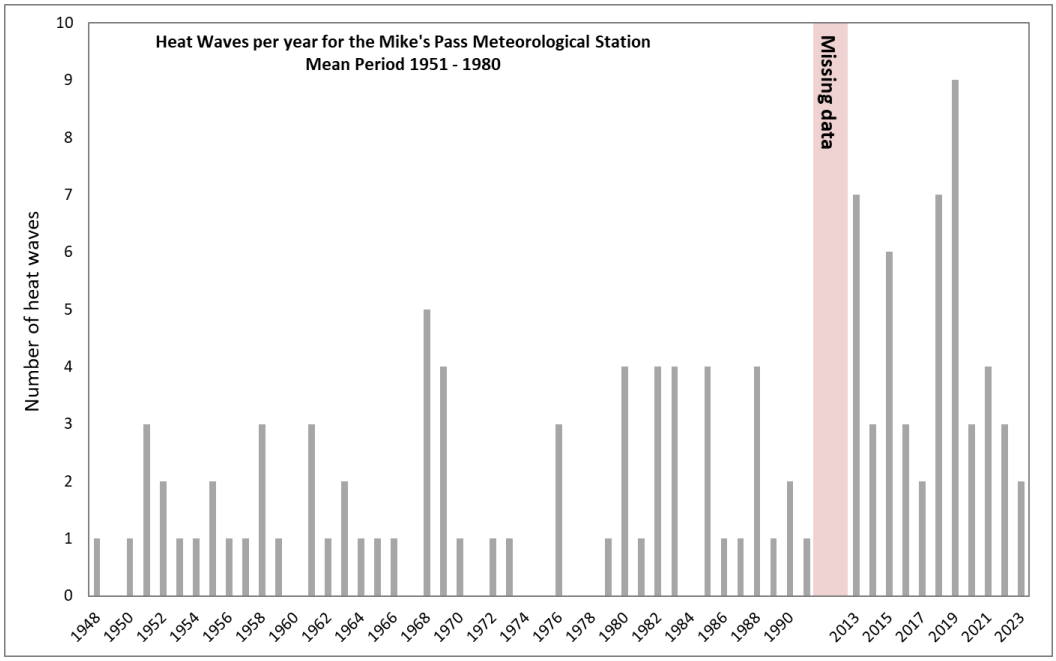


Figure 2-3 Number of heat waves recorded at the Mike's Pass meteorological station

BOX 1: IMPACT OF HEAT WAVES ON CROP PRODUCTION IN COSTONE AND EZIBOMVINI

In January 2023, a six-day long heat wave was recorded at the Mike's Pass weather station. The heat wave was broken with one day falling below the SAWS definition of 5°C warmer than the mean maximum temperature of the hottest month of the year. This was followed by a four-day heat wave.

Mahlathini Development Foundation (MDF) have been working with the Costone and Ezibomvini villages for a number of years, encouraging and tracking the influence of conservation agriculture (CA) on crop production. Reflections on the influence of the January 2023 heat wave on crop production were noted by the MDF team. By late January, the majority of participants' in the MDF maize program were showing signs of drought stress. A few of the lead farmers, such as Mrs PH, in Ezibomvini, however, were spared and their crops remained vibrant. The two photographs below were both taken on the 24 January 2023 after the two heat waves. The homesteads of Mrs CH and Mrs PH are right next to each other and their fields are separated by no more than 50 m.

Both these farmers have been practicing CA since 2014, however the sites have quite different soil characteristics (some innate and some due to farmer's management strategies), which is likely to be responsible for the difference in the performance of the crops. Mrs PH's fields have higher clay percentage (43% versus 27% for Mrs CH), N% (0.19 versus 0.15), organic carbon (2% versus 1.6%) and pH (5.1 versus 4.9). This set of photographs demonstrates that CA improves the capacity of crops to perform well even under circumstances of mid-season dry spells, which are likely to become more common as we experience the impacts of climate change, but only if all three principles of minimum tillage, increased soil cover and crop diversification are diligently followed.

Figure 2-4 Maize showing heat stress in Mrs CH's CA plot (above) and Maize and cover crops looking vibrant with good canopy cover in Mrs PH's field (below). Note: The pictures were taken on the same day and fields are in very close proximity

2.3 PRECIPITATION PATTERNS

The SAEON Grasslands node has monitored rainfall for a full ten (2012/2013-2021/2022) hydrological years (Oct-Sept) in the Cathedral Peak catchments. The primary weather station site, both now and in the historical period, is the Mike's Pass weather station. The rainfall data for the Mike's Pass weather station is presented here, however, it must be noted that these rainfall totals have been checked against three other rain gauges in the same enclosure as the weather station, and that the patterns align with those seen from the other 32 rain gauges across the Cathedral Peak catchments.

The annual rainfall totals for the hydrological years that have been monitored (Figure 2-5) have been lower than the historical mean (1 392 mm) taken as the period 1951-1980 except for the 2020 and 2021 hydrological years. The mean was taken for this period as the confidence in the data was high. The gap in the data between 1990 and 2012 at the Mike's Pass station limits the analyses. Thus, using the SAWS station at the Cathedral Peak hotel, the Mike's Pass station was patched for the period 1990 to 2011. The differences in altitude, localised rainfall events characteristic of the area, and only having one gauge available to patch from, implies that the patching is not ideal and is associated with high uncertainty. The annual rainfall anomalies from the 1951-1980 mean for the full period including patched data are shown in Figure 2-5. Given the short current record period and the concerns about the quality of the patched record, no trend analysis has been undertaken.

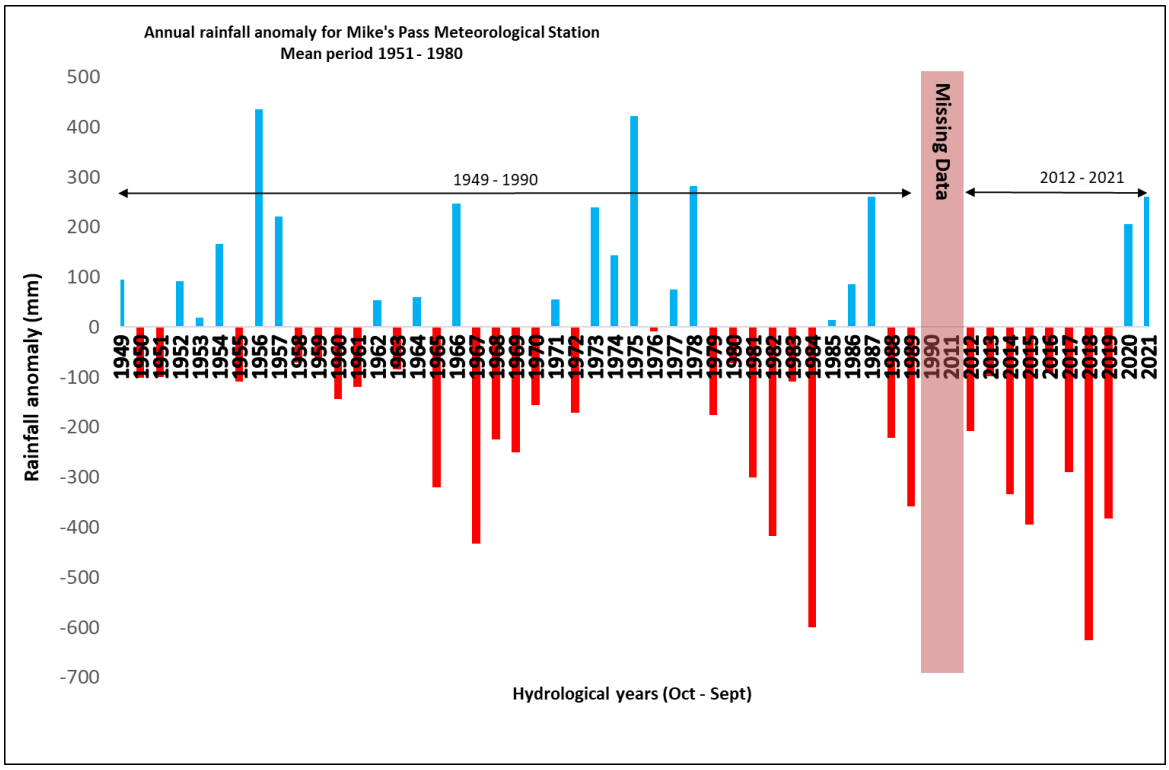


Figure 2-5 Annual (hydrological years) rainfall anomaly for the Mike's Pass meteorological station

During the drought experienced in the early 1980's (1979-1984), the lowest annual rainfall total experienced was 792 mm in 1984, and relative to the historical mean the total deviation for the six-year period was 1 677 mm. During the more recent drought (2014-2019), the lowest annual rainfall total was 765 mm in 2018, the lowest annual rainfall total on record for the site. Although the difference between the total in 1984 and that in 2018 is relatively small, it is the total deviation for the more recent six-year period of 2 120 mm that indicates the severity of the more recent drought relative to the 1980's drought. Further to this, the more recent drought comes on the back of two years of below average rainfall (2012 and 2013). The two most recent hydrological year (Oct 2020-Sept 2021 and Oct 2021-Sept 2022) were wetter than the historical average by 200 and 260 mm, respectively. To provide context, the standard deviation of the historical annual rainfall is 206 mm, thus although wetter the 2020 hydrological year was within one standard deviation of the historical annual rainfall, and the 2021 slightly greater than one standard deviation.

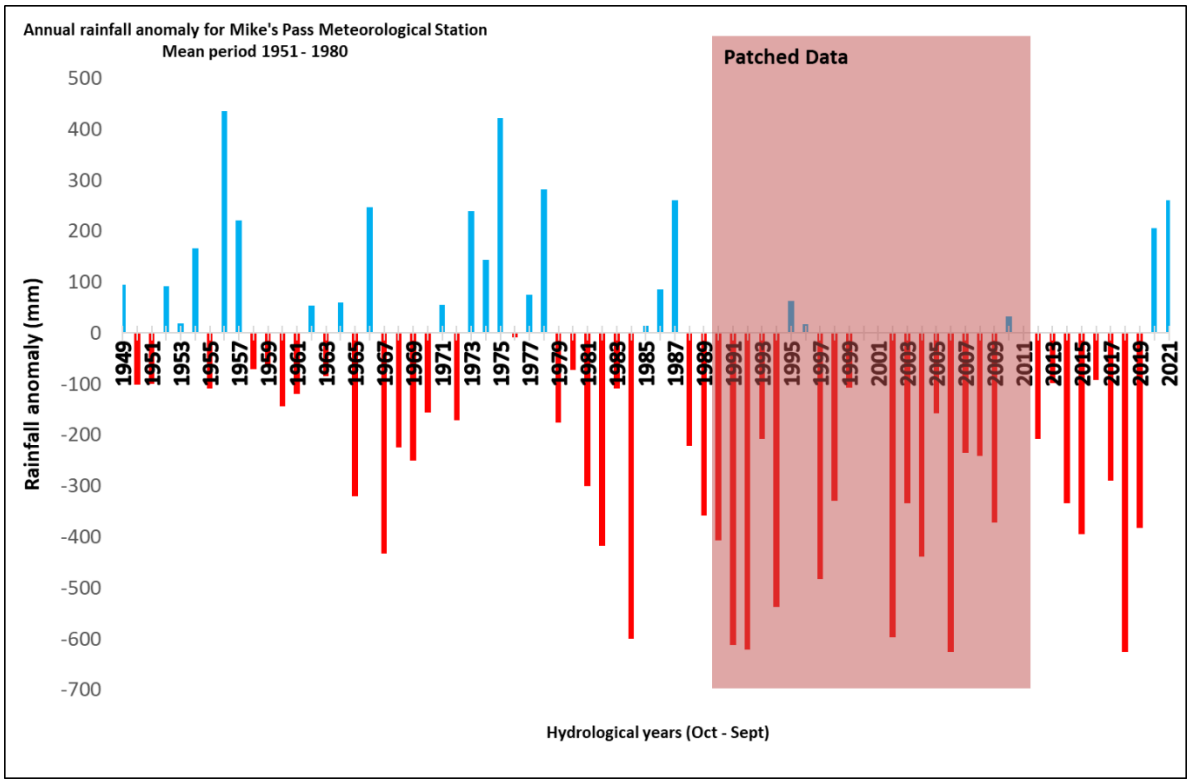


Figure 2-6 Annual (hydrological years) rainfall anomaly for the Mike's Pass meteorological station for the full period 1949-2021 using a combination of in-situ gauged data and infilled data

The monthly rainfall monitor to the end of March 2023 is provided in Figure 2-7. The above average rainfall for the 2020/2021 hydrological year is due to the above average monthly rainfall at the start of the 2020/2021 summer season. The winter months of the 2020/2021 were drier than average, as has been noted for the other hydrological years since the start of the contemporary record at the site.

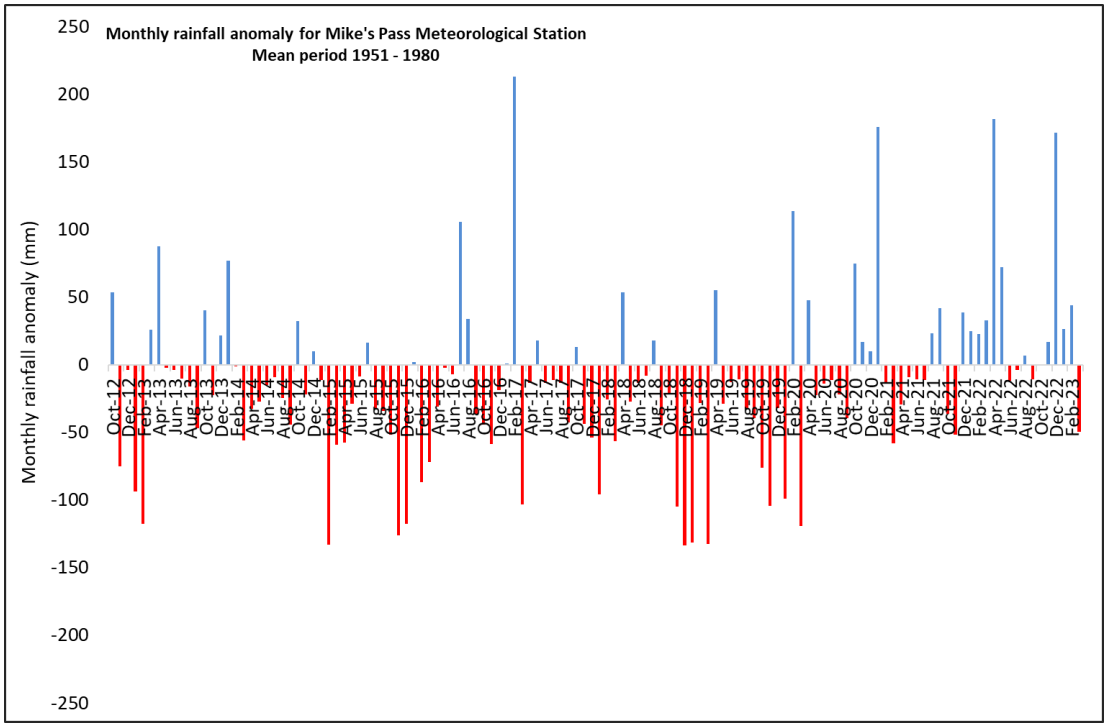


Figure 2-7 Monthly rainfall anomaly for the Mike's Pass meteorological station

2.4 TREAMFLOW PATTERNS

Toucher et al. (2016) showed a declining trend in the streamflows for Cathedral Peak, Catchment IV from 1950 to 1995. With the current streamflow period becoming longer, a full nine hydrological years of streamflow data is now available for the current period an analysis of the patterns in streamflow. Given the shortness of the record and the natural variability, no statistical analysis has been undertaken.

As expected, the streamflow responses lag slightly behind the rainfall experienced as they are moderated by the soil and groundwater stores. The annual streamflow anomaly for the historical and current record period relative to the 1961-1987 mean for Catchment VI, Cathedral Peak is shown in Figure 2-8. The lowest annual streamflow on record was experienced in the hydrological year of 2018, in alignment with the lowest annual rainfall total. During the meteorological drought period, the streamflows in 2016 and 2017 were above normal. The reasoning for this is related to the pattern of the rainfall experienced, the unusually wet July of 2016 and the February 2017 which was 200 mm wetter than the historical average for February. In alignment with the above average rainfall during the 2020/2021 and 2021/2022 hydrological years, the streamflow was above normal.

The monthly streamflow anomaly for the current period (2-7) reflects the same pattern as the annual streamflow graph, showing the influence of the wet July 2016 and February 2017 on the flows. As well as the influence of the wet start to the summer rainfall season of 2020/2021, where the rainfall in October 2020 to January 2021 was above normal resulting in the above normal flows in January and February 2021. Since March 2022 the monthly streamflows have been above normal, with the streamflow in January 2023 being 174 mm above the January mean. The high flows in January 2023 are due to rainfalls above normal from November 2022 to January 2023.

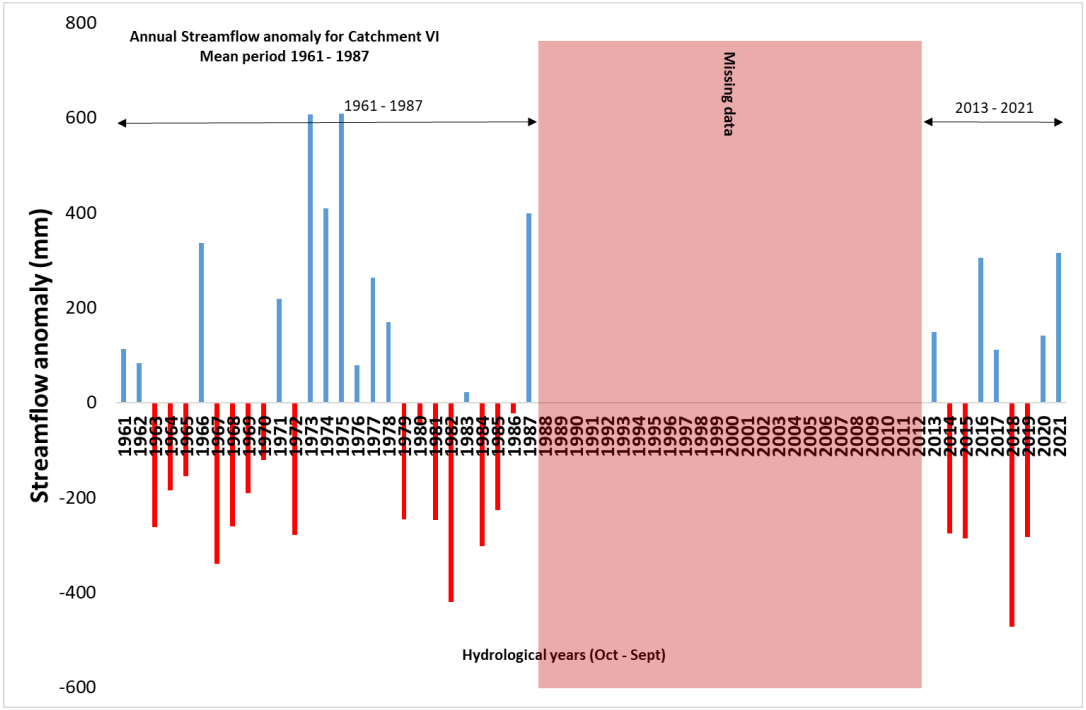


Figure 2-8 Annual (hydrological years) streamflow anomaly for Catchment VI, Cathedral Peak

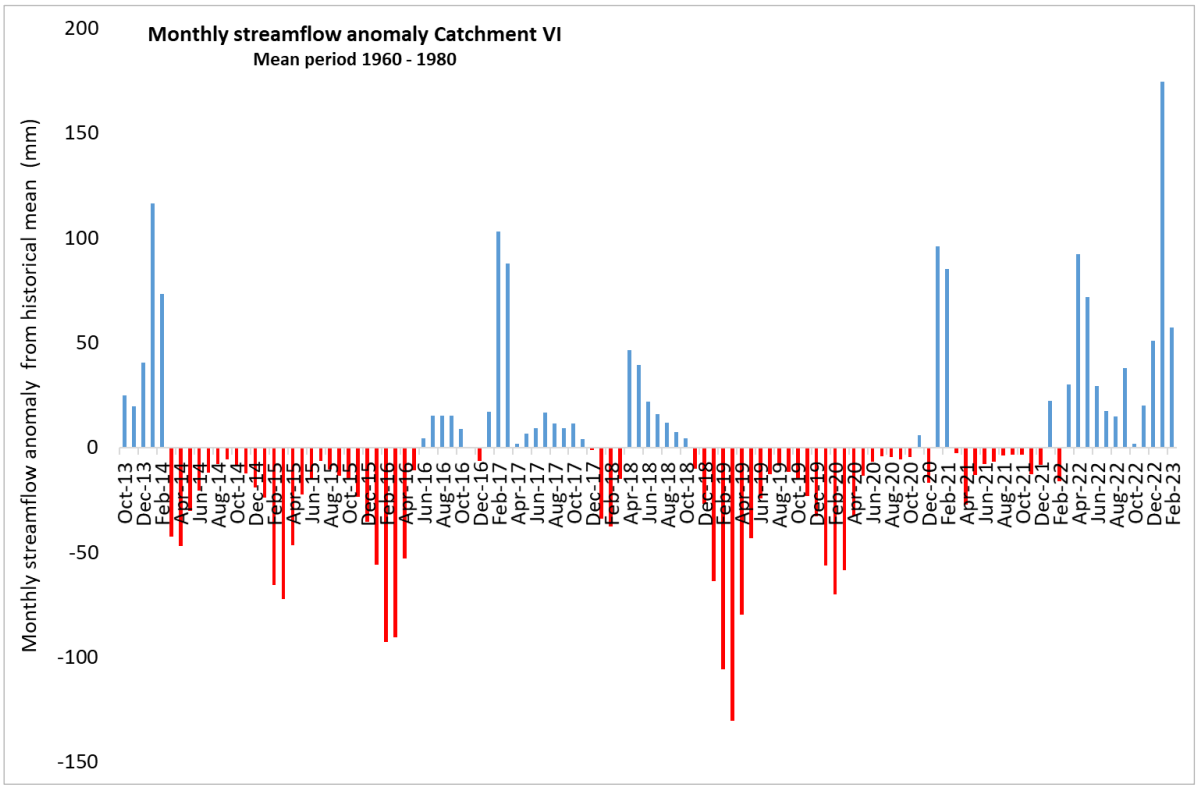


Figure 2-9 Monthly streamflow anomaly for Catchment VI, Cathedral Peak

2.5 IN SUMMARY

The temperatures experienced in the Cathedral Peak region of KwaZulu-Natal are consistently higher than those experienced in the past, with 2019 and 2015 being the hottest years on record for the area. The influence of these warmer temperatures are evident in the increase in the number of heat waves being experienced in the area.

The rainfall in the Cathedral Peak area is highly variable, both spatially and temporally, as shown in the historical and current records of rainfall for the area. This variability in rainfall results in a variable streamflow from the catchments, with the streamflow response lagging the rainfall experienced. The 2018/2019 hydrological year experienced the lowest rainfall on record for the site, and likewise the streamflow was the lowest recorded.

The graphs shown here were presented to the villages of Costone and Ezibomvini during the co-learning workshops. The experiences of the participants were in alignment with the data graphs shown, with many participants noting that they felt that it was much warmer now than what they remember and that the rainfall was different, citing that rainfall now comes in larger events and less frequently. However, the data does not support the participants' experiences of fewer rain events with larger rainfall amounts when it rains. The number of raindays between the historical and current period has not altered significantly, nor has the number of rainfall events greater than 20 mm (Figure 2-10). The participants' views could be influenced by their recent recollections from coming out of the drought period that stretched from 2013 until 2020, into wetter than average conditions with the summer of 2022 being much wetter.

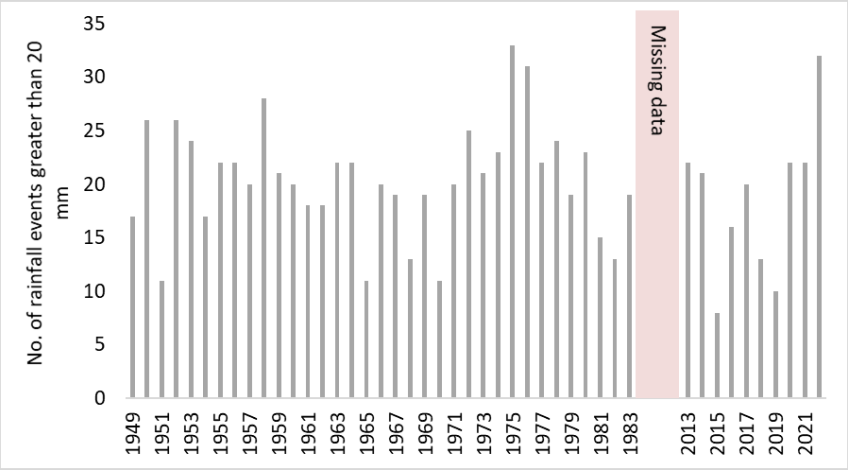


Figure 2-10 Number of rainfall events greater than 20 mm recorded at the Mike's Pass meteorological station

CHAPTER 3: MAPPING OF ECOSYSTEM HEALTH AND FUNCTIONING

3.1 INTRODUCTION

To contribute to Aim 3 of the project, *viz*. "To survey ecosystem health and functioning including biodiversity of community land based on the needs of the communities for their ecosystem services and livelihoods", field and desktop surveys were used to develop maps of the ecosystem condition for both the Ezibomvini and Costone villages.

The maps of ecosystem condition were informed by three aspects,

- field based surveys which focus on water sources, including springs and wetlands, erosion and invasive alien species and woody encroachment
- use of land use and land cover satellite imagery and terrain maps, and
- Veld Condition Assessments (VCA)

The field based surveys in both villages were conducted between August and November 2021. However, the field component of the veld condition assessments were only conducted in late January 2022 with the plant identifications and analyses continuing into February 2022. The boundaries for the villages were determined with the community members during the co-learning workshops. The field surveys considered areas outside of the village boundaries to ensure that any upstream factors affecting the ecosystem condition were included. The maps produced are presented per village. Additionally, the water quality sampling undertaken by the community and the EcoChamps are discussed in this chapter to contextualise the ecosystem health and function.

3.2 METHODOLOGY

3.2.1 Mapping Methods

At the initial co-learning workshops, informal walks through the villages with village members were undertaken. During these walks, landscape features that could impact water quantity and quality were noted. The primary concerns were wetlands, erosion, invasive alien species and woody encroachment. Thus, these, along with the water sources, including rivers and springs, were the focus of the mapping. Following the village walks, the features decided on were roughly identified using Google Earth prior to field visits. The primary method used to produce the detailed maps were in-field surveys to GPS key landscape features. During the field visits, the features were ground-truthed and the extent and condition of the features mapped. In cases where the landscape features could not be accessed, Google Earth was used to supplement the maps. Post-processing of the GPS data was done in ArcGIS Pro with the shapefiles exported to .kml files for use in Google Earth Engine to facilitate easier sharing between team members and ultimately stakeholders.

3.2.2 Veld Assessment Methods

Rangelands are indigenous vegetation that consists mainly of grasses and shrubs/trees that are grazed and browsed by livestock or wildlife (Allen et al., 2011). These natural rangelands support livelihoods through the provision of a range of ecosystem services. The production of livestock is one of the key ecosystem services through intensive ranching on private land or collective ranching on communal lands (Reid et al., 2008). Communal rangelands and their associated residential areas make up 13% of the land surface of South Africa and support a quarter of the country's population and half the country's livestock (Ward et al., 1998). Concerns have been raised about communally grazed rangelands in Africa and similar systems across the world (Vetter et al., 2006). The comparisons

between commercial and communal rangelands have highlighted changes in land degradation and productivity (Todd and Hoffman, 1999). Communal rangelands are commonly considered overstocked, overgrazed, degraded and unproductive.

Rangeland condition is the health of rangeland functioning in terms of ecological status, resistance to soil erosion and forage potential for livestock production (Ndandani, 2016). Rangeland degradation is the continuous loss of species composition and invasion of woody plants (Bosch and Theunissen, 1992). Communal rangelands condition in South Africa is declining due to poor management, land degradation and climate change (Hoffman and Ashwell, 2001). In South Africa, land degradation is mostly due to overgrazing and human activities (Vetter, 2003). Overgrazing decreases palatable plant species and increases less palatable species (Kgosikoma et al., 2012). Additionally, overgrazing changes plant species composition, basal cover, diversity, richness and soil moisture while making the rangeland more susceptible to invasive alien plants and woody encroachment (Vetter, 2013). There is a direct correlation between rangeland condition and animal production (van der Westhuizen et al., 1999) and therefore, these compromised communal systems show a loss of rangeland productivity and poor livestock performance (Lesoli, 2008).

Species composition is one of the means of studying ecological changes in a rangeland (Malan and van Niekerk, 2005). An indicator of rangeland condition is understanding grazing practises and its changes over time (Abule et al., 2007). Veld Condition Assessment (VCA) is the health of the rangeland in terms of ecological status, resistance to soil erosion and the potential forage production for continued livestock production (Trollope et al, 1990). The majority of techniques to determine and monitor veld condition require an assessment of species composition and an estimate of basal cover for the sample site (Hardy and Tainton, 1993). Furthermore, quantifying biomass production can provide realistic estimates of stocking rates for sustainable grazing management (Kunst et al., 2006). VCA is essential for both commercial and communal rangelands to document the effects of current management on veld condition and to monitor changes over time and also for evaluating veld condition relative to its potential in that ecological zone (Hardy et al., 1999). Therefore, this study evaluated the communal rangelands of both the Ezibomvini and Costone villages to understand current health condition and recommend management tools.

The VCA was carried out at Ezibomvini and Costone villages communal grazing lands as demarcated by the communities. A community member accompanied the researchers on the fieldwork. These areas have a mean elevation of 900 to 1 440 m above mean sea level (amsl), a mean annual precipitation of 710-1 120 mm per year and a mean annual temperature 16°C (Mucina and Rutherford, 2006). Members of the communities and in some instances, neighbouring communities, share the communal rangelands. The rangelands are grazed continuously with no restrictions on stocking rates, but with seasonal variations. Cattle and goats are the bulk grazers while sheep and horses are present in lower abundances. The communal rangeland falls within two vegetation types, namely the Drakensberg Foothill Moist Grassland (GS10) and Northern KwaZulu-Natal Moist Grassland (GS4) as described by Mucina and Rutherford (2006). The vegetation and landscape is described as moderately rolling and mountainous with river gorges of drier vegetation types and covered in forb rich grassland dominated by *Themeda triandra* and *Tristachya leucothrix*. *Acacia sieberiana* var. *woodii* woodlands are common in valleys and disturbed sites.

Table 3-1 The dominant grasses for each vegetation type according to Mucina and Rutherford (2006)

Northern KwaZulu-Natal Moist Grassland (GS4)	**Drakensberg Foothills Moist Grassland (GS10)**
Alloteropsis semialata subsp. eckloniana, Aristida congesta, Cynodon dactylon, Digitaria tricholaenoides, Elionurus muticus, Eragrostis patentissima, Eragrostis racemosa, Harpochloa falx, Hyparrhenia hirta, Themeda triandra, and *Tristachya leucothrix.*	*Diheteropogon filifolius, Elionurus muticus, Eragrostis capensis, Eragrostis chloromelas, Eragrostis curvula, Eragrostis plana, Eragrostis racemosa, Heteropogon contortus, Microchloa caffra, Monocymbium ceresiiforme, Panicum natalense, Rendlia altera, Sporobolus africanus, Themeda triandra, Trachypogon spicatus* and *Tristachya leucothrix.*

Site selection within the communal grazing lands was based on vegetation uniformity. At each site, four 100 m line transects were demarcated across the landscape spaced with 20 m between each line transect. We measured grass composition and degree of dominance using the Step-Point method. At 2 m intervals along each transect, the nearest grass species was identified, and distance

and tuft size measured. Forbs were excluded as they have a relatively low occurrence in the landscape. If no grasses were found within a 0.2 m radius from the point, it is recorded as bare soil. A 1 x 1 m quadrant was randomly placed 50 times along the transect to estimate grass and forb cover. Grass species were identified to species level and placed into ecological status classes using the method of Trollope (1989). Grass species are classified into four ecological classes based on grazing value, biomass production and palatability (van Oudtshoorn, 2009). The grasses were grouped into Decreaser species, Increaser I, II and III species and further grouped according to their life form (annual, perennial, and creeper).

Decreaser species are tufted and stoloniferous grasses that are abundant in good rangeland and decrease when over- or under grazed. These species are highly palatable and highly productive, and thus of high grazing value. Increaser I species are tufted grasses that are abundant in underutilized rangeland. These species have medium palatability and intermediate productivity, and thus are of moderate grazing value. Increaser II species are tufted and stoloniferous grasses that are abundant in overgrazed rangelands. Increaser II species increase due to disturbance effects such as overgrazing. These species have a medium to low palatability and high to medium productivity, and thus are of low grazing value. Increaser III species are tufted grasses common in overgrazed rangeland. These species are competitive and difficult to remove, as well as being unpalatable and having low productivity. Thus, the grazing value of Increaser III species is low.

The Ecological Score method was used to determine veld condition. The benchmark method cannot be used as a benchmark veld that would represent best possible botanical composition and cover in relation to climate could not be found. The Ecological Score uses data from the grass species composition survey, the percentage composition of each class is calculated and multiplied with the specific class. The sum of the values represents an Ecological Index with a maximum of 1000. The veld condition is evaluated using the guidelines in Table 3-2.

Table 3-2 Veld condition evaluated according to ecological score

Ecological Score	**Veld Condition**
0-399	Broadly indicates poor veld
400-600	Broadly indicates moderate veld
601-1000	Indicates good veld

A Disc Pasture Meter (DPM) (Trollope and Potgieter, 1986, Zambatis et al., 2006) is used to determine the grass production (fuel load) within most vegetation types (Figure 3-1). It's a rapid, non-destructive method to determine dry mass yield of rangelands. For each transect, 50 readings (disc height in cm) were recorded, 200 readings per village, to calculate mean settling height of the disc. The equation of Zambatis et al., (2006) was used to determine grass Biomass (kg/ha):

$$Kg.ha^{-1} = [31.7176(0.3218^{1/x})x^{0.2834}]^2 \quad \text{Eq. 3.1}$$

Where,

x = mean disc height in cm of a site

The percentage basal cover of each sample site was obtained by substituting the mean distance and the mean diameter values into the following regression equation developed by Hardy and Tainton (1993). The basal cover standards were recommended by Camp and Hardy (1999). The basal covers are: 1-5% critical, 6-10% poor, 11-15% reasonable and 16%+ good to excellent.

$$\text{Basal cover} = 19.8 + 0.39\,(D) - 11.87\,(\log_e D) + 0.64\,(d) + 2.93\,(\log_e d) \quad \text{Eq. 3.2}$$

Where,

D = distance to the nearest tuft (in cm and rounded to the nearest cm), and

D = tuft diameter (in cm and rounded to the nearest cm)

Figure 3-1 Images showing the use of the Disc Pasture Meter (DPM), quadrat and 100m line transect. Features to note on the photo on the right, signs of selective grazing and low sward height

3.2.3 Citizen science water quality tests

Following the initial village walks, the concern regarding water quality was the *Escherichia coli* levels in the water sources used by the communities. Further there appeared to be high sediment loads in the rivers. Given the scope of the project, we were unable to initiate an intensive water quality testing campaign. Further, with the aims of the project the desire was to include the village members, particularly the water committees, in the research we were undertaking. Thus, citizen science methods of assessing the water quality were used. The presence of *E. coli* was tested using a semi-quantitative, relatively cheap, easy to use *E. coli* water test system developed by Praecautio. The advantage of the test is that it can be done in the field, there are no laboratory costs, nor any specialised equipment or training required. Given that no specialised training was required, the water committee members and the EcoChamps in the two villages were taught how to undertake the *E. coli* water tests. The sites that would be tested were decided on together with the village members at the co-learning workshops.

Each test comes in a sealed package. The test consists of a syringe, sealed tube with a powder in it. The person undertaking the test uses the syringe provided to draw up 10 ml of water from the water source that is to be tested. They remove the lid of the tube, and dispense the 10 ml from the syringe into the tube. They replace the cap tightly and shake the sample until the powder has dissolved. The tube then needs to be incubated for at least 24 hours. The incubator option we used was a WonderBag. A hot water bottle was placed in a large WonderBag. The tubes were placed into a small WonderBag which was placed on top of the hot water bottle inside the large WonderBag. The presence or absence of *E. coli* was determined by the colour change of the water in the tube after 24 hours of incubation.

A positive result for *E. coli* is indicated by the liquid in the tube turning green (Figure 3-2). A yellow colour indicates the presence of coliforms (Figure 3-2). A clear colour is a negative result for both *E. coli* and coliforms. The faster the water changes colour the higher the levels of *E. coli* in the water. Drinking water should have no *E. coli* present. A small number of coliforms (less than 10 per ml) are allowed in drinking water, however the optimum is for no coliforms or *E. coli* (i.e. a clear tube after 24 hours).

Figure 3-2 Image showing the colour change of the water in the tube if *E. coli* (left) is present and if coliforms (right) are present

Praecautio indicate that their test results have a high level of accuracy if the concentration of *E. coli* is greater than 10 per ml. At lower *E. coli* levels the accuracy is between 70 and 80%.

3.3 EZIBOMVINI VILLAGE

Within the Ezibomvini village boundary demarcated by the village members there are two distinct areas, a higher lying upper area which consists predominantly of grassland, woody vegetation and wetlands, and the lower lying area which is dominated by homesteads, agriculture and small grassland blocks. Four streams run through the Ezibomvini village and feed into the Lindequespruit River. The field survey was undertaken for the catchment areas of two of the streams, and focused on the higher lying areas (Figure 3-3). The lower section consists of homesteads, agricultural zones and grasslands. A notable, unique and rare botanical feature of the area is a natural Aloe hybrid population between *Aloe arborescens* and *Aloe marlothii*.

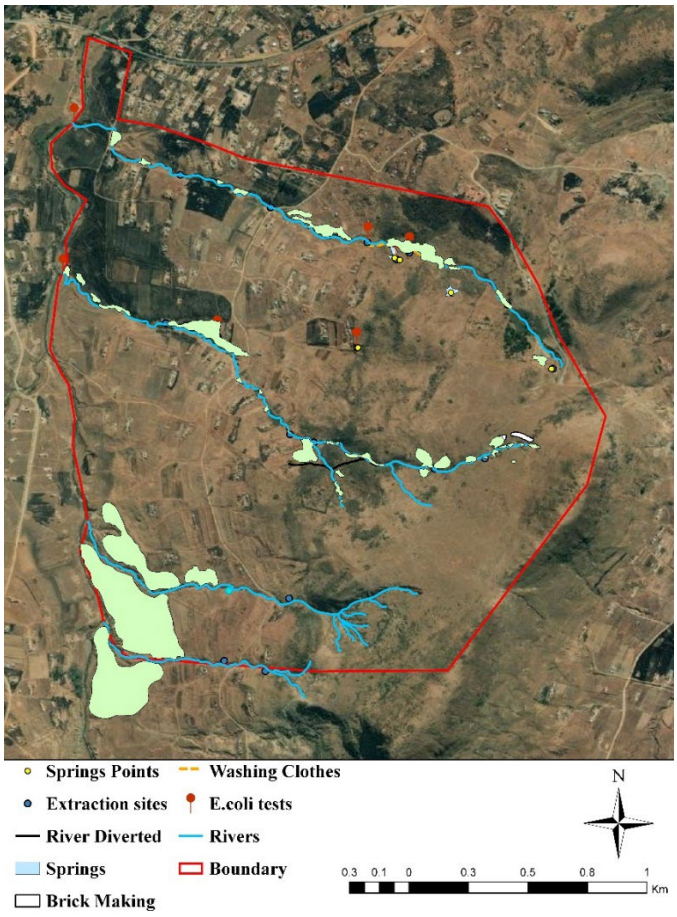


Figure 3-3 Ezibomvini village boundary with the streams, wetlands and springs and locations of *E. coli* tests, as well as the known points of water extraction and use

3.3.1 Ezibomvini village landscape features

Several springs are used for drinking water by the village. These springs are mainly in the higher lying area, near the rivers (Figure 3-3). The water is mainly collected by buckets. The springs are also used by cattle. The springs, however, are not high yielding. Water sources are limited, and are a significant concern in this village. The water collected from the rivers is used in household cleaning, washing clothes and bathing. Cattle, goats, pigs and ducks drink from several points along the river (Figure 3-3). The lower regions of the streams are subjected to dumping of building rubble, household refuse, glass bottles and nappies. The presence of the above mentioned will affect water quality. Given the dependence of the village on these water sources, the water quality is a significant concern. Areas which appear to be wetlands were noted adjacent and near to the river systems (Figure 3-3). These areas were wet in the dry season and had vegetation characteristic of frequently saturated areas. No formal delineation of the wetlands was undertaken. The condition of the wetlands identified varied from severely impacted (Figure 3-4 and Figure 3-5) to near-pristine, however, the majority of the wetlands were degraded and the functioning impaired with significant erosion present. Further, the riparian areas of the streams have been eroded (Figure 3-4), in some areas significantly with deep gullies having formed. The impacts on the wetlands and riparian areas noted in the field included cattle grazing, erosion, invasive alien species and clay harvesting for brick-making. The degradation of the wetland and riparian areas in the upper higher lying areas of the village was noted as a significant concern. It is likely that the extent of the degradation has already negatively impacted the water quantity and quality in the streams, with the risk that further degradation could have significant negative impacts.

Figure 3-4 A Poplar stand growing within the wetland area adjacent to a stream (left) and an example of the gully erosion in the catchment areas (right)

Figure 3-5 A wetland area where clay has been harvested to be made into bricks

To illustrate the extent of impact and concern of potential impacts going forward, interventions should be put in place. A concrete water tank with further tanks downslope were noted during the mapping survey. Community members were asked about the tanks. From their knowledge and memory, the tanks were installed by the Department of Agriculture, Land Reform and Rural Development

(DALRRD), formerly Department of Agriculture (DoA) to gravity supply water to various households. A pipe from the tank was pointed out by the community and it was noted that it no longer supplied water. It was understood that the tanks used to be fed by a spring with a v-box protection high up in the catchment area. On visiting the site of the supposed spring, significant erosion was found, no spring or evidence of it could be found and it appeared as if the v-box had collapsed years prior due to the significant erosion.

The areas of erosion were not limited to the riparian areas, with erosion mapped across the higher lying areas of the village (Figure 3-6). Deep gullies have formed which, in some cases, have been invaded by alien species (Figure 3-7). Scattered rocky areas occur in the high lying areas of the village. An extensive network of cattle paths was noted in the invaded, rocky areas. This is presumably caused by herds of goats. These rocky areas have been invaded by woody vegetation (Figure 3-8), mainly *Lantana camara* (Lantana) and *Aloe marlothii* (Mountain Aloe).

Figure 3-6 Eroded areas in the Ezibomvini village

Figure 3-7 Images of erosion within the Ezibomvini village

Lantana is a category 1b invasive species in South Africa. The rocks provide a favourable micro habitat for Lantana and Aloe to flourish. They provide shelter from veld fires, shade, and increased moisture. Field observations of the Mountain Aloe show all age groups present in the population. The opposite is found for Lantana, which mainly comprises of mature adults. The old aloe leaves and dead lantana branches are collected for making fires. In this community, Lantana is dispersed by frugivorous birds defecating on the rocks. The Lantana encroaches into and competes with the grassland species, decreasing the available cattle grazing areas.

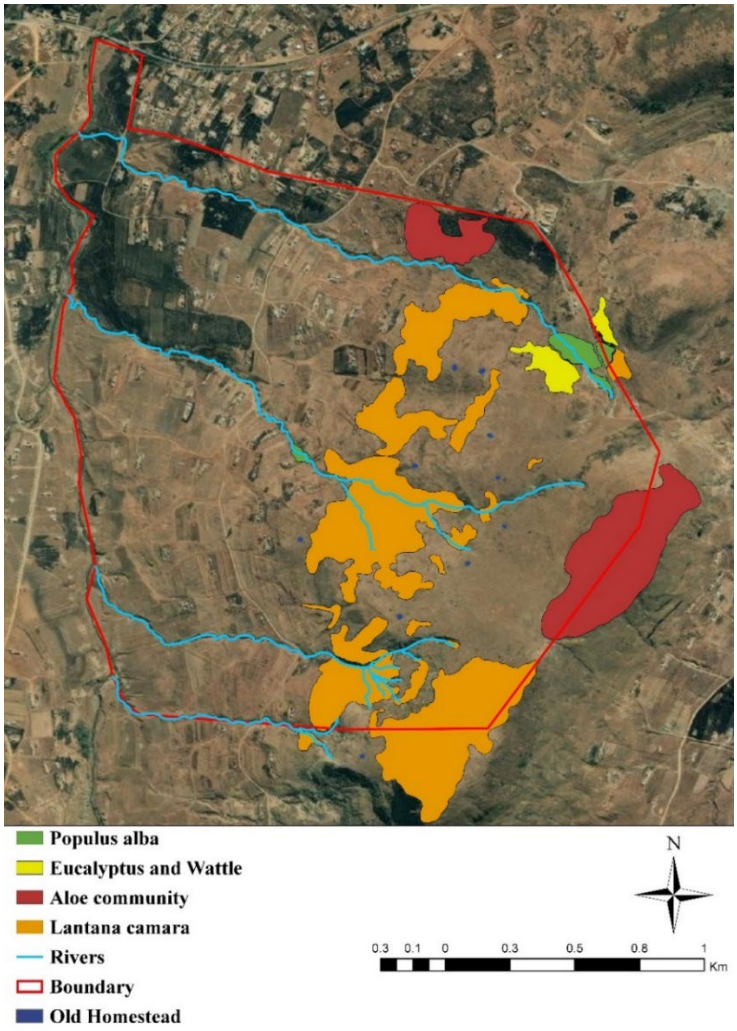


Figure 3-8 Woody invasion in the upper areas of the Ezibomvini village

3.3.2 Veld Condition Assessment results for Ezibomvini village

The veld condition score for Ezibomvini indicated that the rangeland is in a poor condition or moderately degraded. Sixteen grassland species were recorded with nearly 95% being Increasers (Increaser I – 12%, Increase II – 86% and Increaser III – 1%). Decreasers were represented by *Themedra triandra* at 2.5%. The dominant species were *Paspalum notatum, Sporobolus pyramidalis, Digitaria tricholaenoides,* and *Tristachya leucothrix* (Table 3-3).

Referring to the dominant grass species described by Mucina and Rutherford (2006) three species were present during the survey with *Eragrostis plana* and *Eragrostis curvula* with a relatively high occurrence, *Themedra triandra* absent to low occurrence and *P. notatum* as a new dominant exotic rangeland invader.

Table 3-3 Botanical name, ecological status, perenniality, grazing value and composition score of grass species in the Ezibomvini communal rangeland

Group	Species	Perenniality	Grazing value	Grazing value score	Ezibomvini %	Score
Decreaser	*Themedra triandra*	Perennial	High	10	2.5	25
Increaser I	*Alloteropsis semialata*	Perennial	Average	3	0.5	1.5
	Digitaria tricholaenoides	Perennial	High	6	7	42
	Tristachya leucothrix	Perennial	High	9	4.5	40.5
Increaser IIa	*Heterpogon contortus*	Perennial	Average	6	2	12
Increaser IIb	*Hyparrhenia hirta*	Perennial	Average	6	1	6
	Eragrostis plana	Perennial	Low	3	7	21
	Eragrostis racemosa	Perennial	Average	2	4	8
	Sporobolus africanus	Perennial	Low	3	4	12
	Sporobolus pyramidalis	Perennial	Low	3	13.5	40.5
Increaser IIc	*Aristida congesta barbicollis*	Perennial	Low	0	2	0
	Cyndon dactylon	Creeper	Average	3	0.5	1.5
	*Paspalum notatum**	Creeper	Average	3	50	150
	Urochloa panicoides	Perennial	Low	2	0.5	1
Increase III	*Diheteropogon filifolius*	Perennial	Low	0	0.5	1
	Cymbopogon pospischilii	Perennial	Low	2	0.5	1
Total					**100**	**362**

*exotic species

The grazing area veld in Ezibomvini was dominated by grasses and limited forbs (Figure 3-9). The basal cover for Ezibomvini was 16%, indicating good to excellent cover, with the bare soil being below 5%. The good basal cover and low percentage of bare ground was attributed to the dominance of a single grass, *P. notatum*, which has a creeping habit. The biomass production for Ezibomvini had a yield of 1 342 Kg.ha^{-1}. This low yield was also attributed to the dominance of *P. notatum* due to its short sward height and prostate habit.

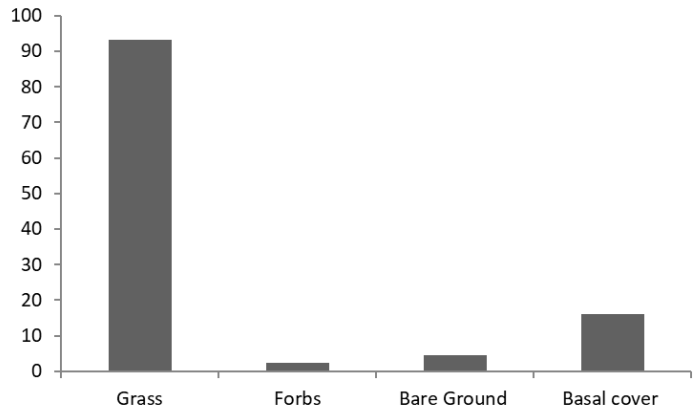


Figure 3-9 The comparison of aerial cover of grass species, forbs, bare soil and the basal cover of grass species

3.3.3 Citizen science water quality test results for Ezibomvini

The presence of *Escherichia coli* was tested at several points along two of the streams in the Ezibomvini village (see Figure 3-3 for the location of these tests) as a once off snapshot in time during the village walks. The samples all tested positive for *E. coli* or Coliforms Bacteria (Figure 3-10). Following the initial tests, the decision taken together with the water committee was to continue testing two

springs that are near to each other, one is protected and the other is not. Additionally, the water in the header tank for the communities' water scheme was tested.

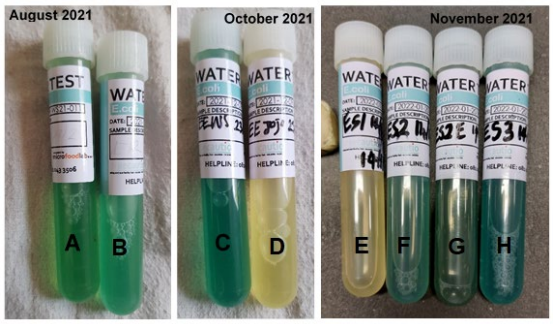


Figure 3-10 Results from the *E. coli* testing. A green colour indicates the sample is positive for *E. coli*, a yellow sample indicates Coliforms Bacteria. The locations the samples were taken from are indicated on Figure 3-3

The *E. coli* tests were undertaken regularly during summer and autumn of 2022 by the water committee members. Testing ceased in winter of 2022. One test was undertaken in November 2022 and one in February of 2023. It must be noted that these tests, although Praecautio indicate high accuracy, are citizen science, low cost tests that are not laboratory based. The results could indicate concerns or trends. The indications from the results seemed to be that when flow conditions were high the water samples indicated no presence of *E. coli*, however, as the flow levels dropped in March and April (Table 3-4). The spring protection seems to help in that the unprotected spring showed levels of coliform bacteria in two of the April tests whereas the protected spring and tank were clear. The presence of *E. coli* indicated that the water should not be used as drinking water unless treated first. The use of the springs by cattle, the degradation of the catchment and wetlands through erosion, and the waste found in the streams, result in the water quality degradation. Although only the presence of *E. coli* was tested. The high sediment load in the rivers was noted on the village walks.

Table 3-4 Results of the citizen science *E. coli* water testing at the protected and unprotected springs used by the village and the header tank for the village water scheme

		Location	
Date	Unprotected spring	Protected spring	Header tank
2022/02/17	Clear	Clear	Clear
2022/02/24	Clear	Clear	Clear
2022/03/04	Green	Green	Green
2022/03/10	Clear	Clear	Clear
2022/03/21	Clear	Clear	Clear
2022/03/31	Green	No result	No result
2022/04/04	Brown	Clear	Clear
2022/04/11	Brown	Clear	Clear
2022/04/18	Green	Green	Green
2022/04/25	Clear	Clear	Clear
2022/05/02	Clear	Clear	Clear
2022/11/15	Clear	Clear	Clear
2023/02/27	Clear	Clear	Clear

3.4 COSTONE VILLAGE

The Costone village is characterized by a high altitude mountain boundary, three river systems, a large wetland in the community area and grasslands. The high altitude regions contain springs that feed the three rivers that flow down through the homestead areas (Figure 3-11). The steep mountain slopes are characterized by a rich diversity of indigenous trees. The lower regions are covered by grasslands, wetlands, homesteads and agricultural zones. As the village area is substantially larger than the Ezibomvini village, the full catchment areas of the rivers could not be walked. Thus, Google Earth images were used to supplement the field based mapping.

3.4.1 Costone village landscape features

In contrast to the Ezibomvini village, Costone has a number of water sources (Figure 3-11). A borehole has recently been drilled in the village, with a pump and tanks installed that supply water to a section of the village. There is a borehole with a hand pump above the homestead area, near to which there is a protected spring (v-box) that feeds into two JoJo tanks from which community members collect water (a significant distance from any houses however). A further key feature with regards to water, is a large wetland in the lower homestead area of the village (Figure 3-12). There are three springs in this area that, at the end of the dry season, had fair yield. Drinking water is collected from these springs, however, they are not protected thus are used by cattle for drinking as well. A wetland assessment and delineation was not done. However, from the field survey it was noted that the majority of the wetland vegetation remains intact. A portion is used for agriculture during dry years and left fallow in wet years. Cattle are allowed to graze within the wetland. There is a good flow of water exiting the wetland into the river. The importance of protecting this wetland and building spring protections to ensure a sustainable water source for the community was evident.

Upstream of the larger wetland, a smaller wetland was noted (Figure 3-12). The smaller wetland was significantly degraded with the impacts noted being overgrazing, clay harvesting for bricks and agriculture. There was no flow exiting this wetland.

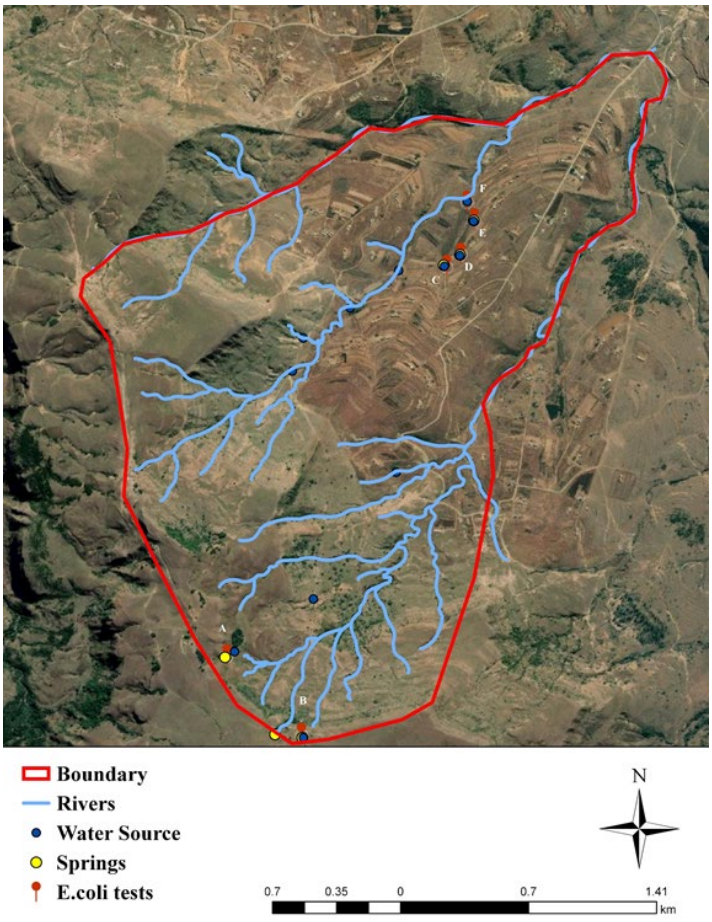


Figure 3-11 Costone Village boundary with rivers, springs and points of water extraction shown as well as locations of sampling for *E. coli*

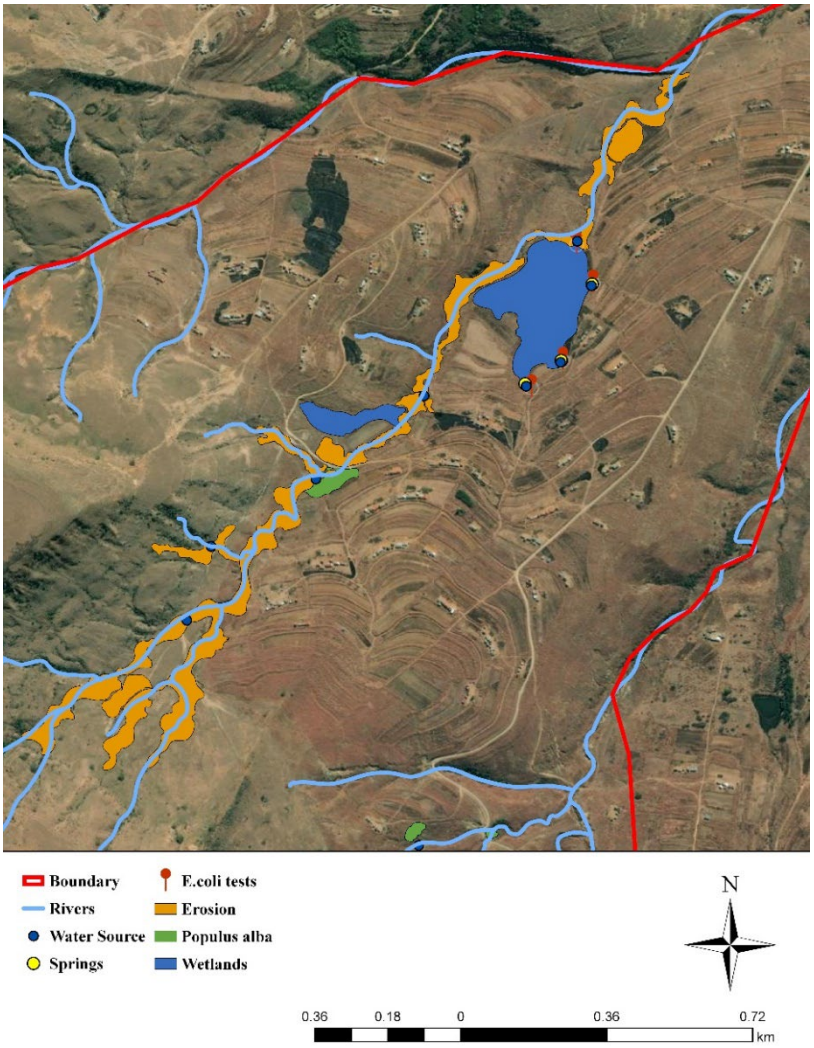


Figure 3-12 Lower portion of Costone Village with rivers, springs and points of water extraction shown as well as locations of sampling for *E. coli*, erosion areas and invasive species

Other water features identified were springs in the upper areas of the village. Three springs in the high lying areas surveyed (Figure 3-13), two of the springs (labelled A and B in Figure 3-11) were flowing while one was dry. The first spring was downstream of an indigenous forest patch. The area immediately below the spring eye is eroding, with gullies forming and wattle invasions in these gullies (Figure 3-14). The impacts noted on the area below the spring are cattle paths and overgrazing. The eye of the second spring was not observed during the field survey, however, wet areas in the landscape were noted. The area is characterised by deep continuous grazing lines, and downstream by a mature *Podocarpus* forest patch. The third spring, which had the highest discharge, was on a steep slope with wattle invasions on evident upslope of the spring eye, while significant erosion near and downstream of the spring were noted (Figure 3-15).

In contrast to the Ezibomvini village area, the erosion in the Costone village area was primarily limited to near or adjacent to the streams. Similarly, the extent of the alien invasive species noted was less than Ezibomvini. Isolated patches of Poplar trees near to streams were noted. The riparian areas of the streams in stretches appeared to be in a near-pristine state, and the upper regions of the village area had a high diversity of indigenous trees and shrubs.

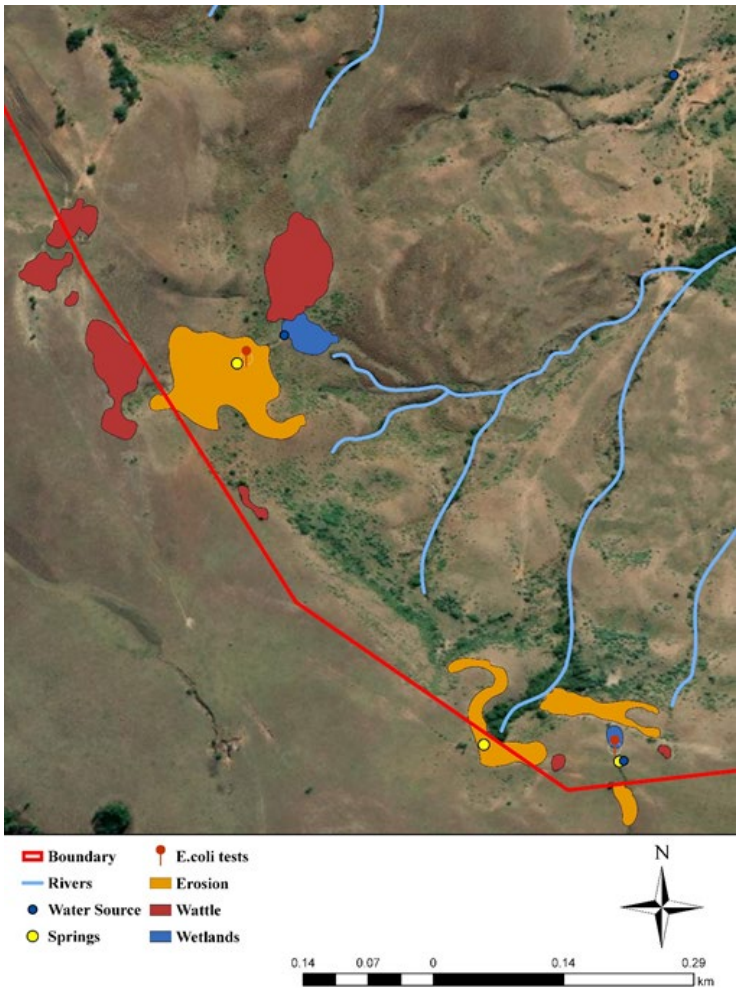


Figure 3-13 Lower portion of Costone Village with rivers, springs and points of water extraction shown as well as locations of sampling for *E. coli*, erosion areas and invasive species

Figure 3-14 Erosion downstream of the eye of the first spring (Spring A)

Figure 3-15 Images showing the erosion and presence of wattle near the third spring (Spring B)

3.4.2 Veld Condition Assessment results for Costone village

Similar to the veld condition score for Ezibomvini, the veld condition score for Costone indicated that the rangeland is in a poor condition or moderately degraded. The Costone grazing area is however, larger than the Ezibomvini grazing area. Notably the villages share a common dominant grass, a perennial exotic stoloniferous grass, *Paspalum notatum*. *P. notatum* occurrence is at least 50% for both villages. Ten grassland species were recorded with 100% been Increasers (Increaser I – 9%, Increaser II – 90.5% and Increaser III – 8.5%). The dominant species are *Paspalum notatum*, *Eragrostis plana*, *Aristida junciformis galpinii* and *Eragrostis curvula* (Table 3-5).

Table 3-5 Botanical name, ecological status, perenniality, grazing value and composition score of grass species at Costone communal rangeland

Group	Species	Perenniality	Grazing value	Grazing value score	Costone %	Costone Score
Increaser I	*Tristachya leucothrix*	Perennial	High	9	1	9
Increaser IIa	*Heterpogon contortus*	Perennial	Average	6	1	6
Increaser IIb	*Eragrostis curvula*	Perennial	High	5	7	35
	Eragrostis plana	Perennial	Low	3	11.5	34.5
	Eragrostis racemosa	Perennial	Average	2	3.5	7
	Sporobolus africanus	Perennial	Low	3	2.5	7.5
	Sporobolus pyramidalis	Perennial	Low	3	3	9
Increaser IIc	*Paspalum notatum**	Creeper	Average	3	62	186
Increase III	*Aristida junciformis galpinii*	Perennial	Low	0	8	0
	Diheteropogon filifolius	Perennial	Low	0	0.5	0
Total					**100**	**294**

*exotic species

As with Ezibomvini village, the veld in Costone is dominated by grasses and limited forbs. The aerial cover for grasses was 93% and for forbs was below 2%. The basal cover for Costone was also above 16% indicating good to excellent cover. The dominance of a single grass, *P. notatum* was the reasoning allocated to the good basal cover, further the creeping habit of the species has reduced bare ground. The biomass production had a yield of 1 121 Kg.ha^{-1} for Costone. The low yield is attributed to the dominance of *P. notatum* due to its short sward height and prostate habitat.

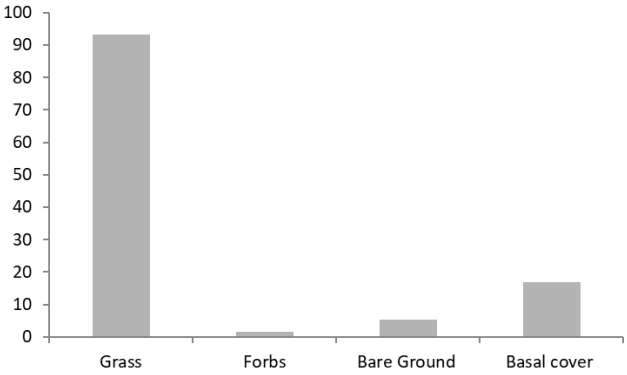


Figure 3-16 The comparison of aerial cover of grass species, forbs, bare soil and the basal cover of grass species

3.4.3 Citizen science water quality test results for Costone village

The presence of *Escherichia coli* was tested at springs on the edges of the large wetland in Costone and at the point where the flow exits the wetland (see Figure 3-12 for the location of these tests). The tests were undertaken on village walks during October and November 2021, and provide a point in time. The samples all tested positive for *E. coli* or Coliforms Bacteria (Figure 3-17). Additionally, *E. coli* test were undertaken on the water flowing from the high springs (A and B, Figure 3-13 - 3-15) in October 2021. The tests showed the presence of Coliforms Bacteria (Figure 3-18). These were a snapshot in time after the dry season.

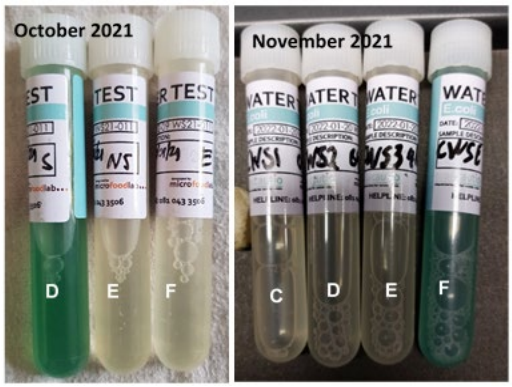


Figure 3-17 *E. coli* samples taken from the three springs on the edges of the wetland (C-E) on two different dates and at the flow exit (F). A green colour indicates the sample is positive for *E. coli*, a yellow sample indicates Coliforms Bacteria

Figure 3-18 *E. coli* samples taken from springs in the high lying areas in October 2021. A green colour indicates the sample is positive for *E. coli*, a yellow sample indicates Coliforms Bacteria

Following the initial tests, the decision taken together with the water committee was to continue testing two springs that are near to each other, a v-box protection was built for the one as part of this project and the other was not protected. Additionally, the water at the wetland outlet was tested. The *E. coli* tests on both springs and the wetland outflow only revealed the presence of *E. coli* on one occasion at the start of March 2022. After noting the contamination of the spring and water system in March 2022, the community undertook to build a swale above the spring in the wetland, as they noticed that runoff from the surrounding areas flowed into the spring intake area and they felt that this is what caused the contamination. However, from the project team view, given the snapshot results and the presence of *E. coli* in March, the concern was high that the water may often have *E. coli* or coliform bacteria present.

Table 3-6 Results of the citizen science *E. coli* water testing at the protected and unprotected springs used by the village and at the outlet of the wetland

Date	Protected Spring	Unprotected spring	Wetland outlet
2022/02/17	Clear	Clear	Clear
2022/02/24	Clear	Clear	Clear
2022/03/04	Green	Green	Green
2022/03/10	Clear	Clear	Clear
2022/04/21	Clear	Clear	Clear
2022/06/16	Clear	Clear	Clear
2022/06/23	Clear	Clear	Clear
2022/09/14	Clear	Clear	Clear
2022/12/05	Clear	Clear	Clear
2023/03/03	Clear	Clear	Clear

In March 2023, Mahlathini Development Foundation took water samples from the protected and unprotected springs to Umgeni Water for a full drinking water quality tests (SANS241). As per the laboratory report, the samples were taken and kept at 4°C for two days prior to analysis, which could affect *E. coli* and Coliform counts. The recommended levels of *E. coli* and Coliform bacteria should be 0 and <10 respectively for drinking water purposes. Ideally, the sampling should have been done within 24 hours of collecting the sample. Regardless of this, the results revealed that the water was generally favourable for drinking except for the presence of *E. coli* and Coliforms bacteria (Table 3-7). Treatment of water for household use will be required. Chemical disinfectant should be added to the header tanks of this system on a daily basis.

Table 3-7 Results of the Umgeni Water laboratory testing of the samples from the protected and unprotected springs in Costone

	Protected Spring	Unprotected spring
E. coli	54	28
Coliforms	1203	2420

3.5 CONCLUSIONS AND RECOMMENDATIONS

Overgrazing is seen as the main cause of land degradation in Africa at 243 million hectares (ELD Initiative and UNEP, 2015). In South Africa a quarter of the land owned by the government and rural communities is degraded (Ndandani, 2016). These communal rangelands are often characterised by high stocking rates and lack of a grazing management system (Lesoli, 2008). Communal rangelands are a shared resource utilized by the community members where everyone has equal access to resources the rangeland provides. However, management decisions are often taken by individual cattle owners (Gxasheka et al., 2017) rather than by a

collective of those making use of the grazing area. Overgrazing occurs when animals defoliate grass before it has had time to recover (Voisin, 1988). This occurs when livestock remain in an area for too long or return too quickly. Recovery time is important for grasses to restore roots reserves and asexual and sexual growth. The period required to recovery varies according to climate, season, and vegetation type and growth habitat. The time frame can vary from 10 days to 90 days or up one year resting (Savory Institute, 2015). Recovery only occurs in the growing season and in the absence of grazing.

The high abundance of Increaser II species indicates long term overgrazing at the loss of Decreaser species in both villages. The increased abundance of species like *P. notatum*, *Sporobolus pyramidalis* and *Eragrostis plana* is an indicator the system is fire suppressed. Selective grazing has been shown to change the structure and species composition of rangelands and favours unpalatable species or species with low to average grazing value (Milchunas et al., 1988). Highly palatable species such as *Themeda triandra* and *Tristachya leucothrix* are lost through continuous selective grazing. Furthermore, trampling and nutrient enrichment significantly impact species diversity (O'Connor et al., 2010). These factors together with the role of fire account for the low grass diversity and veld composition. *P. notatum* is a highly persistent grass that is able to withstand close defoliation due to its extensive rhizome network and low growing points and responds well to fertilizer. Furthermore, the grass is cold tolerant and can tolerate short term droughts (Truter et al., 2014). These competitive adaptations of *P. notatum* make it resistant to selective grazing and benefits from additional nutrients.

Besides grazing, the other primary disturbance mechanism in rangelands is fire. Controlled burning is the use of fire to change rangeland vegetation to favour optimum forage and animal productivity (Trollope and Trollope, 1996). The use of fire in communal rangeland is uncontrolled and influenced by the need to produce a flush of green grass. Livestock will select green grass from burnt areas over unburnt areas (Trollope, 1989). The frequency and time of fires in communal areas often leads to rangeland deterioration. The flush of green growth at the incorrect time of year is short lived and negatively affects growth vigour. Root reserves are depleted and favourable species are weakened to the advantage of Increaser II species. Fire intensity refers to the rate of heat released during a fire and determines vegetation recovery. Fire intensity is directly linked to fuel load. The fuel loads in both systems are low due to the dominance of a *P. notatum*. The rangelands cannot support intense burns due to the short and sparse sward blades. Thus leading to a fire suppressed system.

On a positive note, degraded communal rangelands are resilient and can recover with changes in species composition and diversity. Harrison and Shackleton (1999) have shown changes in grass species composition and grass basal cover with the removal of high and continuous grazing pressure in communal rangelands. The resultant changes may represent replacement of species groups that already exist (Walker et al., 1997). An increase in palatable indigenous species will be favoured over annuals and unpalatable species. Additionally, the absence of grazing showed an increase in the occurrence of palatable species. The protection from grazing reduced the competitive advantage of undesirable species and lead to a decline (Frost et al., 1986). This created openings to facilitate recolonization of palatable species. *P. notatum* is a strongly stoloniferous, adaptable and long lived species. The grass was able to withstand intense grazing and dominate species composition due to its wide network of root reserves, which Strugnell and Pigott (1978) substantiated through root studies. Therefore rotational resting may encourage perennial species to replace *P. notatum*.

The communal rangelands in both villages are moderately degraded and dominated by grass species with an average palatability and low grazing value. Continuous overgrazing has led to a single species dominating the rangeland. Fire as a tool for regeneration is misunderstood. These disturbances have changed the species composition and richness. The use of fire needs to be carefully planned and rest periods where appropriate need to be incorporated after its use. Controlled burning must be integrated with other grazing management techniques to gain the full benefits. Degraded communal rangelands are resilient and can recover with changes in species composition and species diversity.

Changing current communal grazing management depends on the success of any intervention through the presence of local-level institutions and organisations (Rasmussen and Meinzen-Dick, 1995). Moyo et al (2008) has shown communal range management is complex and various factors are required to implement grazing management interventions. The study highlighted that rotational grazing through fencing and paddocks was the ideal method to improve rangeland health and productivity in communal areas but lack of local level institutions, limited knowledge of rangeland management, lack of rules and restrictions on rangeland resources are constraints that would reduce the effectiveness of fencing. Planning rangeland interventions would require consideration of socioeconomic and ecological factors, strengthening of local-level institutions and utilizing land more effectively.

During the co-learning workshops, discussions were held to understand grazing management strategies and practices that are required:

1. To understand historical management and the influence on grazing practices
2. Identify current factors determining present grazing strategies
3. The role of fire in the rangeland
4. Livestock stocking rates

The degradation linked to the overgrazing is the severe erosion evident in both villages. Large gullies have formed in areas related to cattle paths and subsequent water movement down these cattle paths. The erosion is lessening the productive land available for grazing and is also creating hazards and vulnerability in the villages due to the erosion undercutting roads, incising river channels and increasing flow rates. Restoration activities are urgently required to address the erosion and to, at a minimum, slow the rate of erosion with the intention ultimately to restore the landscape. Together with the community, the extent of erosion was discussed at the co-learning workshops. The approaches to restoration were discussed, with local knowledge being gathered.

CHAPTER 4: PARTICIPATORY MAPPING OF LAND USE AND ECOSYSTEM SERVICES

4.1 INTRODUCTION

Ecosystem services, being the benefits humans obtain from interacting with ecosystems, relate to many dimensions of human well-being. These interactions, between the natural environment, human skills and decisions, technology and infrastructure, social-cultural organization and institutions, result in the co-production of ecosystem services (Duraiappah et al., 2014). The resilience of ecosystem services is the capacity of a social-ecological system to reliably sustain a desired set of ecosystem services, in the face of disturbance and ongoing evolution and change. Building resilience of a smallholder agricultural community by focusing on the long-term provision of ecosystem services is a means to sustain livelihoods and the human well-being of its inhabitants – a task critical in South Africa, and Africa as a whole. Novel ways of assessing different kinds of ecosystem services (e.g. provisional, regulating and cultural), as well as linking them to livelihood strategies, makes the ecosystem service concept particularly useful for exploring human-nature benefits and values associated with different kinds of land uses, property regimes and social-cultural contexts (Henriksson Malinga et al., 2018).

Ecosystem service assessments often originate from land use proxies, which involve assumptions of what ecosystem services are associated with various kinds of land uses. Available land use/land cover maps are typically produced at course resolutions, based on satellite imagery. These maps are useful for large-scale landscape and development planning and regional land management. However, in order to create more locally relevant land use maps for local decision-making, verification, ground-truthing and re-classification of land uses are needed. The expert based mapping of resources and land uses presented in Chapter 3 forms a valuable basis for community co-learning of the natural resource base and its current state and condition. However, without understanding of what the landscape is utilized, valued, and appreciated for – from the perspective of those who live there and depend on the resources for their livelihoods – identifying solutions for sustainable management of community resources are likely to be unsustainable and unsuccessful.

This chapter describes how community members formed part of mapping their landscapes in terms of land uses, features of the landscape of importance to the community, as well as a wide range of ecosystem services and livelihoods benefits associated with land uses and specific places. More detailed analysis of the rich set of spatial and qualitative information collected for this chapter will be found in the MSc thesis of Mdoda Ngwenya, currently registered for a Master of Science degree in Environmental Hydrology at UKZN.

4.2 METHODS

The participatory mapping of land use and ecosystem services was conducted through a series of iterative participatory methods; participatory mapping workshops, village walks and co-learning workshops.

4.2.1 Participatory mapping workshops

Three one-day participatory mapping workshops took place in each of the communities; one group with women, one with men and one with decision makers (i.e. people in the communities involved in decision-making processes such as grazing or water committees). Motives for having separate groups with men and women are two-fold; firstly, the differential use and dependencies of resources and parts of the landscapes between men and women are important to understand and capture. Gendered activities such as livestock herding carried out by men, and fetching water that is usually women's responsibilities, are enabled to be discussed at more depth if the groups are separated. Secondly, persistent power dynamics between men and women can affect the confidence and freedom to express ones views and perceptions by women in the presence of men.

High-resolution satellite images sourced from Google Earth were used in order for the workshop participants to mark and identify relevant places, land uses, ecosystem services and features in their community landscapes (Figure 4-1). The boundaries that were

marked out by the community leaders and members during the inception field visit to the communities were confirmed or revised as a start. The information gathered through the mapping activities was digitized using Google Earth, combining information from each of the three workshops in the respective communities.

4.2.2 Village walks

To build on the participatory mapping workshops, three-day village walks were conducted with a group of key informants in each community, consisting of women, men and youth (Figure 4-2). The walk in Costone had five participants who visited nine places, and Ezibomvini saw twelve participants visiting 18 places. On the first day, the participants revisited the maps from the participatory mapping workshops, to identify key areas of significance for the communities to visit. The places to visit and routes for the walks were planned and marked by the group. Some parts of the routes were covered by car due to long distances. At the various stops, participants were engaged in conversations guided by questions including: (i) What is the local name of the place, (ii) why is it important or how is it used; (iii) what has changed and why; (iv) if everyone has access to these places or benefits, and (v) is there any management in place and what the participants think could be done. Location coordinates, notes, recordings and photos of visited places were captured and digitized using Excel spreadsheets and Google Earth.

Figure 4-1 Participants of participatory mapping workshops in Costone (left) and Ezibomvini (right)

Figure 4-2 Participants describing significant places and ecosystem services during village walks in Costone and Ezibomvini

4.2.3 Co-learning workshops

The expert based maps of land uses and ecosystem conditions including water sources (i.e. rivers, springs and wetlands), erosion, invasive alien species, woody encroachment and veld conditions presented in Chapter 3 were shared and discussed with community members in a series of two co-learning workshops per community. Participants marked out additional places of importance, including land uses and ecosystem services that were added to the maps developed during the participatory mapping workshops and village walks.

4.3 LOCALLY DEFINED LAND USES AND ECOSYSTEM SERVICES

The community participants have a rich and detailed understanding of their landscapes and describe a diverse utilization of, and appreciation for, locally defined land uses and their benefits. A wide variety of ecosystem services are associated with specific land uses and places in the landscape. These include crop and livestock production, hunting and wild plants for food; cattle manure for fertilization; fire wood for household fuel; poles, soil and plaster sand for building material; a variety of species for traditional medicines and spiritual uses; places for social relations, cultural heritage and spiritual ceremonies. Apparent in the landscape, and expressed by most of the participants, many of the ecosystem services are declining due to overuse, land degradation, erosion and reduced water availability.

The mountainous grasslands provide important land uses and ecosystem services in both communities such as grazing land, hunting, medicinal plants, wild food, firewood and water sources. Wetlands play a crucial role in providing clean water, foods and flood control. As explained by a participant from Costone during a village walk, there was a previous lack of awareness of the multiple benefits of wetlands: "*Nami bengingakwazi ukubaluleka kwexhaphozi ngiqale ukwazi nje kuleminyakana ukuthi ixhaphosi libalulekile, Mina bengazi ukuthi ixhaphozi yinto nje encolisayo, uthi uyafika ufice nje namanzi ebomvu, ubone ukuthi hhayi! Kusho ukuthi lento into engasebenzi, kwahamba Kabamba nami ngezwa sesikhona la kwaMahlathini ukuthi ixhaphozi liyawacleaner amanzi*", which translates to "*I also didn't know the importance of the wetlands, I have just started to know in past few years that the wetland is important, what I knew is that wetland is just a dirty thing in that when you come here, you find red water, something that is not normal! You will think this is something that does not work. As time goes by, I heard it from Mahlathini that the wetland cleans the water*".

Participants of the Ezibomvini village walk identified a variety of wetlands species used as traditional medicine and food. These species include Ugobho (River Pumpkin – *Gunnera perpensa*) which is described to be commonly utilised to treat menstruation pains and to clean the wombs of livestock (cattle and goat) after they have given birth. "*Imbuzi iyazala kubekhona udoti osalayo ongaphumi kahle bathi isikhundla somntwana lapho kuhlala khona umntwana, mese uyayiphuzisa iwukhiphe wonke loyo doti ukuze izokwazi ukuthi mesilandelwa futhi imuthole kanhle umntwana*", explained one participant, which translates to "*A goat gives birth and there is some waste left that does not come out properly from the womb. The goat is given the medicine to drink for it to take out all the waste so that it gives birth to a healthy baby that would follow*". They reported the species to be scarce in the area even though they continue to utilise it by buying it from pharmacies. The species is perceived to be over utilized due to its demand among women and due to trade to local people and herbalists. Participants explained they used to have their own traditional way of preserving the species by taking off a seedling and leaving other parts to grow, which is a practice no longer followed. The reasoning is said to be that if someone finds the species and does not collect it, someone else will take it. Participants report that some people have started to plant the species at home where it is more secured and can provide a source of income for the women, as explained with excitement by one participant: "*Uma kuqhamuka okuyintombazanyana kuthi ngafa isilumo, ngithi uthenilandi! Ugobha thenilandi!*" This translates to "*If a girl comes up and says I'm dying of period pains, I just tell her R10! Ugobho R10!*" Another species that is reported to be depleted from the wetlands is Isihlambezo, a herbal medicine commonly used by Zulu women to prevent ill-health during pregnancy (Varga and Veale, 1997).

Participants also use wetlands to collect different species of grass, including Istihala and other species used for weaving handcrafts such as mats, baskets and ukhamba (beer vessels), as well as uxhaphozi which is a wild food with similar uses as spinach.

Participants acknowledged that springs are found within wetland areas, but some expressed that they were unaware of the adverse effects of cattle grazing on wetlands. Springs are recognized as a crucial source of water for the community members. In Costone, the participants identified 16 springs across the community landscape during the village walks, while Ezibomvini recorded ten. Several

more springs were later mapped out in subsequent co-learning workshops. Water from springs are used for all household duties, including drinking, cooking, washing clothes and cleaning. Water from springs is also used to make mudbricks, especially in cases where the river is far from households. Most of the springs are reported to be no longer functioning, some dry up in winter, while only a few provide water throughout the year. Water availability in the springs is also perceived to be decreased compared to previously, as expressed by an Ezibomvini participants during the village walk: "*Mina nje mengikhumbula kulomthombo, mekuthiwa kunebhizi nje benikha nize nidele engapheli amanzi, manje nje mengiwabheka ngathi singakha nje isiqomu esisodwa, awasafani nakudala*", which translates to "*If I just remember this well, when there is something busy happening in the village, we would collect enough water, if I am looking at it now, it seems as we could only collect a few water cans, it is not the same as it used to be*".

The participants acknowledge that all their springs are in a poor condition and not protected. One participant in Costone states "*Njengoba ubona nje nawe, imfuyo iyafika ngezinye inkathi iphuze lamanzi iwangcolise futhi, kuthathe isikhathi eside ukuthi aphinde acwengeke. Abanye bawakha enjalo emanzi bazame icebo likuwaclean ekhaya*", which translates to "*As you can see by yourself, livestock sometimes come and drink this water and pollute it too, it takes a long time for it to be purified again. Others collect it as it is and make a plan to clean it at home*". It was described by the participants that the place to draw water from the spring is usually found lower in the ground, and heavy rains wash all the surface debris including soil and dry cow dung into the spring and pollute it. Heavy rains not only pollute the spring, but makes it overflow and difficult to see where to draw water from.

Livestock production is one of the most important ecosystem services for the communities. Livestock graze across the mountain areas in summer and within the homestead/crop area in winter. The communities hold mainly cattle and goats with few households that farm sheep and pigs. Participants explain that some families leave their cattle in the mountains the entire cropping season with herders, while others fetch their cattle daily, especially those households living near the mountain. Due to the risk of livestock theft, some community members prefer to have their livestock sleep at home every night.

During the village walks, participants discussed that the grazing areas are not well managed in the communities and expressed the desire to control the grazing and manage the grasslands. In relation to fire, participants explained that the veld is sometimes burned by people without waiting for the proper time, and this has caused the grass quality to decrease and soil erosion to take place, especially where cattle walk to get to the grazing land. A participant from Costone elaborated: "*Into esingayifuni ukuthi kushiswe umlilo noma ikanjani, nokuthi inkomo zidle noma ikanjani, nokungabibikho ngomthetho ngoba into edala nokuthi kuguguleke njengoba kuguguleke kangaka ukuthi izinkomo ziyahamba zihambe noma ikanjani, lifike izulu line ifike inkomo inyathele kuqhuphuke lakuqhephukeka khona, lifike izulu lithathe lakuqhephukele khona, kathi mekuthiwa ziyalawulwa ukuthi indlela yezinkomo ila, zingahambi layithanda khona*". This can be translated to: "*What we don't want is for the fire to be burned no matter how, and for the cattle to graze no matter how, and for there to be no law, because the thing that causes soil erosion is that the cattle are walking anyhow, when the rain comes and the cow steps on same path it gets broken, and when it rain comes again, all the soil from the broken path is taken away. So it would be better if the walking paths could be controlled*".

Soil erosion in these communities is perceived by the participants to be caused by overgrazing, frequent movement of cattle walking the same path and reduction of soil cover during dry periods. Large gullies have formed in places associated with livestock pathways with subsequent water flow in these paths. Participants have developed an awareness from this project, that there is an urgent need to prevent further soil erosion by implementing restoration activities with the intention to restore the landscape.

The participatory mapping exercises identified mainly four alien invasive species, located in patches across the landscape of both communities. The Costone community has wattle, poplar, lantana and gum plant species, while Ezibomvini has wattle, poplar and Lantana. Costone has many patches of wattle species found along the mountain slopes, river channels and flat landscape, as compared to Ezibomvini which is dominated by lantana along the Nyunyana hill. The nature of the wattle and gum patches found in the Costone community, suggest that they were introduced in the area for specific purposes. Each species provides multiple ecosystem services to the communities such as materials for fencing yards and gardens, building houses and firewood for heating and cooking. Similar results were found by Ngorima and Shackleton (2017), where *Acacia dealbata* (Silver Wattle) in the Eastern Cape province is used for firewood, fencing, and livestock fodder. The Ezibomvini community has two wattle patches that are strictly used for collecting poles for funerals only. Participants explained that the community took a decision to restrict any harvesting after seeing patches deteriorating because of overharvesting. Every bereaved family in the community thus has the right to cut down the poles that will be used when the grave is dug. According to the community, a house is built inside the grave, and poles cut to about a meter are placed horizontally to cover the coffin. Wattle poles are also used to make coffins as explained by a Costone participant: *"Eminye imindeni*

ayilisebenzisi ibhokisi lomngwcabo uma ingcwaba amalungu omndeni yabo ngokwesiko lwabo, ithatha wona uwatela ukwenza ibhokisi elibizwa ngokuthi Uhlaka lokungcwaba umuntu." This translates to "*Some of the families do not use a coffin when they bury their family members as part of their ritual and would use poles from this wattle to make their own coffin called Uhlaka to bury a person".*

Poplar is described as being used to build the roof of traditional houses such as rondavels and Uguqa sithandaze (literally means kneel and pray). These poles are harvested while they are young and able to bend. Some participants explained that they also use the poplar poles to fence their home gardens.

The high use and associated benefits of these alien invasive species plays an apparent role in the communities' management strategies around these patches. This project has contributed to an increased awareness of the species negative impact, particularly on the water supply and its competition with the indigenous vegetation. Lantana, however, is not appreciated by the communities as they have thorny stems that makes it difficult for people to access the grasslands and forest patches. They also prevent livestock from accessing the forage through hurting the animal physically.

The extensive mapping of land uses and ecosystem services from the various expert based and participatory mapping activities have been combined and provided to the community (see Chapter 6 for the various layers). Figure 4-3 shows the overview of Costone and Figure 4-4 of Ezibomvini.

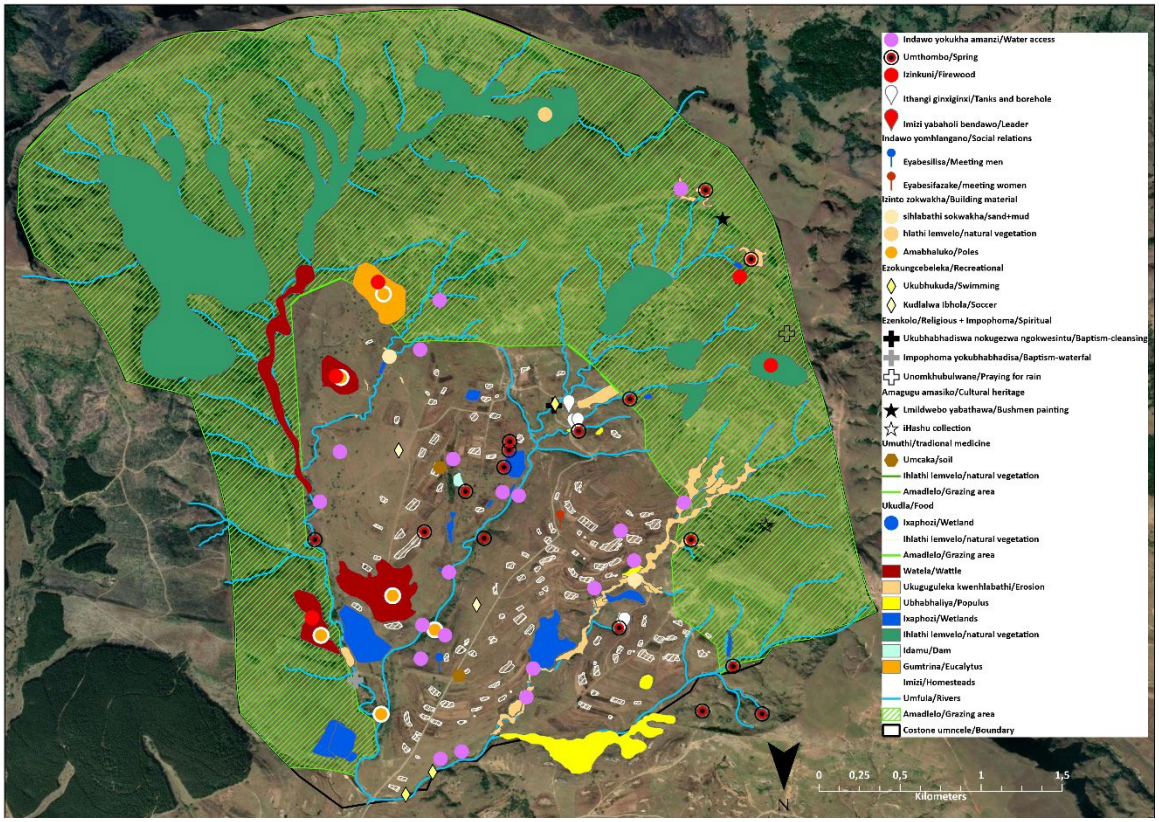


Figure 4-3 Map of important land uses, landscape features and ecosystem services identified by community members through a series of participatory GIS exercises in Costone

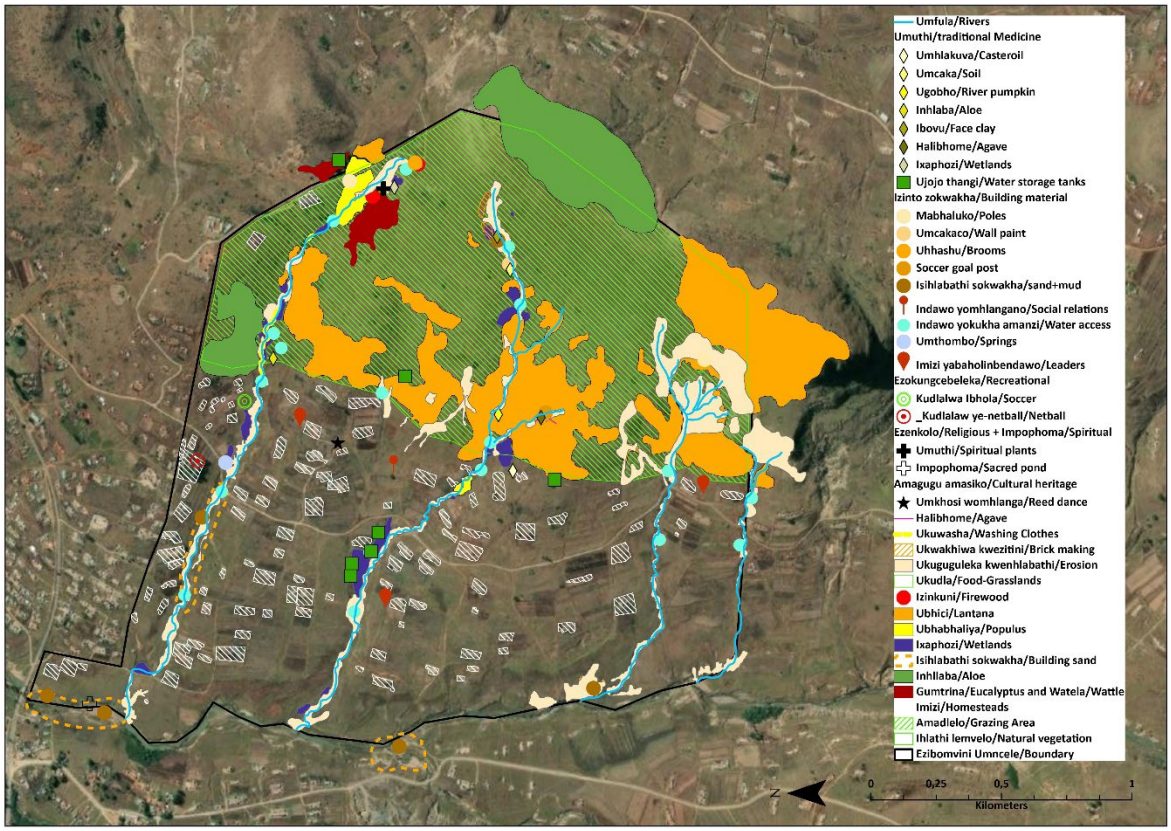


Figure 4-4 Map of important land uses, landscape features and ecosystem services identified by community members through a series of participatory GIS exercises in Ezibomvini

CHAPTER 5: GOVERNANCE, DECISION-MAKING, POWER AND ACCESS

5.1 INTRODUCTION

In theory, natural resources available within common-property regimes are managed by, and accessible to, a given community, where rights of equal access and use are shared by the community members. However, in practice, access to resources is often not equal. In the South African context, post-apartheid land tenure reforms ensured the retention of indigenous or customary authority over communal land by establishing traditional authorities to govern the communities' land and natural resources. Formal and informal agreements and kinship networks that influence community members' access to land and natural resources. Rapid socio-economic and political change since the colonial era, which is when the policy of traditional land tenure was established, has led to inequitable power structures in communities (Benjaminsen et al., 2006). This is manifested through both formal and informal agreements and kinship networks that influence community members' access to land and natural resources. Powerful actors have an advantage over the impoverished, and women often lack opportunities to control and manage land (Cousins, 2009). The combination of traditional authority over communal land, and national legislation and policy adds further complexity to the issues of decision-making towards long-term sustainability and resilience in land use management. Having an understanding of what land uses are present and what management strategies are in place, is not sufficient for developing resilient and sustainable management of the resources in smallholder agricultural communities. The community resource governance structures as well as the multifaceted dynamics between individual and collective decisions around the use and management of land, water and natural resources determine the success of the same (Kenter et al., 2016). Developing a shared understanding of decision-making structures and processes of decision-making, as well as recognizing power imbalances and unequal access to resources, is crucial for the co-development of sustainable and equitable management strategies. This chapter first provides an overview of the background to, and roles, responsibilities and legislation of Traditional Authorities (TA) in South Africa. It then moves to discuss governance structures in Ezibomvini and Costone, as well as insights into decision-making, power and access that has emerged through a variety of engagements with community members including meetings, workshops, focus group discussions, interviews and participation by the project team in the community activities related to the project. More detailed analysis of aspects related to participation, power and governance will be found in the Master thesis of Philisa Dunyana, currently registered for a Masters degree in Environmental Sciences at Rhodes University.

5.2 TRADITIONAL AUTHORITIES IN SOUTH AFRICA

Section 211(2) of the Constitution regards Traditional Authorities (TA) as primary agents of development (Republic of South Africa (RSA), 1996). They are seen as the representatives of the community and as such are entrusted with an important responsibility, namely that of harmonising community customs and traditions with the ethos of the Constitution (Albertyn and Goldblatt, 1998).
In terms of the legislation, the role of traditional leadership is to:

- Promote democratic governance and the values of an open and democratic society
- Progressively advance gender equality within the institutions of traditional leadership
- Promote freedom, human dignity and the achievement of equality and non-sexism
- Strive to enhance tradition and culture
- Promote nation building and harmony and peace amongst people
- Promote the principles of co-operative governance in their interaction with all spheres of government and organs of state
- Promote an efficient, effective and fair dispute-resolution system, and a fair system of administration of justice.

A whole suite of new roles has also been proposed in the White Paper on Traditional Leadership and Governance (Department of Provincial and Local Government, 2003). In essence, the white paper argues for traditional leadership to support local and regional municipal and government structures in development roles and that the governing structures should enable such participation and partnerships. Some of the new roles, which are extensive, include for example:

- Land and Agriculture:
    - Play a role in land administration
    - Advise government on agricultural development and improvement of farming methods
    - Promote sustainable use of land and

- Advise government and participate in programmes geared to prevent cruelty to animals
- Environment and Tourism:
  - Promote environmental management and
  - Promote sustainable use of cultural resources within communities
- Natural Resource Management:
  - Promote sustainable traditional approaches to water resource management

These new roles are based on the premise and assumptions that South African customary law existed long before the adoption of the Constitution and among other things, aims at harmonising the different cultural practices that exist in the country. It is apparent that some traditional cultural practices that still exist are in conflict with the Constitution but, until they are challenged before a court of law, they will remain enforceable in our communities (Bennet, 2004).

Issues related to resource use and management in particular are still not clear. The post-Apartheid approach to water resource management (WRM) has been guided by global trends that include a shift from supply to demand management, decentralisation of water management decisions and a more integrated and participatory approach to WRM. The active involvement of an informed public in the management and allocation of South Africa's scarce water resources is central to this approach. Both the Water Services Act (WSA), No. 108 of 1997 (RSA, 1997), and the National Water Act (NWA), No. 36 of 1998, (RSA, 1998) are based on principles of participation and social justice and contain provisions that require the involvement of citizens in the management of water resources, mainly through the establishment of catchment management agencies (CMAs) and water user associations (WUAs). Incorporation of traditional systems of governance including the customary practices and laws relevant to WRM, have been largely overlooked (Kapfudzaruwa and Sowman, 2009). Water service authorities (WSAs), water service providers (WSPs) and other state agencies such as Department of Water and Sanitation (DWS) and DALRRD, have now assumed authority in terms of water provision and management. As an example, each traditional authority has a ward councillor representative in the WSA, as well as the 'politically' elected ward councillor for the area. The politically elected councillors are considered the mandated representatives regarding water issues for their wards. How or whether these councillors interact with the traditional governance system is not considered.

At present, traditional leaders are still responsible for land allocation in communal tenure areas and take an active role in conflict management and resolution between community members. Although the land allocation system of the traditional leadership has servicing and financial implications for the municipality, there is little or no communication between the institutions. Legislation demands inclusive spatial planning and land use management system as well as municipal control and as such municipal planning has no influence on traditional council decisions or vice versa, leading to fragmented development and conflict (Dubazana and Nel, 2016).

Traditional Authorities also nominally manage grazing in their communities and generally provide strict dates for harvesting of field crops and allowing of livestock back into the village areas, from grazing areas, during the winter season. They are represented in the livestock associations and dip tank committees for most villages. Again, there is a mismatch between their governance roles and those assigned to local government and the DALRRD.

The issue of the role of traditional leadership in natural resources management has only very recently been given some attention and includes suggestions for governance related to land use management, livestock grazing and environmental law enforcement.

5.2.1 Traditional leadership, in summary

Traditional leadership is expected to provide democratic governance directly or through supporting the government institutions across all spheres within their communities, without clear avenues, processes, structures or finance provided to do so. The local government processes have however failed in most respects to provide the leadership, support and funding required for coherent land use, water and natural resources management, leading to largely unregulated overuse and mismanagement of resources in communal tenure areas. Local inhabitants have to some extent stepped into this void and made their own arrangements, generally clearly designed to provide personal benefit to some individuals, and none of which are necessarily supported legally. This situation has further weakened the position of women and the poor in these communities.

5.3 METHODS TO EXPLORE GOVERNANCE, DECISION-MAKING, POWER AND ACCESS

MDF has through decades of engagement with groups and individuals of Ezibomvini and Costone, gained an in-depth understanding of the governance structures in the two communities, as well as navigated decision-making structures influenced by power imbalances and unequal access to natural resources and decision-making processes. Further data to gain understanding into the community members' perceptions of the complexities of decision-making, power and access in the Costone and Ezibomvini communities has been collected throughout the project. This has taken place when the project team has engaged with communities through meetings, co-learning workshops and community activities using participant observations, taking note of conversations that relate to decision-making processes, power imbalances and unequal access. Direct questions relating to power and access were further asked to participants during the village walks and participatory mapping workshops described in Chapter 4.2. Focus groups discussions have taken place, namely one group of 20 participants in Ezibombini, and two groups of five and 22 participants respectively, in Costone. The discussions covered topics such as natural resource management and land use, land use practices in past, present and future, who makes decisions, and for whom, who have access to resources, communities' relationships to traditional authorities and ward councillors, roles of ward councillors, changes in access to resources over the past decade; and the impact of climate change on natural resources and community members' access thereto. Furthermore, in-depth semi-structured interviews were held with multiple stakeholders including local authorities, NGOs, water committee members in Costone and Ezibomvini as well as with EcoChamps to address questions related to power dynamics within water governance, management, access and collaboration.

5.4 GOVERNANCE STRUCTURES AND DECISION-MAKING IN COSTONE AND EZIBOMVINI

These villages, in the Emmaus region of rural Bergville fall under the Amangwane Traditional Authority. The Nkosi for the area, Mr N Dladla resides in Eqeleni, a village nearby and each village also has a TA ward councillor, Mrs Hlongwane for Costone and Mr Faqa Dubazane for Ezibomvini. The villages are represented in the OLM by ward councillors elected according to political party affiliations, in this case Mr Cyprian Dladla, an Inkatha freedom Party councillor, who resides in Costone. In each of the two villages there are a few further committees or organisational structures. Prominent among these are the Dip tank committees, which also serve as the Livestock Associations for these villages, overseen by the KZNDARD. Water committees consisting of community members and TA councillors are also present in adjacent villages but were not present in either Costone or Ezibomvini prior to their more recent processes involving NGOs. Specific interest groups also exist among which different church groups are the most common. It is notable that community organisation in both Costone and Ezibomvini were very weak upon entry by MDF, who started working in these villages around 2013-2014. Relationships with both the TA and the OLM have also been strained, conflictual and minimal.

In both communities, decision-making processes appear to be primarily driven by the community members, particularly men, with an emphasis on maintaining peace and preserving natural resources. Different aspects of community land use and livelihoods activities, such as protection of forests, plantations, grazing rangelands, cropping, and harvesting, involve decisions made collectively by specific groups, or by individual members.

When it comes to protecting the forests and plantations used for collecting wood for burials, the community men discuss and share their ideas among themselves, subsequently informing other community members about the agreed-upon approach. This demonstrates a partial participatory decision-making process within the community, where ideas are shared and consensus is reached (women excluded from some areas of decision-making, including livestock management). Regarding grazing rangelands, livestock farmers take charge of protecting these areas and prevent others from settling or farming there. In case of disputes arising from new occupants, the local chief assists in resolving the conflicts. This implies a shared responsibility between the livestock farmers and the chief in managing the grazing lands and addressing any conflicts that may arise. For cropping decisions, each individual has the autonomy to decide what they will farm in a given season. According to dates given by the local chief, livestock farmers take their livestock to grazing areas away from the crop fields to avoid any disputes arising from livestock damaging growing crops as many crop producers lack proper fencing. At harvesting season, the chief gives precise harvesting dates to community members and failure to complete the harvest within the given time frame is considered the farmer's fault as the livestock owners are allowed to bring the livestock back from the mountains to forage in the crop fields and common areas around homesteads. Any dispute arising from this matter is solved at the discretion of the field and livestock owners.

The common view is that water resources are generally freely accessed by the community members without restrictions or regulations. It is mentioned that the Costone community has faced issues with the ward committee regarding access to water sources provided by the municipality (occasional boreholes or tanks with a tap), but they have found ways to overcome these challenges and use the water freely. The soil does not seem to be regulated, except from individual homesteads including crop fields. Boundaries, on the other hand, are controlled by the local chiefs, suggesting their involvement in defining and managing the land boundaries within the community.

Overall, decision-making processes in these communities involve a combination of collective discussions among some selected groups of community members, individual autonomy in certain areas, and the involvement of the local chief and councillor in resolving disputes and managing resources. While there is a focus on community participation and preserving natural resources, there are also challenges and tensions in the relationship between the community and certain governance structures, as highlighted in the case of municipal water access and the perceived lack of effective leadership.

The conversations with community members and observations during community engagement portray a sense of frustration and discouragement within the community regarding the Induna, the TA, the councillors, and the local chief. The community members feel let down by their leaders who are not effectively addressing their needs and concerns, and instead, seem to prioritize their own interests. The community's relationship with both the local chief and the councillors is strained, and their roles lack clarity and effectiveness. These challenges within the governance structure contribute to a growing sense of frustration, highlighting the need for improved leadership and communication to address the community's needs and build trust.

5.4.1 Contested perceptions of resource access

In Costone and Ezibomvini, designated grazing areas and forest/plantation patches are for communal use and are regulated by the TA to a certain extent. Similarly, water sources are considered open access to all. Mostly, the relation is done through the resolution of individual conflicts that arise, rather than active engagement of the community as a whole. It was commonly expressed during workshops, focus group discussions and village walks that community members typically have free and equal access to natural resources. When exploring the matter of management solutions and interventions in-depth, however, contradictions to the notion of free and equal access surfaced. Discussion during the co-learning workshops brought some more insight into the matter. There are a number of issues related to land use, water and natural resource management that are both partisan and unregulated – either through local norms existing governance structures or legal frameworks. The community organisation is coloured by the prevalent thinking of community members and highly influenced by the more prominent members of the community. This is an inevitable and somewhat unfortunate outcome of the need to develop communal practice without the benefit of guiding governance and legal frameworks and principles. Another inherent difficulty with these processes is that if individuals are unwilling or even obstructive related to agreements made, there is very little recourse for the community groups to ‘force’ compliance. In both communities, there is a lack of effective management by the local authorities, resulting in people taking matters into their own hands and making their own rules regarding resource use and management. The concept of ownership has emerged, where individuals claim resources such as land, water sources, and trees as their own. Thus, public access to resources has diminished, not only because of factors such as a drier weather and land degradation, but also as individuals increasingly claim and manage their own land, including water sources, wattle, and poplar stands. Some provide free access to community members but deny access to those from further away. Others consider the resources as their own and are unwilling to share. Concerning land allocation, the demand for land for settlement is much higher than available land. This has meant encroachment into farming and grazing land and also allocations that include both very eroded land and wetlands. It has also led to an informal ‘land market’ where land is ’sold’ to newcomers by ‘existing’ owners and a pattern of claiming of resources by individuals. There is little recognition in the claimed ownership of also having a responsibility to manage the resource.

In some instances, infrastructure for water access has been vandalized as a response to perceived unequal access. With the newer group based local water access schemes, individuals from outside the community or with authority in the TA have come into the village with vehicles and filled up large drums of water, refusing entreaties to be part of the groups in terms of payments and effort provided. The absence of external authority has contributed to the current situation and participants recognize the need for some form of management in such circumstances to prevent the destruction of infrastructure and ensure access to resources. There is no external authority currently intervening in these disputes.

5.4.2 Power dynamics within water governance, management, access and collaboration

The power dynamics within water governance in the upper uThukela Catchment as a whole have an effect on power dynamics within water management, access and collaboration in and between individual communities. The analysis of power dynamics in collaborative water governance processes in the catchment revealed various aspects that influence the effectiveness of collaboration. One aspect is political party contestation, which involves competition between different political parties in power, leading to negative competition, duplication of services, poor operational flow, and a lack of urgency in addressing water challenges, such as those in the communities. Furthermore, negligence has been observed since the amendment of water acts in 1994, leading to a lack of trust, conflicts, and poor service delivery. The lack of willingness to participate in community and multi-stakeholder engagements focusing on topics such as water availability and access, by the water service authority, is a significant barrier. Their absence hinders sound decision-making and necessary support and alignment between parties of different levels in the governance structures. Additionally, undisclosed plans and agendas by ward councillors to gain or maintain power, resulting in inconsistency in decision-making and low or non-existing priorities regarding water supply for communities.

The mechanisms of access to water resources in the Upper Thukela catchment include institutional arrangements, rights, and entitlements. Formal and socially embedded institutions shape access, while rights and entitlements regulate access. These mechanisms involve various stakeholders such as local government structures, traditional councils, water committees, and traditional courts. Marginalized communities face discrimination based on socio-economic status, lack of agency and political affiliations, leading to violations of human rights and undermining dignity.

Access to water affects social association at a local level, particularly women and children, who primarily collect water for domestic use. Understanding the consequences of power dynamics and implementing strategies to overcome barriers are crucial for effective collaboration. Institutional arrangements, rights, and entitlements shape access to water resources, while outcomes of collaborative governance systems impact political voice, social association, access to water, livelihoods, and catchment outcomes. Addressing power imbalances and promoting transparency, accountability, and meaningful participation are essential for equitable and sustainable management of water.

5.5 BUILDING TRUST, SOCIAL AGENCY AND LOCAL CAPACITY

Within this context of governance, decision-making, power and access outlined in this chapter, one of MDF's goals was to provide for a process of building social agency in these villages, facilitated by initially setting up voluntary learning groups in Climate Resilient Agriculture (CRA). The learnings groups were set up to facilitate exploration of adaptive strategies and improved agricultural practices, as this was a priority for community members. Over time, these CRA learning groups, being inclusive, open, participatory and developmental, have become the hubs from which further community organisation and relationships with external stakeholders have developed. They have provided community members with a process for engagement, for developing systems of representation and building motivation for involvement in the larger water and resource management issues, which have been mired in intractable conflict in the past.

Village savings and loan associations were set up, followed by water committees (inclusive of TA representation) and marketing committees. The CRA learning groups have hosted and built relationships with a range of external role players including research organisations and universities (such as the research team involved in this project) other NGOs, SAPPI, GrainSA the uThukela Economic Development Agency and the Department of Health, thus a wide range of institutions. The CRA learning groups have also been drawn into multi-stakeholder processes and platforms under the auspices of WWF-SA, the WRC and SANBI and now represent their communities in the recently constituted Northern Drakensberg Collaborative (formerly the Upper uThukela Catchment Partnership) – a multi-stakeholder platform focused on water and resource conservation issues in the region.

It is important to note that this gradual development of capacity and trust within these two villages have formed the backbone of greatly improved collaborative efforts in the community – between community members and also with local authority representatives, enabling them to develop systems and rules for water and resource management at community level, to which the Traditional Authorities have been party to.

The existing CRA learning groups, including the enhanced trust with, and facilitated by MDF, enabled a valuable entry point for the project team of this project. The ongoing activities in the communities were efficaciously and positively expanded, or built on, with the activities rolled out through this project.

This has enabled community members to engage in a number of different activities that have brought both social and environmental improvement in their communities. Members have engaged in:

- *Joint farming activities:* providing land preparation and planting support to each other, engaging in bulk buying of inputs together, learning and implementation for a range of CRA practices and integration of livestock through production of fodder and winter supplementation. Rules around livestock movement and management have been an emergent characteristic of this, as has increased involvement in farming by community members as well as intensification of agricultural activities for greater productivity. Other outcomes have been much reduced runoff and erosion in and around fields.
- *Joint water access activities:* Community members have formed localised water structures and have provided labour and financial support towards provision of small multipurpose use water schemes from protected spring and boreholes reticulated to either communal standpipes or household connections. Emergent characteristics of this participatory process of water access design have been increased awareness of water resources, how they are used and water quality issues. Community members have undertaken operational and maintenance control of their small schemes and have developed rules for daily management. They have become more aware of the importance of both wetlands and groundwater in their systems and the basic requirements for protection of these water sources.
- *Joint economic activities:* providing for better financial management and cash flows of individual members, increased access to village based and local markets in their marketing groups, increased ability to manage group funds for mutual benefit and increased ability to engage in productive activities rather than only consumptive ones.
- *Joint social activities:* through the learning group community members have become more aware of and willing to assist vulnerable individuals and groupings in their villages, including for example young single mothers and ailing pensioners. Emergent characteristics here have been the improved status of both women and youth in these villages, and has seen women both young and more mature take on prominent leadership positions in their community structures.
- *Joint resource conservation activities:* this is a more recent development, as a result of the intensive participatory mapping and planning processes undertaken in this project, linked to information provision regarding the state of their communal resource, such as veld assessments, climate information, and resource assessments. Now, more specifically in Costone, community members, through the CRA learning group and Dip tank committee have been engaged in regular environmental workdays, undertaking erosion control measures, grazing management, river clean ups, alien clearing and road maintenance. In Ezibomvini, which lacks the social coherence of Costone, due to the continual influx of new and unrelated people, the drive towards action has been a lot slower and requires a greater level of intervention by the facilitating organisations – It is not unwillingness as much as lack of relationships that have provided for a much slower process.

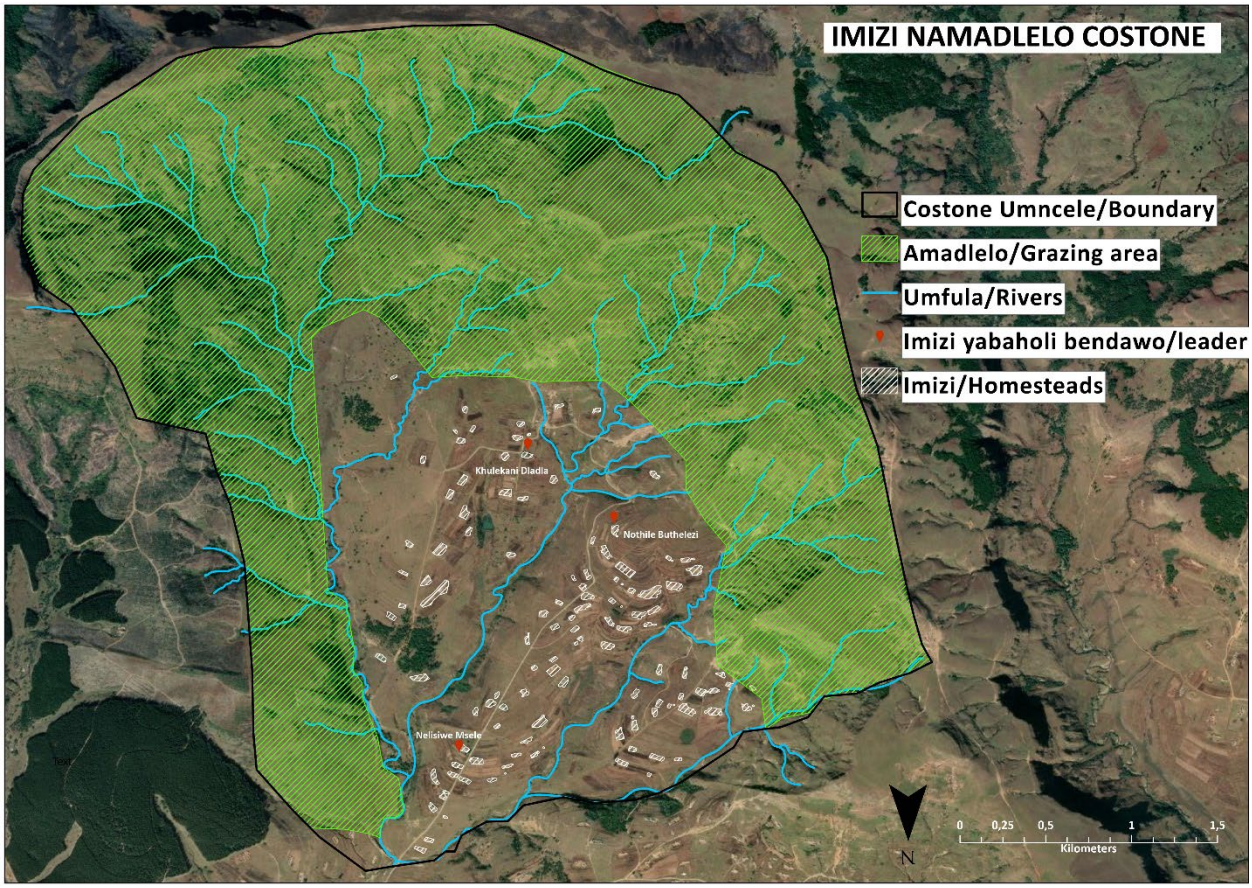
PART II: CO-LEARNING FOR SUSTAINABLE MANAGEMENT OF COMMUNITY RESOURCES

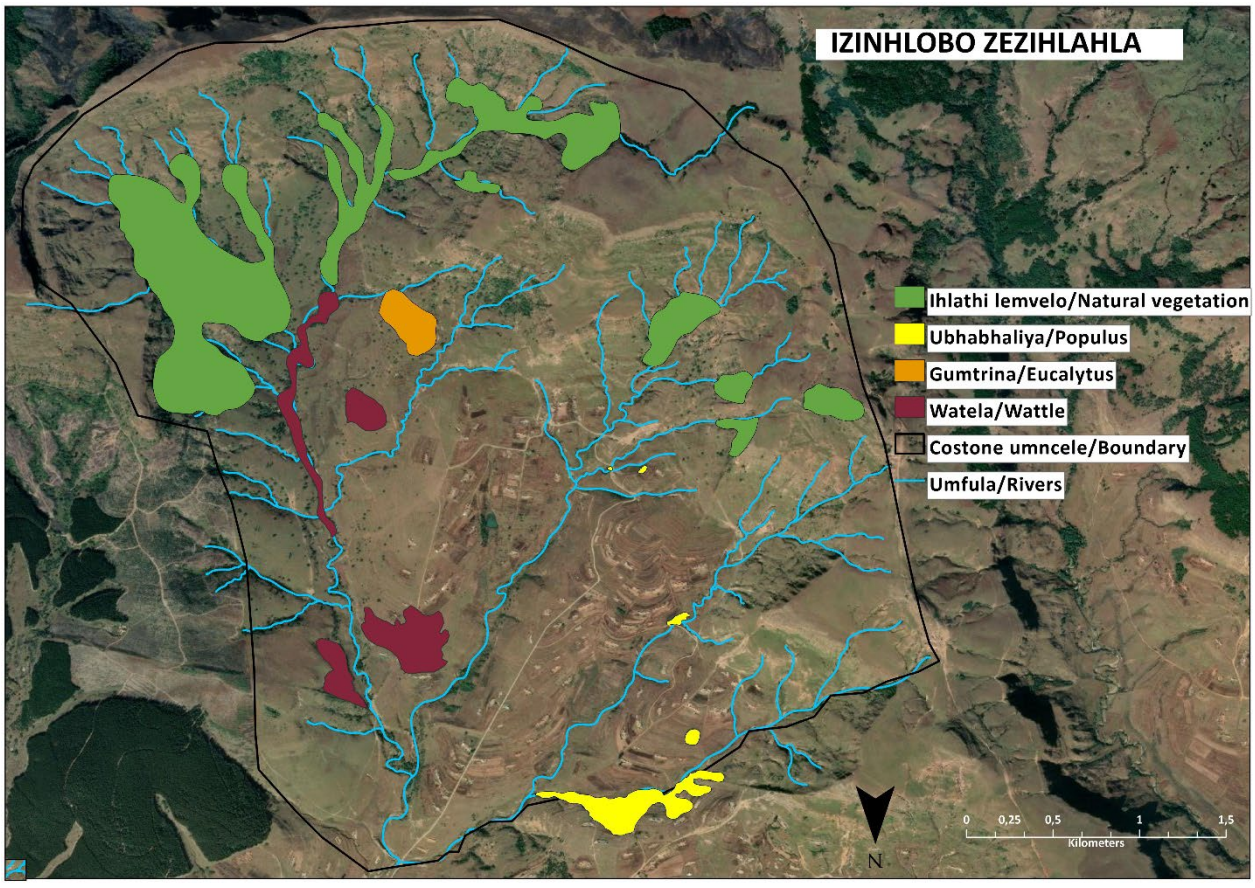
CHAPTER 6: A TRANSDISCIPLINARY SOCIAL-ECOLOGICAL GIS SUPPORT TOOL

6.1 COMMUNITY MAPS

A series of map layers were produced for each of the communities, with geographical information about the community landscapes generated through an iterative process involving expert based mapping of resources and land uses, participatory mapping, village walks and co-learning workshops. The maps include layers of land uses and landscape features such as grazing areas, homesteads, water points, springs, rivers, wetlands, alien invasives, indigenous and planted forests, erosion, ecosystem services and the communities' restoration priority areas. Preliminary maps were presented to the communities during the final co-learning workshop were participants provided feedback and suggested edits and additions (Figure 6-1). The maps (see Figure 6-2 and G) were then updated according to the feedback and prepared for printing to be handed out. The maps are available to the communities as printed and laminated A3 maps for continued decisions on community resources and management strategies. It was agreed to provide five and six sets of maps to Costone and Ezibomvini respectively, to be held in the different sub-sections of each village, to ensure easy access for both meetings and the resource management activities.

Figure 6-1 Team members outline the different maps for the community in Costone (left). In Ezibomvini community members looking through and discussing the various layers of the maps (right)


IMIZI NAMADLELO COSTONE
Costone Umncele/Boundary
Amadlelo/Grazing area
Umfula/Rivers
Imizi yabaholi bendawo/leader
Imizi/Homesteads
Khulekani Dladla
Nothile Buthelezi
Nelisiwe Msele
N
0 0,25 0,5 1 1,5
Kilometers


IZINHLOBO ZEZIHLAHLA
Ihlathi lemvelo/Natural vegetation
Ubhabhaliya/Populus
Gumtrina/Eucalytus
Watela/Wattle
Costone umncele/Boundary
Umfula/Rivers
N
0 0,25 0,5 1 1,5
Kilometers

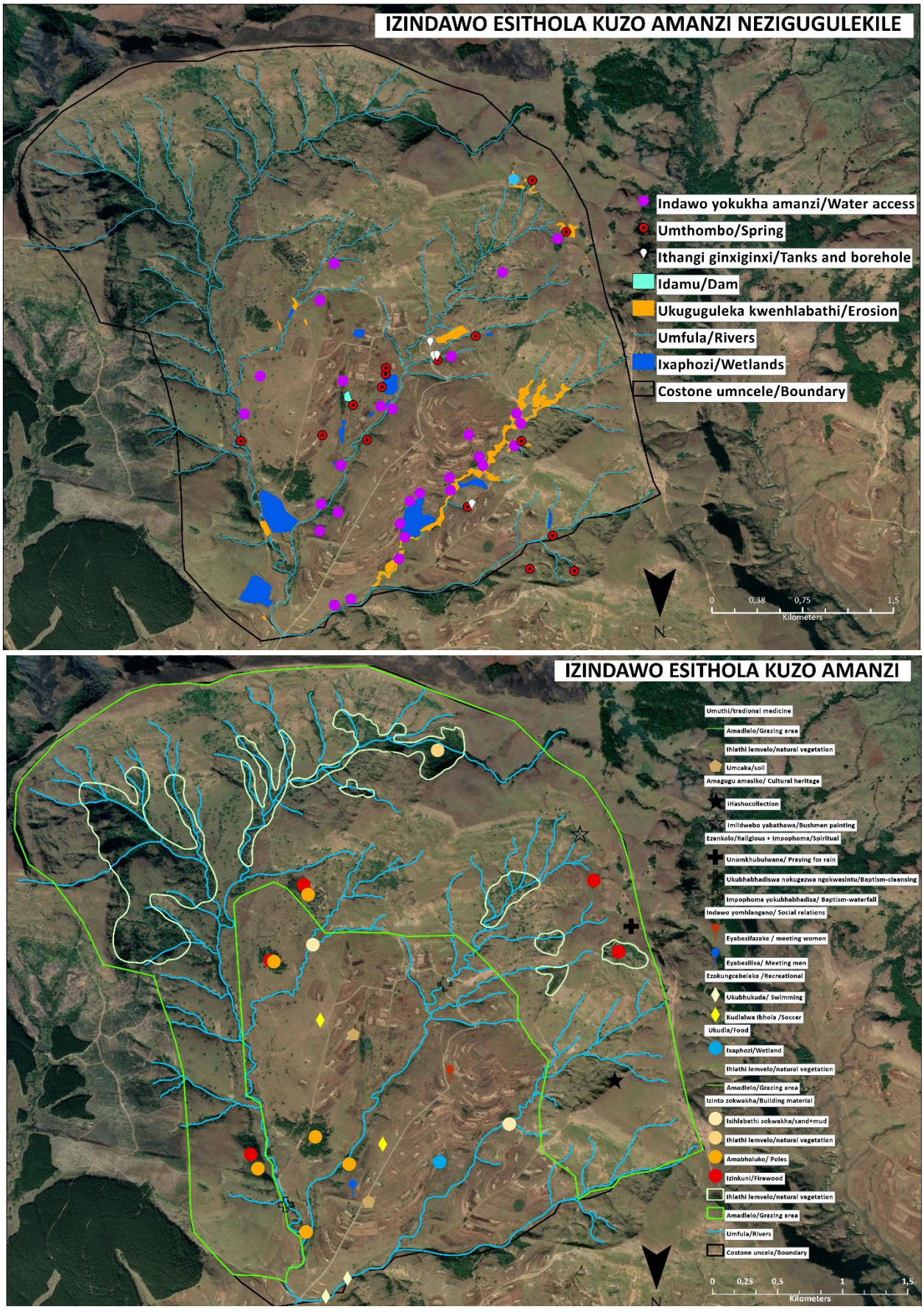
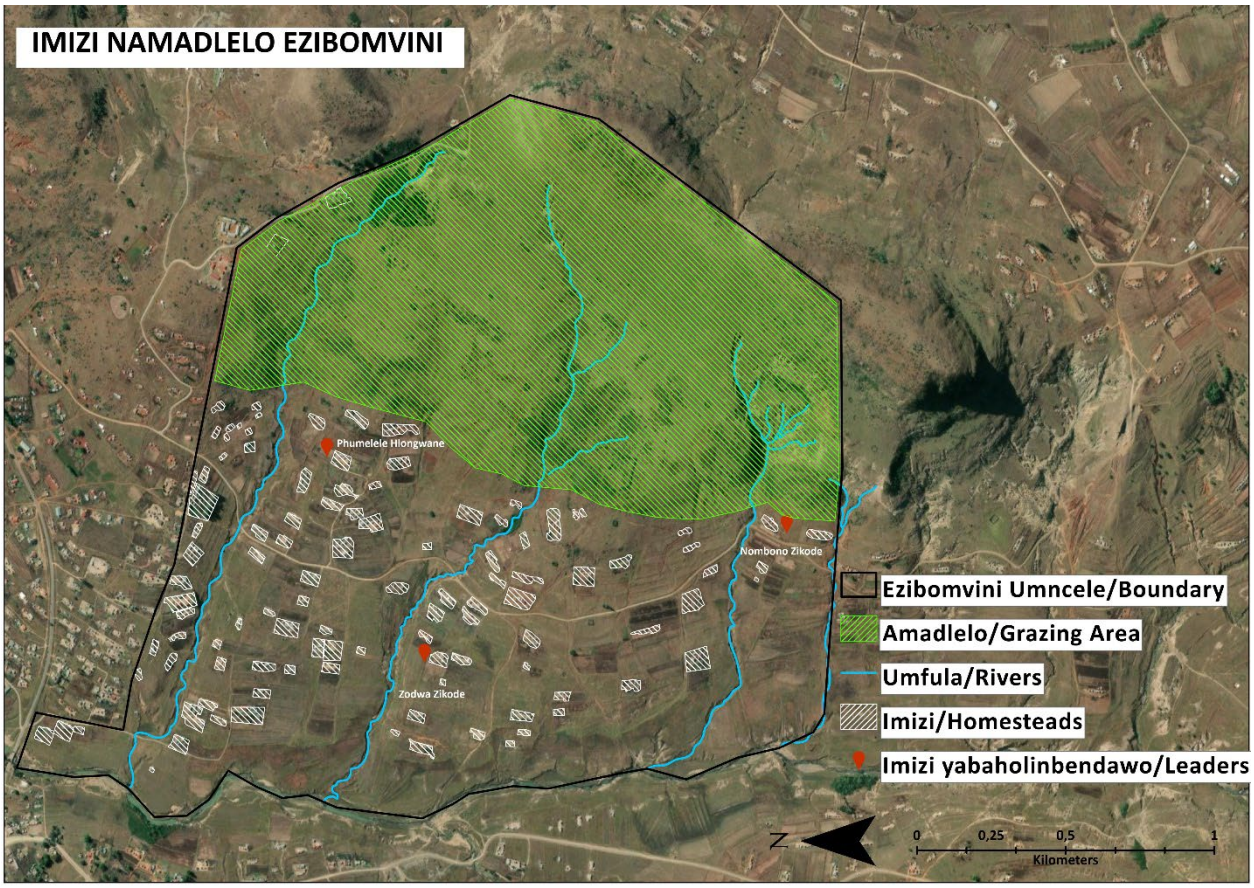


Figure 6-2 Four layers of maps over Costone to be printed, laminated and delivered to the community


IMIZI NAMADLELO EZIBOMVINI
Phumelele Hlongwane
Nombono Zikode
Zodwa Zikode
Ezibomvini Umncele/Boundary
Amadlelo/Grazing Area
Umfula/Rivers
Imizi/Homesteads
Imizi yabaholinbendawo/Leaders
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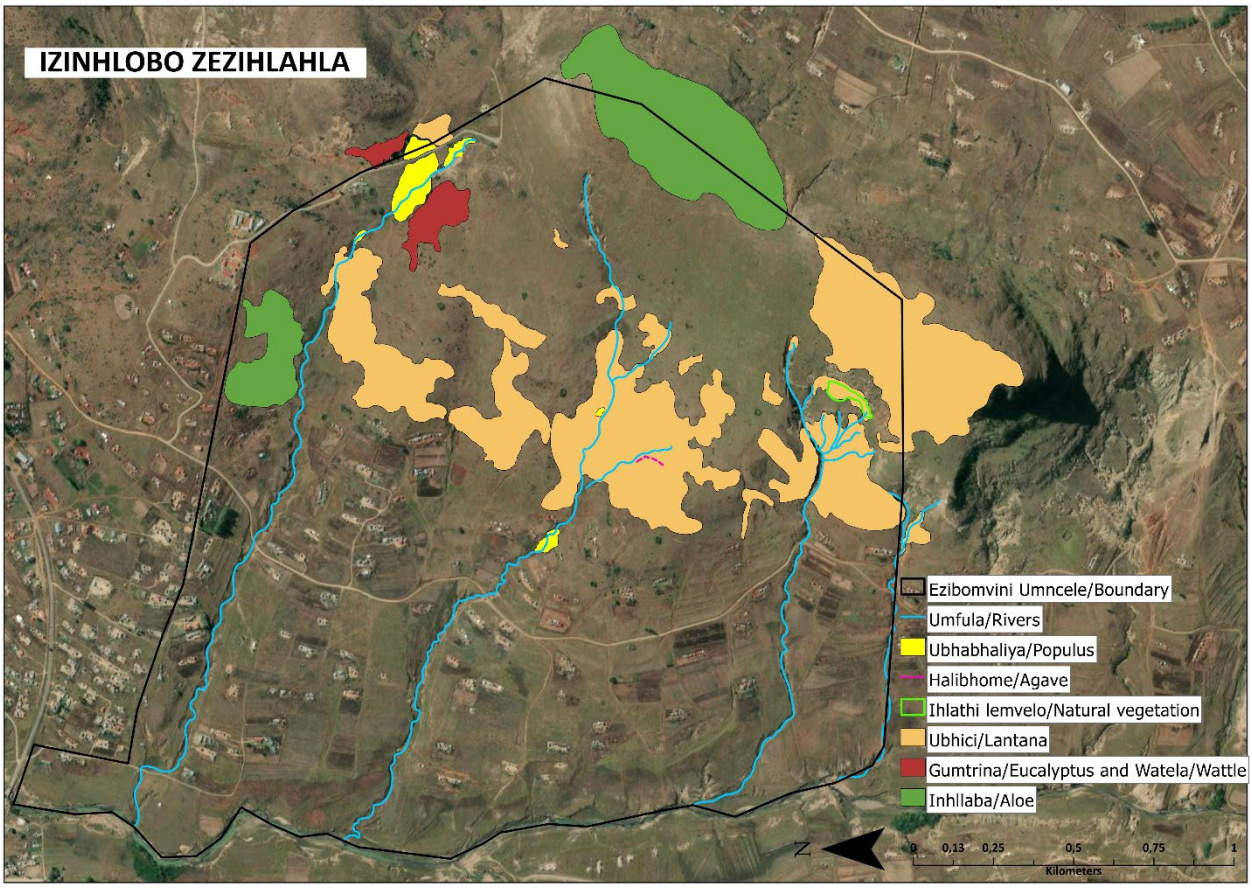
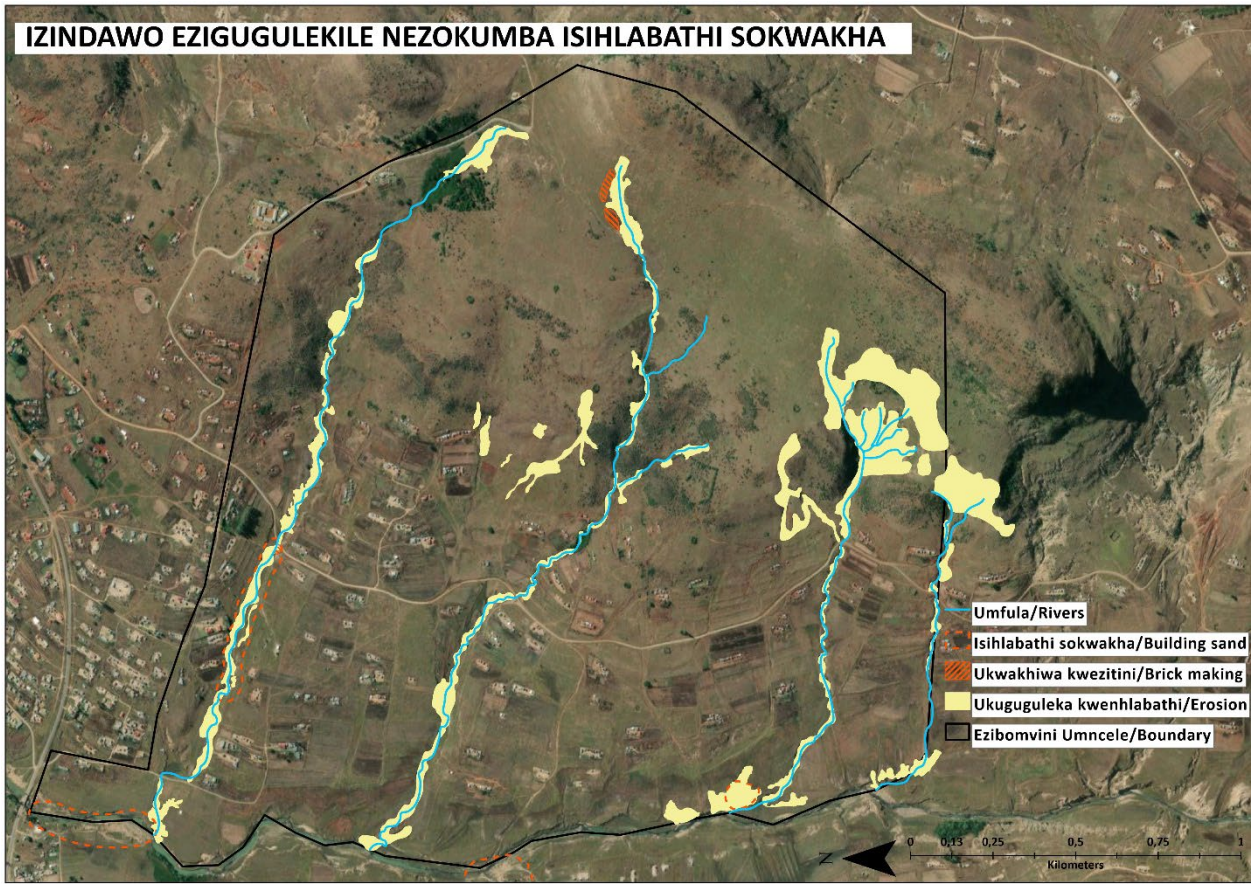
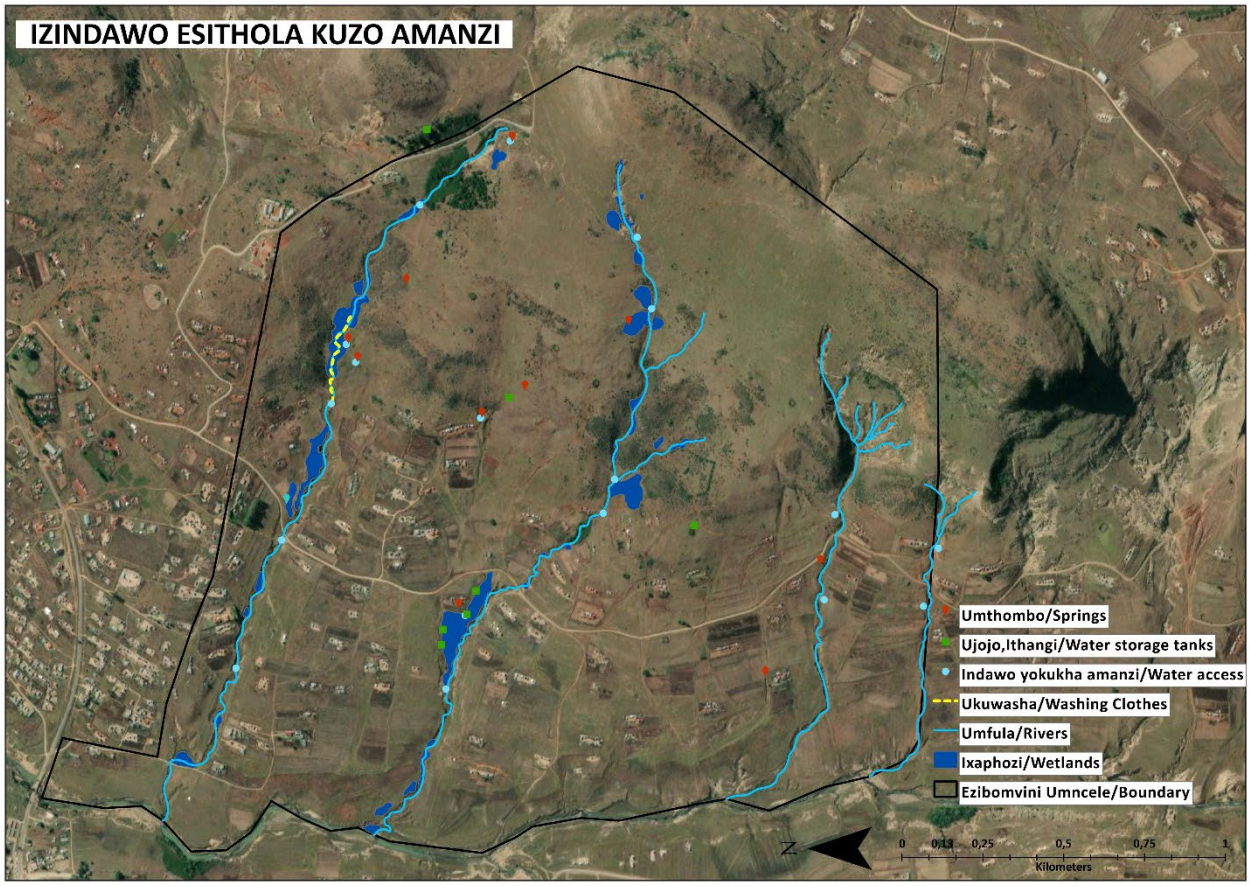
1
Kilometers


IZINHLOBO ZEZIHLAHLA
Ezibomvini Umncele/Boundary
Umfula/Rivers
Ubhabhaliya/Populus
Halibhome/Agave
Ihlathi lemvelo/Natural vegetation
Ubhici/Lantana
Gumtrina/Eucalyptus and Watela/Wattle
Inhllaba/Aloe
N
0
0,13
0,25
0,5
0,75
1
Kilometers


IZINDAWO EZIGUGULEKILE NEZOKUMBA ISIHLABATHI SOKWAKHA
Umfula/Rivers
Isihlabathi sokwakha/Building sand
Ukwakhiwa kwezitini/Brick making
Ukuguguleka kwenhlabathi/Erosion
Ezibomvini Umncele/Boundary
0 0,13 0,25 0,5 0,75 1
Kilometers


IZINDAWO ESITHOLA KUZO AMANZI
Umthombo/Springs
Ujojo,Ithangi/Water storage tanks
Indawo yokukha amanzi/Water access
Ukuwasha/Washing Clothes
Umfula/Rivers
Ixaphozi/Wetlands
Ezibomvini Umncele/Boundary
0 0,13 0,25 0,5 0,75 1
Kilometers

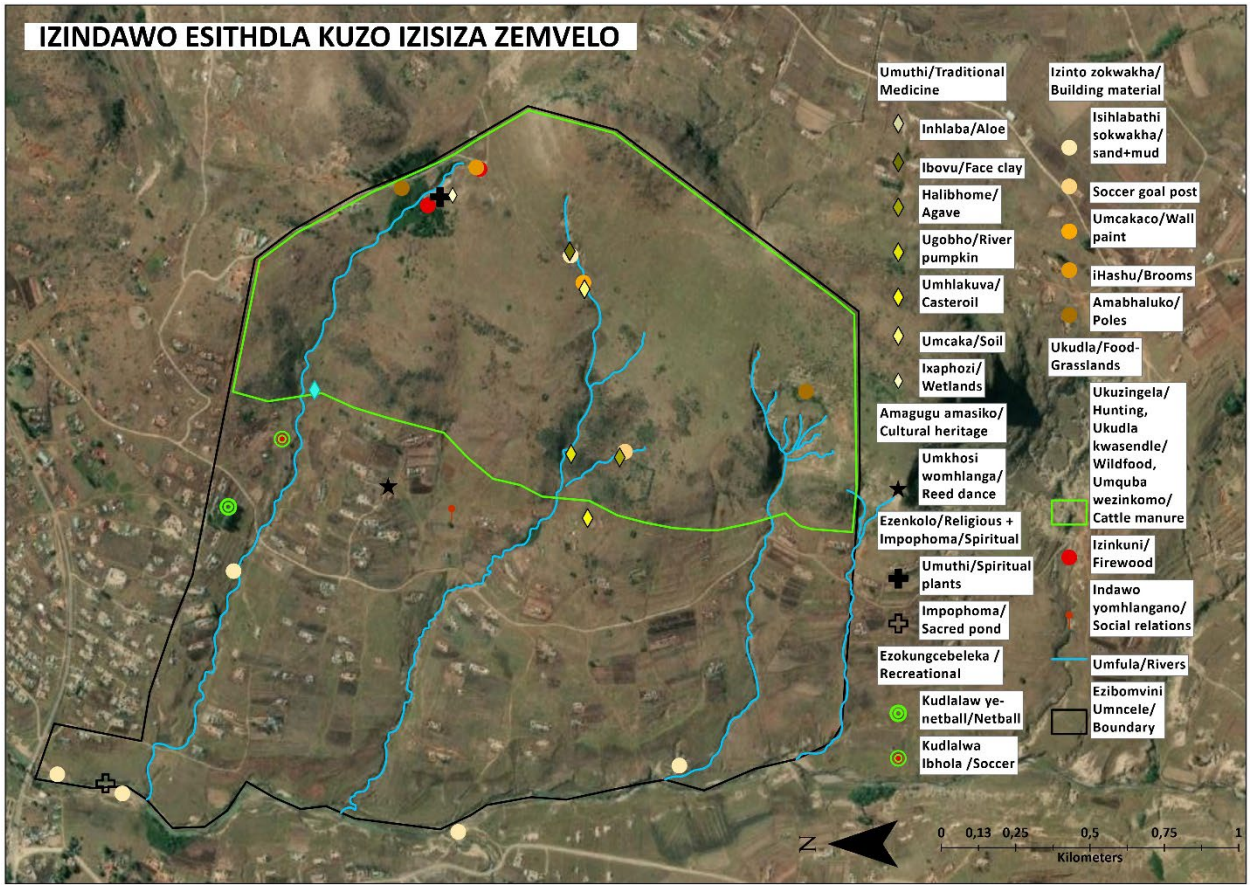


Figure 6-3 Five layers of maps over Ezibomvini to be printed, laminated and delivered to the community

CHAPTER 7: COMMUNITY RESOURCE MANAGEMENT PLANS

7.1 INTRODUCTION

Co-learning about the climate, the environment, and the communities' needs, priorities and decision-making structures, between scientists, the MDF facilitation team, community members and leaders, has enabled the development of participatory community resource management plans that are community-led and expert guided. The process has empowered the communities to plan, innovate and take action towards sustainable and equitable management of their resources and to build social agency. This chapter describes how the learnings and outcomes described in Chapters 2-6 were employed to facilitate the communities to develop detailed management plans for selected priority areas and take action on these learnings for deeper and more long-lasting impacts.

Figure 7-1 Co-learning workshops in Ezibomvini and Costone. Top row: First workshop, bottom row: second workshop

7.2 METHODS

Two co-learning workshops were held in each community to create a shared understanding between scientists, the MDF facilitation team and the communities about land and water resources, the communities' needs and priorities, decision-making structures as well as climate change and variability that have consequences on social, economic, environmental and agricultural aspects of the area (Figure 7-1). During the first workshop, the participants and researchers reflected on, and discussed the implications of changing rainfalls and temperatures, erosion, water quality and availability, alien invasive species, veld condition and grazing, and communicated around land management practices and options, as well as landscape use and dependency. The maps from Chapter 3 were shared and discussed, and additional features were marked out on the maps to be included in the transdisciplinary social-ecological GIS tool (Chapters 4 and 6). The second workshop started with recapping the learnings from the previous workshop, and additional features were marked out, similar to the first workshop. Thereafter the participants were asked to brainstorm and list priority areas of concern that are of need for protection, restoration or targeted management. In both communities, the priority areas were identified as water

sources (springs, streams and rivers), wetlands, alien invasives (poplar, wattle, eucalyptus and lantana), erosion and gullies, and grazing land/livestock management. These areas were marked out on maps (Figure 7-2) and the participants were divided into two groups to each work on a selection of the priority areas. Guided by a pair of facilitators, the groups were tasked with developing management plans for the priority areas, using a method developed from elements of the Strategic Adaptive Management approach (Rogers and Luton, 2011, Palmer et al., 2018). The management plans developed included detailed and structured information about the priority area and location, the importance of the area for the community, what needs to be done to manage, restore and/or conserve the area, what are the actions required, who will be involved from the community and from other organizations, timeframe for the actions and what resources are needed for the actions.

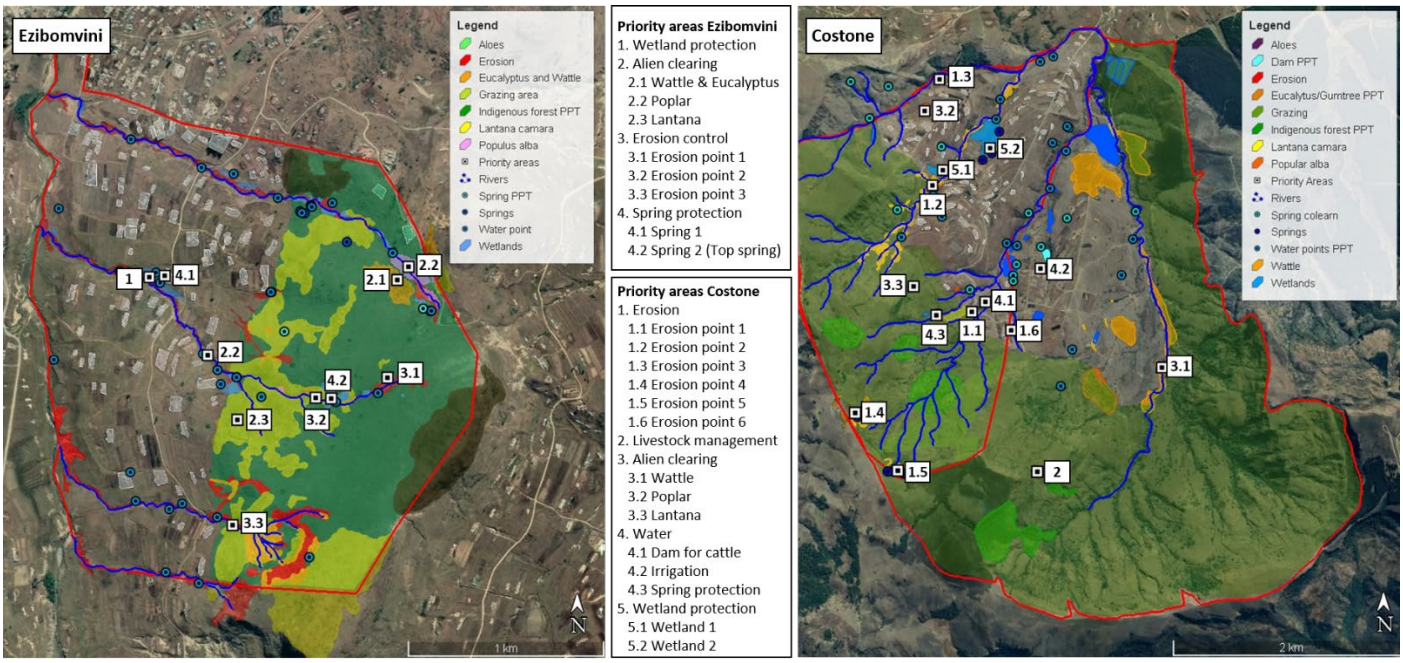


Figure 7-2 Priority areas of Ezibomvini (left) and Costone (right)

7.3 SUMMARY OF COMMUNITY RESOURCE MANAGEMENT PLANS

Both Ezibomvini and Costone developed detailed plans for their respective communities, with clear action plans including who to take charge, who to be involved and agreed timeframes. The participants were generally engaged and enthusiastic and it was observed that the process encouraged agency and commitment to take action and follow through with the plans. Ezibomvini community however had less engagement, and participants were often hesitant to commit, while Costone has acted with intention on the commitments and followed through with many of the actions. Costone's activities following the development of the management plan is described in Chapter 8.3.2. The priority areas and action plans were fairly similar in both communities, with variations with regards to people involved and timeframes. Table 7-1 provides a combined summary of the management plans from Costone and Ezibomvini. Detailed management plans for each community are found in Appendix 1.

Table 7-1 Summary of the community resource management plans in Costone and Ezibomvini, combined

Key Area	Management required	Notes
Grazing areas (Amadlelo) - Livestock feed and water, firewood, medicinal plants	Restoration and management. - Clear Lantana and use poison after cutting to stop regrowth - Rotational grazing - Control wildfires and make firebreaks. Storage drums for emergencies with fire one can use - Explore financial benefit – grant/incentive mechanisms - Monitor and manage nutrition of veld (erosion control, overgrazing control, removal of poisonous weeds, re-seed of palatable species) - Awareness raising in the community and for livestock owners.	- EcoChamps to do clearing - Dip tank committees and livestock associations - Better community collaboration with dip tank committee as well as TA and councillors - Community workdays
Wetlands (Amacaphuza) - Reeds (incema) - Food and water for cattle, also in winter - Medicinal plants - Fire retardant - Runoff and flood water management - Improved water quality - Fertile soils with earthworms	Small management changes to manage condition of wetlands. - Fencing to ensure good condition and make drinking troughs for livestock - Awareness raising on wetlands functions and services - Replanting important species into wetlands; then someone needs to police this and ensure people don't just harvest everything - Protection and restoration of important medicinal species for sale: Stop people with big bags who come in and take for selling - Avoid pigs coming in as they mess things up - Avoid fires and burning - Livestock inclusion managed, e.g. allow livestock in at certain times only, design grazing camps, allow livestock to graze on the edges, cut and carry feed.	- TA involvement and 'landowners' in wetland areas to outline rules and responsibilities - Community as a whole to follow these - Local water and land use committees to undertake specific actions related to water access and management - Issues around rights around use of water and important medicinal plants need further interventions - Suggestion: talk to livestock association then bring their comments and suggestions to the water committee to continue the conversation and include all
Erosion control - To ensure availability and quality of water and soil resources	Restoration - Awareness raising and outline of responsible actions to enforce - Avoid expanding of minor erosion into dongas. - Prevent siltation and pollution. - Allow re-vegetation, naturally or through re-seeding - Prevent run-off - Check dams, brush packs, stone packs, - Prevent livestock from causing further damage - Control wildfire – make fire breaks	- TA and livestock committees to undertake some actions - EcoChamps to assists - Some actions and contributions from community as a whole, e.g. loan of tractors, small financial contributions - External support - Continued support from UKZN and MDF in mapping, planning, proposal development, community structures and management

	Storage drums for emergencies with fire one can use	
Alien trees - Eucalyptus, poplar, wattle plantations, and patches	Small changes - Promote better management by 'owners' - Cut down and poison lantana and encroaching poplars - Ensure management of wattle patches - Remove trees from water sources and streams in all cases	-TA, Nkosi and 'owners" encouraged to undertake management activities as trees are useful in the community and cannot just be cleared.
Springs and streams - Water provision for drinking, laundry, irrigation, construction and livestock - Water quality and quantity – Issues are floods, livestock trampling, children use as toilet, litter	Protection, restoration, and management – must protect the water sources to ensure supply. - Should protect water so that livestock don't disturb the sources - Protect the springs; with fencing and the ditches above to avoid water from flowing in overland and contaminating these springs. - Check water quality. - Remove eutrophication. - Check springs regularly. - Drinking spots for livestock - Community awareness and education – and for children - Maintain the water infrastructure that is there. - Avoid doing laundry in the water sources and keeping them clean, no pampers, no urination, no use as toilet, no dumping of dead animals. - Protect springs with pipes to be able to irrigate the gardens (reticulation to taps) - Also use grey water for irrigation. - Water harvesting and use. - Make sure children don't play around the water sources… or pollute them	- TA, local municipality, water committees and localised groups of people using specific water sources to work together on access and management plans and implementation - Community must come together and make rules and regulations regarding hygiene and water - Those that are involved should talk to others and ensure they also learn – involve the TA councillors and Nkosi - Asking MDF to help with fencing and funding for water access - Day to day activities of cleaning springs, digging furrows to reduce contamination to be done by locals - Dig refuse pits for disposal of waste – in each locality - Awareness raising and communications - Involve schools - EcoChamps to assist with spring protection and management and schools' interventions

CHAPTER 8: CO-DESIGNED INNOVATIONS AND ACTIONS

8.1 INTRODUCTION

While the work described in Chapters 2-7 has aimed to increase the communities' knowledge and understanding of their natural resource base to be better prepared to make decisions for improving their management practices, the communities are not technically and financially equipped to test and experiment with innovations, and to take action on management strategies developed. This project therefore committed to provide the participants with additional support for management actions and community experimentation to test innovations that they, through this long-term co-learning decision-making process, have thoroughly reached consensus to implement. Building the innovation testing based on thorough decisions and taking actions on co-developed management strategies, including reflecting on how decisions are made (Chapter 5), have resulted in tangible impact and potential for long-lasting change. This chapter first describes the involvement of a youth group, the "EcoChamps" in ecosystem and water resource management and restoration activities in Costone and Ezibomvini. It then presents the process and outcomes of co-designed innovation for spring protection and reticulation in Costone, as well as the restoration, alien clearing activities and other actions derived from the co-development of the community resource management plans, review and follow up planning and a cross-community visit. Lastly, this chapter describe the multi-stakeholder engagement processes in which these communities have been involved over the project duration.

8.1.1 EcoChamps

Eight EcoChamps (four young community inhabitants of Costone and four of Ezibomvini) have been involved in training and application of a number of ecosystem and water resource management and restoration activities in both communities. These activities include river ecology (clarity tubes, MiniSASS and velocity plank), *E. coli* testing, clearing alien plants, building check dams, brush packs, planting on bare lands, spring protection and other ad hoc work in the communities. The EcoChamps have worked together across both communities and assisted community groups, such as the water committees, and thus contributed to cross-community learning, sharing and relationship strengthening. The EcoChamps were also represented during the multi-stakeholder workshops arranged for the NDC.

Figure 8-1 EcoChamps from Ezibomvini and Costone These activities include river ecology, *E. coli* testing, alien clearing, building check dams, brush packs, planting on bare lands, spring protection and other ad hoc work in the communities

8.2 COSTONE SPRING PROTECTION AND RETICULATION SCHEME

As a preparation of the resource innovation in the communities, water and resources mapping walks ("water village walks") were carried out in the two communities. These walks were aimed at co-assessing the water sources with the most potential to be protected and developed for water provision to the communities. The project team and key informants from the communities (water committee members) were accompanied by an agricultural engineering consultant which provided valuable opportunities to co-learn about the landscape, resources, options, needs and priorities.

After the water village walks, the agricultural engineer developed potential layout and access scenarios for a number of options for Costone, aligned with the priorities of the community representatives and feasibility. The prioritization looked at the geographical positions, strength and condition of these sources as well as their potential to supply as many households as possible with water. These scenarios were used to work with the committee and community members to finalise the options for implementation. It was decided to protect a spring in a wetland and reticulate water to 5000 L header tanks with four taps downstream (one added a little later by participants themselves) to support 28 households. The spring supplies around 10 000 L/day. Among the 28 households, 17 are located below the spring and gets access to 500 L/day at a distance of 200-400 m for one of three taps. An additional eleven households are located nearby and have access to the reticulated water but without easy access to taps, or have access to a fourth tap, with an allocation of 200-380 L/day. The participants contributed financially to establish a maintenance fund, and with labour to dig ditches, bring building material to the site and assist with the construction work, which also the EcoChamps assisted substantially with. As it is a gravity fed system, ongoing financial contributions are not required. A spring committee was formed which has been devoted, functioning well and actively supported by the traditional ward councillor.

Roles of committee members include:

- Responsible for any issues arising with the water scheme
- Solve problems with people not following the rules
- Allocate the use of water and ensure everyone who is eligible gets access
- Check regularly that the system is working and used properly
- Open a bank account for the financial contributions and undertake small maintenance activities
- Call meetings with membership to report on usage, maintenance issues and get permission to use funds for specific activities
- Communicate with the community level water committee and also the TA and councillor
- Request assistance from community level water committee for issues they cannot solve

To date, all participants have followed the broad instructions and have also assisted in ensuring that people do not come from outside the village to use this water. In the beginning people came from eMadakaneni and Eqeleni with bakkies to load up with water. All participants in this scheme are satisfied with the scheme and with their access to water. The small conflict around taps however did indicate that some levels of conflict and decision-making still require a respected 3rd party with 'authority", which in this case was MDF. Such support may still be required to make decisions and ensure positive actions and outcomes.

Figure 8-2 Preparation and construction of spring protection and reticulation in Costone

8.3 ALIEN CLEARING AND RESTORATION

8.3.1 Activities by the EcoChamps

The EcoChamps have played a role in building check dams to prevent run-off in a number of eroded areas in both communities. The check dams were built using available stones (stone packing) starting from the top of the mountain to the bottom part of the mountain. These check dams were built using the contour line levels to ensure stable structures, properly keyed into the banks of the gulley and reduce the speed of water flow down slope. The check dams quickly reduced the runoff and blocked soil that sank tight into the stone packs, and formed new soil layers. When stones were not available, the EcoChamps experimented with various alien invasive species to construct brush packs. Lantana was proven unsuccessful and the EcoChamps had issues getting permission from those claiming ownership on wattle and poplar stands. Where wattle was available, however, successful erosion regulation was created using brush packs. Planting of grass species on bare lands where the soil has been retained in the check dams, has been experimented with and tried out in both communities. With support and funding from the INR and PepsiCo, Costone has seen some successful restoration in some areas (Figure 8-3). The work of the EcoChamps on clearing aliens and preventing erosion has been fruitful not only in the ecological and hydrological impact, but it has also been instrumental in capacity building, knowledge sharing, co-learning and catalysing actions by the broader community.

Figure 8-3 Wattle clearing, brush packing and planting of grass for erosion control in Costone

8.3.2 Community led implementation of resource management plans

Through the efforts of the Livestock association, the CRA learning group and the Water committee in Costone, community members have been mobilized to work together, in a genuine effort to implement the co-developed community resource management plan described in Chapter 7. In Ezibomvini, a more expected scenario, of no further activity has played out. There, further intervention by the facilitation team would be required. Below sections outline the extensive work carried out in Costone, during the course of only a few weeks.

The community made an agreement to have community workdays on Thursday every week, or as close to that as possible. Initially a decision was made to spend two days on each activity and then move on to the next. Later, it was however decided that if an activity logically requires a bit more time then the groups would be flexible on the issue. The EcoChamps overseen by Mahlathini and the CRA learning group have been centrally involved in all activities and have provided skills and information related to what they have already learnt to the community members. Examples include how to do stone packs and check dams, use of herbicides to reduce regrowth after alien clearing and how to do brush packing.

Three community workdays in the eroded area above the dip tank have been undertaken. The first day was spent changing the position of the gate leading into the grazing camp, from the dip tank and fixing the fence line of the main grazing camp (Figure 8-4 a). This would allow for a reduction of erosion pressure on the paths used by cattle and for erosion control activities to proceed. For the following two days, stones were collected and transported closer to the site and then moved by community members to the eroded areas for construction of stone lines, stone packs and check dams in heavily eroded areas (Figure 8-4 b, c). The water committee further organised a river cleaning day as part of their campaign to stop community members from discarding their waste and nappies in the water courses (Figure 8-4 d). They have also agreed on a few central sites where pits have been dug for waste disposal.

Figure 8-4 Costone. a: Grazing management (moving gate and fixing fence line of grazing camp), b-c: erosion control (community members constructing check dams and stone packs), d: river cleaning (A group of women spent a day collecting waste that was discarded in water courses in the community)

As a way to include more community members, it was decided to start on wattle clearing in the water courses and to allow all participants in these activities to collect firewood from there. The main patch of wattle that is managed by the Nkosi for communal use for funerals, was not touched, although there have been discussions around clearing the lantana on this site and also thinning the stand to allow for regrowth of grass. This will be the next step once river clearing has been completed. Two community workdays were held for wattle clearing. Community members are aware that the seed stock for these wattle are the big patches high up in the grazing areas. These are however difficult to get to and quite far away from the village. Community members have opted for an easier initial activity.

Figure 8-5 Community members and EcoChamps working together on wattle clearing in one of the larger streams in Costone. The stumps of felled wattle trees have been treated with herbicide to stop regrowth

8.3.3 Community resource management review and planning sessions

Workshops were held in both Costone (45 participants) and Ezibomvini (52 participants) towards the end of the project, in October 2023, to review the progress in the resource management planning and implementation.

The participants in Costone selected committees to proceed with the activities. Three committees were formed, each led by three representatives. The actions that were planned were as follows:

- Continue working on the second water access initiative from higher up in the hills, assisting with construction of two small v-boxes and weirs, the tank stands and ditches for piping.
- Stone packing in gullies alongside and below the dip tank, just above the low-level bridge and the road is to be undertaken in February 2024, to ensure that the road remains passable for taxis and local community members
- A focus on rotational grazing and setting up of grazing camps was considered important. A Livestock association member mentioned that a meeting had been held in Bergville where assistance through the OLM and the DALRRD was promised for fencing for grazing camps. Although the community members are somewhat doubtful that this will materialize, this process will be taken forward as the only option presently available for funding assistance
- There was an issue regarding the Mbhorompo, Emahlathini and Emadakaneni villages, who have been helping themselves to the cleared wattle for firewood. They are part of the broader Stulwane area in which Costone is located and have taken it as their right to also benefit from this activity. The Costone community would like to propose a meeting with other communities involved to explain the purpose of the clearing and management and also invite them to work together in this and also practise these activities in their villages. A suggestion was made to meet with the

ward councillor and then jointly have a meeting with the Emahlathini community in this regard as a starting point. The meeting was scheduled in October 2023, and the community requested MDF's involvement
- A local KZNDARD extension officer has also compiled a list of all active gardeners across the villages working with MDF, to garner further support for these participants in their production and marketing activities

In Ezibomvini the resource management process is not as well developed as in Costone and the community was not yet ready to select representatives. Their commitment to maintaining work done in spring protection for the area as well as to continue some initial clearing work started by the EcoChamps is a significant step for this village and also a good indication of their improved social agency toward better governance in the area.

- A decision was made to undertake resource management activities on Thursdays every week, rotating between the different activities planned, and the work was to be started with the litter clean-up workdays
- Planned alien clearing above the village, working on clearing the Lantana invasions there. A request for support with the required herbicide was made. In this regard, the EcoChamps would assist the community in the correct procedures for cutting as well as herbicide application. It was agreed that it is better for the community themselves to collect small amounts of money for their activities than to wait for assistance from government and outsiders, which can take a long time to materialize
- The community had also been cleaning the spring that provides them with water, which gets clogged by sediment after heavy rains. They have collected money to buy cement to rebuild the basin there, to make it easier to clean on an ongoing basis
- Sharing of knowledge at the schools has been undertaken and they will continue with this activity

This progress shows that the communities, especially the Costone group are taking on challenges that are starting to encompass the broader community and spearheading a process for broader involvement as an organic, evolutionary step in this process and also how the government stakeholders are slowly being brought on board by the community themselves to provide the needed support and assistance. It is evident that the community has developed enough confidence to engage stakeholders and ask for support is a significant step in their improved agency and in developing improved governance in their communities.

8.3.4 Community cross-learning: Community level resource conservation activities

Fifteen members of the village-based learning group in Ezibomvini visited Costone in the end of September 2023 to learn about the resource conservation activities this group has undertaken in their village (Figure 8-6). The Costone community showcased their litter clean-up campaign to keep their rivers and streams clean, showed the gulley reclamation and erosion control work they have undertaken in their grazing area, the wattle clearing in their riverine systems and their work on digging ditches in preparation for their most recent local water scheme development. This entails reticulating water from two sources high up in the hills, to the two sections of their village, to benefit around 75 households. They explained that community workdays were undertaken every Thursday. Activities are organised through the CRA learning groups, the livestock association and the traditional authority in the village. The initial push for these activities were undertaken during the winter season and participants benefited from having access to wood from the cleared wattle in the riverbeds. During spring, most of these activities are on hold, to allow for the community's field cropping activities.

Some of the learnings shared by the Costone group is that it is good to start with only the few people who initially turn up for the joint working days and not try to make sure everyone is there from the start. Other community members will see them working and will join the activities over time. This is how it worked in Costone. In addition, unity in the community is very important. When they started, they had different smaller groups doing different activities, as their plan was ambitious and there is a lot to do. So one group worked on waste clearing and another on stone packing. This caused a bit of unhappiness in terms of the division of labour. Thereafter, they worked at a more measured pace with everyone involved in one activity at a time, which worked much better.

Figure 8-6 Ezibomvini cross-visit, with group discussing alien clearing at one of the riverine sites in Costone, gulley reclamation at the stone packs above the dip tank and having a focus group discussion to talk through implementation strategies and plans

The Ezibomvini participants reported the following:

- There is little unity in Ezibomvini and when meetings are called to discuss the resource management issues very few people participate, which makes it hard to pass on messages and start the work
- After the first meetings in March and June, a Livestock association member went to have a chat with the owners of the land where the wetland is, asked for permission and explained to them that there is a plan made to protect the wetland and replant indigenous vegetation and medicinal plants back to the wetland. The family agreed and gave the community permission, as the wetland falls within their 'land allocation' and nominally belongs to them. He then went to another wetland at the top where there is an abundance of medicinal plants (Kalumuzi and Gobho). The idea is to take root stock from this wetland to replant in the degraded and over-harvested wetland lower down
- A decision was made to advertise the community litter clean-up community campaign and the first working day at the ward council meeting in October 2023
- The community had identified the access road as one of the key areas. They had planned to do some repairing for vehicles to be able to go into the area. A community ward committee member started by requesting from the OLM to assist with their road constructing machinery, and some repairs were undertaken. For the community it was unexpected and very positive that these kinds of requests were actually heeded by the municipality
- A CRA learning group facilitator commented that the cross visit has given them ideas of how to go about implementing their plans

A suggestion during the discussions was to set up local resource management committees who could assist to provide some focus and organise the community level working days. The areas are large, and it would be good to have representation from the different sections to assist in communication. In addition, these committees would have to be diversified by having youth, women, and men, to encourage men and youth to take part as it is usually the women who take the lead and participate.

An immediate outcome of this cross-visit was that the Ezibomvini community went back to their area with renewed purpose and immediately started a litter clean-up campaign for their streams and water sources (Figure 8-7). They had the additional foresight and connection with the OLM to arrange for this litter to be picked up by the municipal waste removal truck. This activity also assisted to raise awareness within the community as a whole to ensure that community members would refrain from discarding their solid waste and used disposable nappies in and around water sources in the future.

Figure 8-7 Community littler clean up days in different sections of the village and removal of this waste by the Municipal waste removal truck

8.4 MULTI-STAKEHOLDER ENGAGEMENTS

The community members and leaders have been participating in, and hosting, a number of multi-stakeholder engagement events throughout the project. These engagements were arranged by the convening team of the WWF-SA funded Northern Drakensberg Collaborative (NDC) (formerly the DSI/WRC funded SANBI Living Catchment Project), which this project team forms part of. Shared trust and relationships have been established with a wide and diverse range of stakeholders within the upper uThukela Catchment, starting with the first SANBI Upper uThukela Living Catchment Project multi-stakeholder meeting in Bergville in May 2021.

Around 110 delegates from the spheres of government, academia, research institutions and civil society organisations attended the 2nd Catchment-based Indaba on Ecological Infrastructure within which the MDF hosted a field visit in the Ezibomvini and Costone communities. A group of 24 visitors representing the INR, SANBI, the Duzi-uMngeni Conservation Trust (DUCT), Amanzi Ethu Nobuntu, UKZN, Ezemvelo KZN Wildlife, The Maloti-Drakensberg Transfrontier Conservation and Development Project (MDTP), WRC, and WWF-SA, visited three project participants and discussed the implementation of CRA practices, resource conservation and water managements practices as well as crop-livestock integration.

In June 2022, almost 40 stakeholders who live, work or have an interest in the water resources in the upper uThukela catchment, including community representatives from Costone and Ezibomvini, met at the OLM in Bergville for a one-day Adaptive Planning Process (APP) workshop. This workshop built on the workshop in May 2021, and included a structured process to collaborate towards creating a shared vision between a wide and diverse range of stakeholders. The participants consisted of 17 women and 22 men, representing the local communities, water committees, action groups, youth EcoChamps, representatives of the Amakhosi areas AmaZizi, AmaNgwane and AmaSwazi; as well as ward councillors, and representatives from OLM, WWF-SA, WILDTRUST, DWS, SAEON, UKZN, University of Free State, Rhodes University, the Farmers No-till Club and KZNDARD.

Building on the SANBI Living Catchment Project partnership in the Upper uThukela, WWF-SA has supported the strengthening and expansion of the partnership to include other stakeholders within the Northern Drakensberg Strategic Water Source Area (SWSA), now established as the Northern Drakensberg Collaborative (NDC). Two additional multi-stakeholder meetings were held in November 2022 and May 2023, in the OLM and the Alpine Heath Resort and Conference Facility, respectively.

In order to allow for enhanced learning and reflection around real-life cases of spring protection, community action, climate smart agriculture and environmental rehabilitation, the NDC held a meeting in the Emmaus community hall, and a field visit to Costone community, in September 2023. One of the intended outcomes of the fieldtrip was to take the partnership forward towards establishing themes of communities of practice that have more focused interactions, as well as to showcase the work of the Costone community. A group of about 45 people met at the community hall in Emmaus, comprising farmers from Costone and Ezibomvini, staff from Ezemvelo KZN Wildlife, MDTP, EFTEON, INR, Endangered Wildlife Trust (EWT), African Conservation trust (ACT), Agricultural Research Council (ARC), WILDTRUST, members of clearing and restoration teams working with WILDTRUST and INR, and a

representative of the local No-till Club. The participants then travelled through to Costone, where community members explained their activities to visitors (Figure 8-8).

One farmer explained the process that has been taken to protect springs and improve access to water for households, which is currently being expanded to include additional households. This process is led by the locally elected water committee and is community driven, managed and owned. A young EcoChamp from the village explained the nature of the restoration activities and how some of the interventions have been taken forward through community action that is undertaken on a voluntary basis. At another homestead, where lunch was served, there was opportunity for more discussion as well as a demonstration of some the agricultural technologies being promoted by MDF, such as the two-row minimum tillage planter, the agroecological and water conservation practices and the micro-tunnels for intensive vegetable production.

Figure 8-8 A stakeholder visit to the donga rehabilitation and re-grassing site in Costone, a visit to the spring based water supply system and a farmer explains the climate smart food security system

The participation of the project team and the communities in the wider stakeholder network facilitated by the NDC, has been, and will continue to be, valuable to all partners. The progress and findings from this project have been shared and communicated in all the multi-stakeholder engagements since the start in May 2021. For further sharing of these valuable findings and recommendations, a policy brief has been produced for dissemination within the NDC and elsewhere (Appendix 2). This policy brief will be translated into isiZulu and shared with Costone, Ezibomvini, other communities and additional relevant stakeholders.

CHAPTER 9: DECISION SUPPORT FRAMEWORK

9.1 INTRODUCTION

This chapter outlines the community level learning and decision support process for implementation of Climate Resilient Agriculture (CRA) practices and improved local governance. This process focuses on capacitating village level learning groups of smallholder farmers in improved agricultural production, local economic development and natural and water resources management through a systemic innovation development approach that includes building of social agency in the villages. The CRA learning groups provide a voluntary platform for community members to explore the impact of climate change on their resources, their livelihoods and farming systems, incorporating a wide range of perspectives (scientific, local and traditional). The cyclical process of innovation is shown below outlining also how the CRA learning groups become the central point for development of further focus areas and social organization and interact with external stakeholders (Figure 9-1).

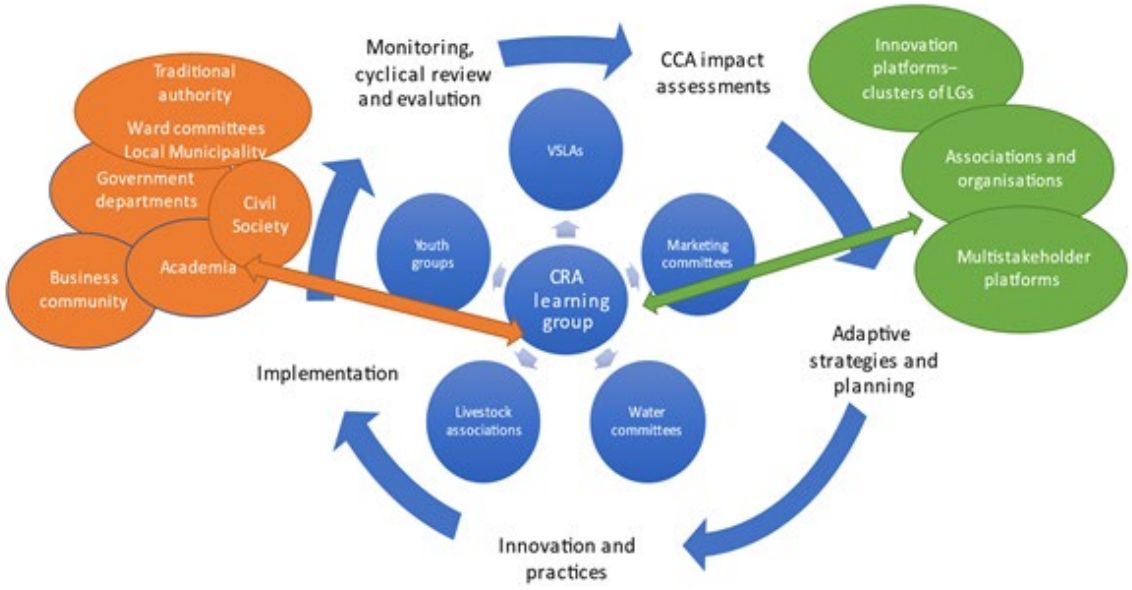


Figure 9-1 Climate Resilient Agriculture (CRA) learning groups and relationship building with local and external stakeholders

The following principles of Locally Led Adaptation (LLA) to climate change (Coger et al., 2022) have been incorporated into this process:

- Devolving decision-making to the lowest appropriate level
- Addressing structural inequalities faced by vulnerable and marginalized groups including women, youth, children and people living with disabilities
- Providing patient and predictable funding that can be accessed more easily: Supporting long-term development of local governance processes, capacity, and institutions
- Investing in local capabilities to leave an institutional legacy for adaptation initiatives over the long term
- Building a robust understanding of climate risk and uncertainty
- Flexible programming and learning: Enabling adaptive management
- Ensuring transparency and accountability
- Collaborative action and investment

9.2 DECISION SUPPORT FRAMEWORK

Based on the learnings and outcomes of this project we propose a decision support framework – a framework that supports innovation and decisions for sustainable resource use management and improved livelihood opportunities. We propose that support for sustainable and equitable community resource management is designed based on the following principles:

- Community-based initiatives are promising approaches to lessen the impacts of climate change while empowering people and bolstering community resilience. Local innovation and agency are critical complements of these programs in fostering sustained community resilience
- Community-based approaches with direct engagement of the vulnerable population, and which are adequately supported by international agencies, national and local government, academics, experts, and non-profit organizations, have the potential to develop locally relevant, culturally appropriate, and sustainable solutions
- Solutions are developed in context by integrating indigenous knowledge, scientific information and global experiences. They focus on supporting livelihood opportunities, and they are governed at the community level, making use of existing social capital and other complementary programmes
- The process would include participatory solutions and iterative learning at the local level, complemented by transformative action at national, regional, and international scales. Monitoring and learning are a key part of the process
- The scope would consider the impacts of climate change alongside poverty, ecological integrity, gender equality, and other development priorities
- The outcomes include proactive planning for maximising Sustainable Development Goal (SDG) attainment and disaster risk reduction, which allows climate change adaptation activities to tap into and find synergies with these cross-cutting imperatives
- The methodological process of ensuring knowledge co-creation and innovation development in and beyond these CRA learning groups entails three broad facilitated interventions. This entails analysing the present situation, identifying intervention options and processes and implementing these and building improved systems and social agency. This is also a cyclical process where learning and implementation can be strengthened and deepened over time

The overall outcomes of such process are expected to be:

- Improved participatory decision-making to support implementation and innovation.
- Improved governance – new community-based structures
- Improved governance – improved rules and logistics within community-based structures.
- Improved governance – coherent collaboration with stakeholders and role players.

The process with steps outlined are shown in Table 9-1.

Table 9-1 Decision support framework developed based on the learnings from this project

DECISION SUPPORT FRAMEWORK/ FRAMEWORK TO SUPPORT INNOVATION AND DECISION MAKING					
PRESENT SITUATION →		**INTERVENTIONS AND PROCESSES TO BUILD SOCIAL AGENCY** →		**IMPROVED DECISION MAKING AND GOVERNANCE OUTCOMES**	
Actions	**Joint analysis**	**Actions/Outcomes**	**Co-learning**	**Actions/Outcomes**	**Joint decision making**
Focus group discussions and mapping: socio-ecological patches	Present situation in land use and management, including needs and issues (emerging from discussions)	Focus group discussions/ Thematic workshop: CC, resource issues (erosion, alien invasion, wetlands and rivers, water access, grazing management)	Socio-ecological mapping: Impact of human interventions and climate on the environment	Adaptive planning workshop using layered socio ecological maps (expert and community combined)	Management plan for water and land resources
Village walks for detailed resource discussions and mapping (key informants)		Community workshops on CC impact (social, economic, farming, resources). Adaptive strategies (communities and stakeholders combined)	CC impact and adaptive strategies		Build improved systems and social agency
Expert ecological mapping (GIS)incl EIA, Veld assessment, water resource survey etc. (with key informants)	Collect and analyse information	Prioritization of adaptive measures, and practices -	Village based learning groups	Further social organisations develop (including marketing, microfinance, water livestock etc.)	Linked youth groups in resource management and enterprise development
		Experimentation with new practices and innovations in Climate resilient agriculture (Individual smallholders and support organisations)	CRA experimentation and implementation	Iterative experimentation with CRA practices to tackle more complex issues,	Improved land use and coordination at community level
		Seasonal review and re-planning	Identify options and implement	Stakeholder engagement - innovation platforms and multistakeholder forums etc	
Focus group discussions, individual interviews	Local structures and decisions made by them, including factors that influence individual and community decision making (emerging from discussions)	Thematic focus areas: water access and management, livestock and grazing management, natural resources management,	Learning group discussions and prioritization of urgent issues	Committees discuss, plan, and implement (with support) prioritized actions in thematic areas	Community level structures develop for improved governance- with broader and equitable community involvement linked to local and traditional authorities
		Further engagement with stakeholders for expanded implementation options around water and resources management		LGs, committees, and community structures engage in resource management projects with a range of stakeholders	

OUTCOMES

- **Improved participatory decision making to support implementation and innovation.**
- **Improved governance - new community-based structures**
- **Improved governance improved rules and logistics within community-based structures.**
- **Improved governance- coherent collaboration with stakeholders and role players.**

CHAPTER 10: SUMMARY OF THE FINDINGS, CONCLUSIONS & RECOMMENDATIONS

10.1 SUMMARY OF THE FINDINGS AND CONCLUSIONS

This project set out to 1) Enhance the knowledge base towards a shared understanding of the natural resource base, climate variability, community needs and priorities, and governance decision-making and power dynamics, and 2) co-learn for stimulating action, building social agency and improved decision-making and governance outcomes, in two communities in the Drakensberg. This was achieved by bringing together experts from various scientific disciplines (hydrology, ecology, sustainability science, environmental sciences, agricultural engineering and social sciences), community development practitioners and local communities, using a transdisciplinary, participatory approach.

The findings below outline the new knowledge co-generated in the project to enhance the knowledge base of the project team and community participants:

- *Hotter temperatures with variable rainfall and streamflow*: The temperatures in the areas are higher than those experienced in the past, with 2019 and 2015 being the hottest years. Related to the warmer temperatures being experienced in the villages, are an increased numbers of heat waves. The rainfall is highly variable, which results in variable streamflow from the catchments. 2018/2019 had the lowest rainfall and lowest streamflow on record. A drought period stretched from 2013 until 2020, followed by an unusually wet period, with the summer of 2022 being much wetter than average. While most of the data used in these analyses were not predominantly collected for the use in this project, it was interpreted and communicated with the communities for their use and benefit. The communities incorporated their enhanced knowledge of rainfall, temperature and water flows into their planning and management of community resources and livelihood activities. We thus show the importance of sharing climate related information with local users such as smallholder agricultural communities that are those mostly affected by the adverse effects of climate change and variability.

- *Moderately degraded rangelands with low grazing value*: The communal rangelands in both villages are moderately degraded and dominated by grass species with an average palatability and low grazing value. Continuous overgrazing has led to a single species dominating the rangeland. Fire as a tool for regeneration is misunderstood. These disturbances have changed the species composition and richness. The communities have begun to alter their management of degraded grasslands and livestock herding based on their enhanced knowledge gained from this assessment.

- *Severe erosion and gully formation*: The degradation linked to the overgrazing is the severe erosion evident in both villages. Large gullies have formed in areas related to cattle paths and subsequent water movement down these cattle paths. The erosion is lessening the productive land available for grazing and is creating hazards and vulnerability in the villages due to the erosion undercutting roads, incising river channels and increasing flow rates. Enhanced knowledge in the communities have led to widespread community-led initiatives to battle erosion, and simultaneously control alien invasive vegetation.

- *Diverse but declining land use benefits and ecosystem services*: The communities have a rich and detailed understanding of their landscape and describe a diverse utilization of, and appreciation for, locally defined land uses and their benefits. A wide variety of ecosystem services are associated with specific land uses and places in the landscape. These include crop and livestock production, hunting and wild plants for food; cattle manure for fertilization; fire wood for household fuel; poles, soil and plaster sand for building material; a variety of species for traditional medicines and spiritual uses; places for social relations, cultural heritage and spiritual ceremonies. Many of the ecosystem services are declining due to overuse, land degradation, erosion and reduced water availability. The iterative process to develop expert-led, participatory maps of the community resources was vital in enhancing the shared understanding of the landscape, understanding the links between management practices and generation of ecosystem services available to the communities, and in initiating community led landscape planning and management.

- *Contestation of access to communal resources, decision-making and governance structures:* Overall, decision-making processes in these communities involve a combination of collective discussions among some selected groups of community members, individual autonomy in certain areas, and the involvement of the local chief and councillor in resolving disputes and managing resources. While there is a focus on community participation and preserving natural resources, there are also challenges and tensions in the relationship between the community and certain governance structures. The concept of ownership has emerged, where individuals claim resources such as land, water sources, and trees as their own. Thus, public access to resources has diminished.

Below we present the outcomes of the transdisciplinary and participatory co-learning approach between the project team and community participants for stimulating action, building social agency and improved decision-making and governance outcomes:

- *A transdisciplinary landscape GIS support tool*: A series of map layers were produced for each of the communities, with geographical information about the community landscapes generated through an iterative process of expert based mapping of resources and land uses, participatory mapping, village walks and co-learning workshops. The maps include layers of land uses and landscape features such as grazing areas, homesteads, water points, springs, rivers, wetlands, alien invasives, indigenous and planted forests, erosion, ecosystem services and the communities' restoration priority areas. The map reading literacy and ability to interpret spatial information was significantly improved during the course of the project, which enables the communities to use the printed maps for continued decisions of community resources and management strategies.

- *Community Resource management plans*: Co-learning between the project team and community participants about the climate, the environment, and the communities' needs, priorities and decision-making structures enabled the development of participatory community resource management plans that are community-led and expert guided. The process particularly empowered the Costone community to plan, innovate and take action towards sustainable and equitable management of their resources and to build social agency. Ezibomvini did not see the same rate of success and require more support. However, after a cross-learning workshop between the two communities, the Ezibomvini gained momentum for initiating community led activities and took action.

- *Co-designed innovations and restoration actions*: Community resource innovations and management actions were co-developed between community participants and the project team. An engineer assisted with co-designing an innovation for spring protection and reticulation in Costone providing 28 households with water. Along with the efforts of a youth group, the "EcoChamps", community members in Costone initiated a number of restoration actions derived from the community resource management plans. Such actions include grazing management alterations, alien clearing, river cleaning and erosion control activities using check dams with stone and brush packs and planting on bare soil.

These findings and outcomes were co-developed, discussed and reflected on in a series of engagements, co-learning workshops and cross-visits in the communities. This project highlight the importance in creating a shared understanding of the communities' resource base between scientists, practitioners and community members, the communities' dependency and management of their landscape, governance and decision-making structures and mechanisms for social learning, generation of agency and action, and assuring long-lasting and fair impact. This project has led to improved governance within the communities by establishing new community-based structures and improved rules and logistics within these structures. Enhanced participatory decision making generated through this project has supported sustainable and fair implementation and innovation, and ensured coherent collaboration within the communities, and with other stakeholders and collaborating partners.

This project contributes with new knowledge and enhanced understanding of the mechanisms and processes required to stimulate action, build social agency and improve decision-making for sustainable and equitable management of community resources. Lessons learnt from this project include 1) the importance of genuine, caring and intentional presence in the community for building trust, 2) experienced and skilled facilitation, continuously within and outside of structured workshops, as well as, 3) the significance of livelihood support for participants to enable effective, collective engagement in broader community matters. These aspects of transdisciplinary science-action research requires funding support for longer term engagement, significant funds for meaningful facilitation of community

engagements, and larger proportions of funds that directly benefit communities to support their livelihoods. The learnings from this project can be used to inform the design, implementation and funding of similarly aimed projects and programs.

Although there is evidence that both social and environmental shifts towards sustainability and equity have occurred in both communities during the duration of the project, the communities require continued, long-term support to remain within this positive trajectory. Further research is recommended to assess and analyse the mechanisms and factors contributing to successful mobilization of agency and action that was initiated in this project, and what is required to assure long-lasting and fair impact.

10.2 RECOMMENDATIONS

- Sustainable management of water and natural resources is a complex and context dependent issue and needs to be addressed with co-created knowledge from scientific experts, facilitation practitioners and community members jointly
- Restoration activities in these communities are urgently required to address the erosion linked to overgrazing and to, at a minimum, slow the rate of erosion with the intention ultimately to restore the landscape
- Rangeland management requires an integrated approach including well informed and controlled fire management strategies with resting periods and controlled grazing to avoid further degradation and loss of productivity
- Mapping and assessment of landscape resources requires a participatory approach to build a shared understanding of the landscape's capacity, use and benefits including ecosystem services
- Enhanced understanding of climate patterns, ecosystem health and functioning, and consequences of management practices enables better-informed and climate-resilient community resource decisions
- Enhanced understanding about the community governance structures, decision-making processes, and community needs and priorities enables better guidance from project experts towards equitable and sustainable management of natural and water resources
- Addressing power imbalances and promoting transparency, accountability, and meaningful participation are essential for equitable and sustainable management of natural and water resources
- Co-learning processes involves experienced and skilled facilitation, continuously within and outside of structured workshops
- A carefully designed, expert guided and community led co-development of adaptive community resource management plans enables social agency, stimulates action, and improves decision-making and governance outcomes
- Collaboration with mandated government structures providing communities with an innovation platform for trying out and integrating locally relevant ideas has the potential for long-lasting impact
- Supporting participants' livelihoods opportunities prior to, or in parallel with, community engagement activities enables collaborative commitment and engagement that is not hindered by individual poverty struggles
- Building trust through genuine, caring and intentional presence in the community is essential to stimulate commitment and collaboration between the project team and community participants

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APPENDIX 1 – COMMUNITY RESOURCE MANAGEMENT PLANS

Community Resource Management Plan Costone

Define **Key Area**	**Importance:** 1. water + soil/land or 2. cultural + livelihoods or both	Categorize with type of **Management** required/possible/desired: a) **conservation** (protect the state it is, and not use/exploit) b) **restoration** (larger efforts to get into a different desired state) or c) **small change** in management required to achieve the desired benefits	List of **Actions**	**Who** will/should be **involved** from the community and from other organizations?	**Time frame** What can be done in the next week/month/ year	What other **resources** are needed?
Grazing areas (Amadlelo):	Erosion control Rotational grazing: Frees up time and livestock kept away from crops/homesteads.	Rotational grazing Avoid fires Financial benefit – grant/incentive mechanism Nutrition	1.Rotation grazing 2.Avoid fires and make firebreaks 3.Raise awareness 4.Enquire about financial incentives 5.Establish collaboration with dip tank committee	1.Dip committee, chairperson and TA 2.Mr B, Working for fire, MDF, TA and Nkosi 3.Mr BB 4.Mr DB, Livestock association, MDF 5.Mr DB, chairperson of dip committee, livestock owners, MDF	1.end May 2.Now and ongoing 5.26th April	2.Water containers, people to assist, fire equipment
Erosion 1.At the dip 2.Gogo I. 3.Madakaneni 4.At the topx2 4.By Ms DH	Prevent soil erosion and run-off. Danger to people and livestock Loss of grass and vegetation Loss of water and siltation of water courses	Control movement of livestock and people Control wildfire Make brush packs, check dams, stone packs, plant grass	1.Talk to livestock owners- call a meeting 2.Move gate 3.Fence areas being worked on 4.Choose stones for control, that aren't needed where they are 5. Cut and remove dangerous grass – look at dominance of unpalatable species, plant seed of palatable grasses	1.Livestock association and owners (Mr BB, Mr DB and Mr AB 3.Community to save and contribution from MDF and DoA 4.Ms LD, Ms NZ – eco champs - brush packs 5.Eco champs will join the community and livestock owners. Include EFTEON and MDF	1.31st March 2.May 3.May	1.Maps 3.Money for wire, poles standards/wattle-Save and 5.Tractor, spaces, wheelbarrow, saws, pangas.
Aliens: Wattle, poplars, lantana			1.Cut down and poison (poplar and lantana) 2.Make brush packs from wattle	1. Ms SD, Ms NZ, eco champs and MDF. 2. Ms LD and Eco champs working to clear invasives, with MDF	June	Poison, gloves, tools and equipment

Water access and management	Water is life. Nothing can be done without it. Livestock also need water. And for irrigation. Also building houses.	Management and protection: -Must protect the water sources, to ensure supply -Maintain the water infrastructure that is there. -Avoid doing laundry in the water sources and keeping them clean, no pampers, no urination, no use as toilet, no dumping of dead animals. -Should protect water so that livestock don't disturb the sources -Protect the springs – also with fencing and the ditches above to avoid water from flowing in overland and contaminating these springs. -Protect springs with pipes to be able to irrigate the gardens -Also use grey water for irrigation. -Storage drums for emergencies with fire one can use – water harvesting and use. - It is important to check the hygiene of water we are using -Check springs first for quality and quantity before protecting them -Make sure children don't play around the water sources… or pollute them WATER ACCESS -Big issue	- If we happen to get water access- we should respect each other and look after the system. Unite as a community with respect and listen to each other. . -Cut the trees in the rivers – wattle, poplars (closest to SAPPI plantation -We should not take livestock through where our water sources are. Livestock drinking points. - In community we should make ditches and pits for dumping, so not to o it in the streams. Should be teaching the rest of the community. --Local community should be organised to look after these springs and streams- local groups work in shifts to check and ensure things are working in the longer term. -Important the community is involved in planning where and how. -One big spring to be surveyed for reticulation – work with water committee – ensure all potential people involved. -Find a solution for checking dip tank borehole strength… Can also reticulate from those two tanks. In present scheme- some people taking more water than others – Not a major problem but will decide on boundaries	-Community must come together and make rules and regulations re hygiene and water -Those that are involved should talk to others and ensure they also learn - involve the TA councillors and Nkosi…. -Asking Mahlathini to help with fencing: Community can find poles, if MDF can get wire - Must check if perennial.. Mr MR to talk with community to do that. Mr K, Mrs M, Mrs M in meetings Water committee, Mrs M (councillor). Still need to involve the municipal councillor – although community would rather only work with Mahlathini Water committee	End-April 31st March at the dip tank 3rd April	Fencing materials from MDF, poles, cement, Black garbage bags
Wetland restoration	-Get traditional medicines -Wetlands sieves and cleans water -Feed and water for livestock -Reeds for craft -earthworms which increase soil fertility	Protect: -Don't over harvest medicines -Avoid pigs coming in as they mess things up - there is still availability of reeds and medicines in the wetland. - Shouldn't burn	-Arrange meetings as a community to raise awareness about the importance of wetlands -Pig owners will control their animals -Fencing of wetlands and make drinking troughs for livestock – work together as a community -Livestock inclusion – will allow them in at certain times only. Or maybe make camps and move them. Or allow them to eat around the wetlands and allow livestock to graze on the edges Or cut and carry feed from the wetland.	Mr K, Mr SB volunteering also for this. Mr MR, livestock committee, MDF, eco champs? Suggestion: talk to livestock association then bring their comments and suggestions to the water committee to continue the conversation and include all	31st March	- Spades, picks, fencing, stones.

Define Key Area	**Importance: 1. water + soil/land or 2. cultural + livelihoods or both**	**Categorize with type of Management required/possible/ desired:** a) conservation (protect the state it is, and not use/exploit) b) restoration (larger efforts to get into a different desired state) c) small change in management required to achieve the desired benefits	**List of Actions**	**Who will/should be involved from the community and from other organizations?**	**Time frame What can be done in the next week/month/ year**	**What other resources are needed?**
Grazing areas (Amadlelo): this may include many of the issues:	Lantana (ubici), to allow for grass to regrow, soil erosion at the top of 3rd river, where the eco champs started work,	- Restoration. It came from Australia- people planted it as hedges and then spread from there.	1.Clear Lantana and use poison after cutting to stop regrowth -Eco champs didn't do this for very long, so big area still needs work. -sometimes other people will cut, but only if it can be used for firewood.	1.Eco champs and others will also do it. Community meeting, agree to once or twice a month. People feel everyone should do it not just cattle owners.		
Wetlands (Amacaphuza),	-Reeds (incema) for craft: big one -Food for cattle -Medicinal plants -drinking water for cattle -wetlands don't burn with wild-fire -When wetlands gone the water runs very fast, -In winter recover faster and livestock get food from there.	Small management changes to manage condition of wetlands.	1. Fencing to ensure it stays in good condition, to manage the movement of cattle. But this belongs to S family and others cannot do anything there. Will need to talk to them. Invite them into these kinds of meetings to improve their understanding. 2. Awareness raising on wetlands functions and services 3.Replanting important species into wetlands; then someone needs to police this and ensure people don't just harvest everything 4.Protection and restoration of important medicinal species for sale: Stop people with big bags who come in and take for selling	1.Mr N to speak to Mr H who will speak to the family -Fencing cannot happen now -first need permissions and more thinking 3.Rights on use of medicinal plants -do they remain with S? There is no clarity	31st March	
Erosion control: 1. Where eco champs have been working 2.At the top	Avoid expanding into dongas. Prevent siltation and pollution. Allow re-vegetation. Prevent run-off.	Restoration Replace stones form the mountain. Check dams. Return vegetation naturally or through re-seeding. Prevent livestock	1.Talk to community – committee 2.Talk to livestock owners about livestock management 3.Get together as community to collect stones 4.Hire tractor 5.Collect nutgrass and transplant 6.Buy seeds- collect monies	1.Mr JH, Mr GD 2. livestock owners 3.All community members 4.tractor owners 5. All community members 6.Collect R5	1.8th April 3.15th and 22nd April 4. Later when needed 5. and 6. October	1.Maps, this plan 3.Wheelbarrows, picks, rakes 4.Money R800 5.Hando=hoes, bucket, spades 6.Money

Alien trees- Eucalypt, poplar, and wattle plantations (amahlathi)- separate different trees,	-Poplars (Sibiya, Mkhonza) for building, and other uses in emergencies, -Wattle better because gumtrees are bad and take water from the springs, wattle for firewood, for funerals, medicinal use of bark Not grown here as it finishes the water. Wattle takes a long time to germinate and needs fencing. -Eucalyptus. Medicinal, firewood, poles, wind breaks, suck up water in waterlogged areas -Lantana- no uses.	Small changes: promote better management by 'owners'	1.Poplars and other trees are bought from owners. - their families planted those… 2.Some poplars are encroaching on others' land – these need to be cut down. 3.Some people don't think management is required for the poplars 4.Lantana is a much bigger issue:			
Springs and streams 1. one next to JoJo tank feeds wetland a 2.At the top v-box. Important for creating access to drinking water.	Water provision for drinking, laundry and livestock Water quality and quantity Issues are floods, livestock trampling, children use as toilet, litter	Fence springs Check water quality. Remove eutrophication. Check springs regularly. Drinking spots for livestock Community awareness and education – and for children	1.Talk with community using that spring 2.Ask for help to know how to check water quality 3.Clean spring together with community, check regularly 4.Open furrows and ditches 5.Ongoing communication 6. School focus	1. Community, Mr JH 2. Mahlathini and Eco champs 3. Those benefitting 4. Ms ZZ and Ms LS 5. Those benefitting 6.Mahlathini and Eco champs	1. After easter 2. 31st March 3.Now and ongoing 4 31st March 5.Now and ongoing 6. 31st March	1.Money 2.Test tubes, hotbox 3.Brushes, sacks 4.Handhoes, spades, picks, buckets 5.Our voices 6. Pictures, info leaflets for learn

CHAPTER 1 Policy Brief
December 2023

Co-learning for sustainable and equitable management of community resources

A case study in two Drakensberg communities

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Aim of Policy Brief

This brief aims to outline the key messages and findings from a four-year transdisciplinary project focusing on sustainable and equitable management of community resources in two agricultural villages in the Drakensberg Mountains, South Africa. The brief highlights the importance in creating a shared understanding of the communities' resource base between scientists, practitioners and community members, the communities' dependency and management of their landscape, governance and decision-making structures and mechanisms for social learning, generation of agency and action, and assuring long-lasting and fair impact.

Key messages

Message 1: Sustainable management of water and natural resources is a complex and context dependent issue and needs to be addressed with knowledge from scientific experts, facilitation practitioners and community members jointly.

Message 2: Restoration activities in these communities are urgently required to address the erosion linked to overgrazing and to, at a minimum, slow the rate of erosion with the intention ultimately to restore the landscape.

Message 3: Rangeland management requires an integrated approach including well informed and controlled fire management strategies with resting periods and controlled grazing to avoid further degradation and loss of productivity.

Message 4: Mapping and assessment of landscape resources requires a participatory approach to build a shared understanding of the landscape's capacity, use and benefits including ecosystem services.

Message 5: Enhanced understanding of climate patterns, ecosystem health and functioning, and consequences of management practices enables better-informed and climate-resilient community resource decisions.

Message 6: Enhanced understanding about the community governance structures, decision-making processes, and community needs and priorities enables better guidance from project experts towards equitable and sustainable management of natural and water resources.

Message 7: Addressing power imbalances and promoting transparency, accountability, and meaningful participation are essential for equitable and sustainable management of natural and water resources.

Message 8: Co-learning processes involves experienced and skilled facilitation, continuously within and outside of structured workshops.

Message 9: A carefully designed, expert guided and community led co-development of community resource management plans enables social agency, stimulates action, and improves decision-making and governance outcomes.

Message 10: Collaboration with mandated government structures providing communities with an innovation platform for trying out and integrating locally relevant ideas have the potential for long-lasting impact.

Message 11: Supporting participants' livelihoods opportunities prior to, or in parallel with, community engagement activities enables collaborative commitment and engagement that is not hindered by individual poverty struggles.

Message 12: Building trust through genuine, caring and intentional presence in the community is essential to stimulate commitment and collaboration between the project team and community participants.

Background and Methodology

Smallholder communities in the uKhahlamba Drakensberg Mountain, KwaZulu-Natal, depend on the natural resource base of their lands to sustain agriculture, water resources and ecosystem services for their livelihoods and well-being. Climate change, poverty and degraded landscapes call for urgent need to implement sustainable management strategies for securing these resources. Conventional approaches to natural resource management have typically involved technical and top-down strategies, which are rarely successful due to the varying and contextual nature of resource dependent rural communities. The context-specifics in such communities include historical, institutional, and social-cultural settings, which shape the land management decisions made by community members and leaders. Increasingly, it has been suggested that increased participation by community members, integration of knowledge systems and co-design of resource management plans positively influence the implementation and long-lasting impacts of natural resource management strategies.

This project took place in two agricultural communities, Costone and Ezibomvini, in the uKhahlamba Drakensberg Mountain, KwaZulu-Natal. These communities depend on their lands to sustain agriculture, water resources and ecosystem services for their livelihoods. Poverty, climate change and degraded landscapes call for urgent need to implement sustainable and participatory management strategies for securing these resources. Experts from various scientific disciplines were brought together with community development practitioners and local communities, using a transdisciplinary, participatory approach to 1) create a shared understanding of the community resources, climate variability and local governance and management structures, and 2) co-learn for stimulating action, building social agency and improved decision-making and governance outcomes.

This integrative and iterative science-action approach involved methods such as historical and current monitoring of climatic and hydrological observations, landscape mapping, veld assessment, participatory mapping and village walks, and facilitated co-learning workshops and dialogues. Community-led activities for spring protection, later reticulation, grazing management and restoration occurred throughout the project.

Project outcomes, part 1: Enhancing the knowledge base towards a shared understanding

This section outline the new knowledge generated in the project to enhance the knowledge base of the project team and community participants. These outcomes were shared, discussed and reflected on in a series of co-learning workshops in the communities.

Hotter temperatures with variable rainfall and streamflow

The temperatures in the areas are higher than those experienced in the past, with 2019 and 2015 being the hottest years. Related to the warmer temperatures being experienced in the villages, are an increased numbers of heat waves. The rainfall is highly variable, which results in variable streamflow from the catchments. 2018/2019 had the lowest rainfall and lowest streamflow on record. A drought period stretched from 2013 until 2020, followed by an unusually wet period, with the summer of 2022 being much wetter than average.

Moderately degraded rangelands with low grazing value

The communal rangelands in both villages are moderately degraded and dominated by grass species with an average palatability and low grazing value. Continuous overgrazing has led to a single species dominating the rangeland. Fire as a tool for regeneration is misunderstood. These disturbances have changed the species composition and richness.

Severe erosion and gully formation

The degradation linked to the overgrazing is the severe erosion evident in both villages. Large gullies have formed in areas related to cattle paths and subsequent water movement down these cattle paths. The erosion is lessening the productive land available for grazing and is creating hazards and vulnerability in the villages due to the erosion undercutting roads, incising river channels and increasing flow rates.

Diverse but declining land use benefits and ecosystem services

The communities have a rich and detailed understanding of their landscape and describe a diverse utilization of, and appreciation for, locally defined land uses and their benefits. A wide variety of ecosystem services are associated with specific land uses and places in the landscape. These include crop and livestock production, hunting and wild plants for food; cattle manure for fertilization; fire wood for household fuel; poles, soil and plaster sand for building material; a variety of species for traditional medicines and spiritual uses; places for social relations, cultural heritage and spiritual ceremonies. Many of the ecosystem services are declining due to overuse, land degradation, erosion and reduced water availability.

Contestation of access to communal resources, decision-making and governance structures

Overall, decision-making processes in these communities involve a combination of collective discussions among some selected groups of community members, individual autonomy in certain areas, and the involvement of the local chief and councillor in resolving disputes and managing resources. While there is a focus on community participation and preserving natural resources, there are also challenges and tensions in the relationship between the community and certain governance structures. The concept of ownership has emerged, where individuals claim resources such as land, water sources, and trees as their own. Thus, public access to resources has diminished.

Project outcomes, part 2: Co-learning for sustainable management of community resources

This section present the outcomes of the transdisciplinary and participatory co-learning approach between the project team and community participants for stimulating action, building social agency and improved decision-making and governance outcomes.

A transdisciplinary landscape GIS support tool

A series of map layers were produced for each of the communities, with geographical information about the community landscapes generated through expert based mapping of resources and land uses, participatory mapping, village walks and co-learning workshops. The maps include layers of land uses and landscape features such as grazing areas, homesteads, water points, springs, rivers, wetlands, alien invasives, indigenous and planted forests, erosion, ecosystem services and the communities' restoration priority areas. The map reading literacy and ability to interpret spatial information was significantly improved during the course of the project, which enables the communities to use the printed maps for continued decisions of community resources and management strategies.

Community Resource management plans

Co-learning between the project team and community participants about the climate, the environment, and the communities' needs, priorities and decision-making structures enabled the development of participatory community resource management plans that are community-led and expert guided. The process particularly empowered the Costone community to plan, innovate and take action towards sustainable and equitable management of their resources and to build social agency. Ezibomvini did not see the same rate of success and require more support.

Co-designed innovations and restoration actions

Community resource innovations and management actions were co-developed between community participants and the project team. An engineer assisted with co-designing an innovation for spring protection and reticulation in Costone providing 28 households with water. Along with the efforts of a youth group, the "EcoChamps", community members in Costone initiated a number of restoration actions derived from the community resource management plans. Such actions include grazing management alterations, alien clearing, river cleaning and erosion control activities using check dams with stone and brush packs and planting on bare soil.

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