Towards sustainable and equitable management of water resources:

Understanding the interlinkages between water, ecosystems and society through spatial mapping of ecosystem services and livelihood benefits.

WRC 2019/2020-00150 Rebecka Henriksson, Mdoda Ngwenya, Michele Toucher, Sachin Doarswamy, Erna Kruger and Michael Malinga

## Content

- 1. Innovation produced/envisaged
- 2. Progress towards New Knowledge
- 3. Work programme
- 4. Capacity Building
- 5. Community/Institutional Empowerment
- 6. Knowledge Dissemination

## 1. Innovation

- 1. Conceptual Framework:
- Water-Ecosystem-Society
- Transdisciplinary
- Co-learning



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#### 2. Methodology:

Established disciplinary methods + cutting-edge sustainability science methods

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Expert led, participatory mixed-method approach for analysis of water resource management, communities use & dependency, and decision making processes

## 1. Innovation

- 1. Conceptual Framework:
- Water-Ecosystem-Society
- Transdisciplinary
- Co-learning



### 2. Methodology:

Established disciplinary methods + cutting-edge sustainability science methods

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Expert led, participatory mixed-method approach for analysis of water resource management, communities use & dependency, and decision making processes 3. Power dynamics:

- Power imbalances in decision-making
- Inequitable access to resources

## 2. Progress – towards New Knowledge

Year 1		Year 2			Year 3	
Apr 2020 - Sep 2020	Oct 2020 - Mar 2021	Apr 2021 - Sep 2021	Oct 2021 - Mar 2022	Apr 20	22 - Sep 2022	Oct 2022 - Mar 2023
Aim 1. Rainfall and wa	ater quantity					
	Aim 2. Map layers of land use, ecosystem services and livelihoods					
Aim 3. Ecosystem health and		Ith and functioning				
Aim 4. Decisions and social-			cultural factors			
Aim 5. Co-learning for sustainable management of land and water						

Main outcomes:

i) Increased understanding, by scientists and community stakeholders, of the natural resource base (water resources and ecosystems) from which the communities derive ecosystem services they depend on for their well-being and livelihoods

ii) Creation of a comprehensive, transdisciplinary, GIS tool to support local and regional decision making, including map layers of fine-scale land uses (social-ecological patches) and the spatial distribution of associated ecosystem services and livelihood benefits

iii) Through co-learning between scientists and community stakeholders: increased understanding of management and decision making, design and testing of sustainable natural resources management innovations



## Progress: Aim 1. Rainfall and water quantity

Aims

## Aim 1. Rainfall and water quantity

Outcomes

Understanding of the water resource (changes of water quality, quantity, streamflow, recharge potential, sediment load)

Methods

Historical and current monitoring of climatic and hydrological observations, hydrological modelling.



3 meteorological station (and a high altitude station outside this area) **36 Raingauges 6** Streamflow gauges **3 ISCO water sampler 2** Spectral probes (WQuality) **1 Eddy Covariance flux tower (includes CO<sub>2</sub>) 2** Surface renewal systems Warming chambers **Fire disturbance records Repeat vegetation surveys plots Monthly Leaf Area Index Cosmic Ray Probe** 3 pits of TDR soil water probes to 1.6 m Monthly Diviner readings at 18 points through catchment LiCor-8100 Soil Respiration System Monthly manual gas extraction collars

## Rainfall monitoring

2012/2013 - 2020/2021

Historical mean 1392mm (1951-1980)

Only 2020/2021 was wetter than the historical mean, by 200mm



Annual (hydrological years) rainfall anomaly for the Mike's Pass meteorological station

### Rainfall monitoring

2020/2021: Wetter only during the start of the season



Monthly rainfall anomaly for the Mike's Pass meteorological station

## Temperature monitoring

Historical mean (1951-1980)

0,5 to more than 1,5 degrees warmer than the historical mean every year



Annual mean temperature anomaly for the Mike's Pass meteorological station

### Temperature monitoring

Winter months often more than 2 degrees warmer than the historial means



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

## Streamflow monitoring

Above normal flows in January and February 2021



Monthly streamflow anomaly for Catchment VI, Cathedral Peak

## Way forward

- Trend analysis stream flow
- Mahlathini weather stations included and assessed
- Community interests to determine how data will be communicated
- Other indeces will be available (e.g. fire risk)
- ACRU agrohydrological model

## Progress: Aim 3. Ecosystem health and functioning

health and functioningMap of<br/>ecosystem<br/>health and<br/>functioningKnowledge<br/>support of<br/>management<br/>optionsExpert led<br/>survey and<br/>mappingSeries of<br/>workshops<br/>(Aim 5)

Aim 3. Ecosystem

- Field based surveys
  - water sources (springs and wetlands)
  - erosion and invasive alien species
  - woody encroachment
  - E. coli testing (Aim 5)
- Land cover satellite imagery and terrain maps
- Veld Condition Assessment



## Ezibomvini Village



The areas of significant erosion in the Ezibomvini Community.

Images of erosion within the Ezibomvini village.



October 2021 November 2021 WATER WATER WATE VATER VATER VATER TEST WAT D

Results from the E.coli testing.

August 2021



A wetland area where clay has been harvested from to be made into bricks.

Ezibomvini village boundary with the streams, wetlands and springs and locations of E.Coli tests, as well as the known points of water extraction



The woody vegetation components in the upper region of the community.

A Poplar stand growing within the wetland area adjacent to a stream

## Costone Village



Rivers, springs and points of water extraction shown as well as locations of sampling for *E.Coli* 



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.



Upper 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.



Images showing the erosion and presence of wattle near a spring



Erosion downstream of the eye of the first Spring

## Veld Condition Assessment

- Grass species diversity 200 points per village
- Grass and Forb cover 1 m quadrat
- Grass Biomass Disc Pasture Meter



Sampling showing line transect, quadrate estimating cover, measuring grass biomass and dominant grass species (*Paspalum notatum*)

## VCA- Results

-

	Ezibomvini		Costone	
Vegetation type	Open Grassland		Open Grassland	
Grass diversity	16 species		10 species	
Palatable Grass % (High graving value)	Themedra triandra Digitaria tricholaenoides Tristachya leucothrix	2.5% 7% 4.5%	Tristachya leucothrix Heterpogon contortus	1% 6%
Dominant Grass Grazing value	Paspalum notatum - Average Sporobolus pyramidalis- Low	50% 13.5%	Paspalum notatum- Average Eragrostis plana –Low	62% 13%
Grass cover Bare soil Grass Biomass	93% 4.5% Low		93% 5.4% Low	
Veld Score	Poor - Moderately degraded		Poor – Moderately degraded	
Invaders	Lantana		Lantana and Wattle	

#### Summary of the Veld Condition Assessment data

## Conclusion

- Overgrazing
- Loss of diversity and palatable species
- Rangeland dominated by single species

Recommendations

- Resting
- Fire



### Progress: Aim 2. Map layers of land use, ecosystem services and livelihoods







## Participatory mapping and analysis of social-ecological patches, ecosystem services and livelihoods in the Drakensberg, KwaZulu-Natal

MSc Student: Mdoda 'Nduna' Ngwenya Supervisor: Dr Rebecka Henriksson Co-supervisor: Ms Erna Kruger Date: 24 May 2022 **Research question** 

How can mapping and analysis of land uses, ecosystem service and livelihoods guide sustainable and equitable management of land and water resources.

This study aims to guide sustainable and equitable management of land and water resources through mapping locally relevant land uses and ecosystem services.

**Objectives** 

Aim

Identify and map different socialecological patches found across the village landscape.

Identify how these patches are used by the community in terms of ecosystem services and livelihood benefits. Identify ecosystem services and livelihood needs of the community that are insufficiently met by the socialecological patches.

Identify power dynamics and inequalities that cause inequitable access to ecosystem services and livelihood benefits within the communities.

Assess how the land and water resources can be managed in the community for more sustainable and equitable outcomes.

### Study area







#### Results



nage © 2022 Maxar Technologies

### Results

A selection of reflections and comments gathered during three participatory workshops in **Costone**, with women, men and decision-makers respectively.

Step	Women (n=9)	Men (n=8)	Decision makers (n=7)
Identify natural resources and land use	<ul> <li>Livestock also graze within the homestead</li> <li>No specific area allocated as cemetery but bury around their homestead</li> </ul>	<ul> <li>No specific place for medicinal plants collection - everywhere on the landscape Many do cropping</li> </ul>	<ul> <li>No specific place for medicinal plants collection - everywhere on the landscape</li> <li>Thatch grass is only found along the edges of the cropping fields but when fields are cultivated</li> </ul>
Identify areas of inadequate supply	- Some women used to collect firewood from KwaKhanyile forest but restricted now	<ul> <li>The road to ehlathini elimpunga is eroded, they can no longer go and collect firewoods, poles for funerals and construction</li> <li>They only get water from springs and no taps</li> </ul>	- Water sources that no longer have water or in short supply
Identify restricted areas and unequal access to resources	- The forest called UMntwana and KwaKhanyile are restricted for only collecting poles that are used in funerals	<ul> <li>The forest called UMntwana is restricted for only collecting poles that are used in funerals.</li> <li>Livestock grazing is communal</li> </ul>	- The forest called UMntwana is restricted. Only for collecting poles for funerals.
Priorities/needs of community on land use and natural resources	- Water is essential to them - Fence the cropping fields	<ul> <li>Fence cropping area</li> <li>Maintain the springs</li> <li>Some of the springs are drying up on winter and dug out in summer</li> </ul>	<ul> <li>The need a cropping field area to be fenced to prevent livestock and begin to cultivate again</li> <li>They also want a fence along the main road to prevent livestock from entering the homestead</li> </ul>
Suggestions for managing land and water resources sustainably and equitably	<ul> <li>Need laws to manage resources equally and sustainably</li> </ul>	<ul> <li>Work together</li> <li>Community members should be an eye to everything</li> </ul>	<ul> <li>Community should work together.</li> <li>Decisions should be taken together. Agree together as community on things that help them the community</li> </ul>

- Additional data through Village transact walks and interviews.
- Analyze SE patches in terms of ES and livelihoods opportunities.

# Siyabonga! Thank you!

## Progress: Aim 4. Decisions and social-cultural factors

## Aim 4. Decisions and social-cultural factors

1 focus group in Ezibomvini 20 community members (17 women and 3 men)



Understanding of local decision making (individual & communal) Focusgroup discussions / interviews

22 community members (not in committees) (20 women and 2 men)

2 focus groups in Costone

5 participants representing water and diptank committees

#### Topics:

- Understanding of natural resource management
- Land use priorities and access to resources
- Land use practices in the past, present and future.
- Decision makers and decision making (community, local chiefs and councillors)
- Impact of climate change on natural resources

## Progress: Aim 5. Co-learning for sustainable management of land and water







### Multi-stakeholder engagements

Stakeholder mapping	<ul> <li>SH categories (local or governmenal organization</li> <li>Roles in community (released or governmenal organization)</li> <li>Roles in community (released or government)</li> <li>Roles in community (released or government)</li> <li>Sources of information</li> </ul>	<ul> <li>SH categories (local communities and leaders, local organizations and government, non-governmenal organizations, academia, other land owners/users)</li> <li>Roles in community (resource users, decision makers, land owners and representatives, service delivery, learning, training and capacity building, biodiversity conservation, food and water security, development)</li> <li>Sources of information and insights</li> </ul>			
Stakeholder meeting (SANBI LCP) May 2021	Community visits 2 <sup>nd</sup> SANBI Catchment based Indaba November 2021	Meeting with Uthukela District Municipality Water Service Division March 2022	WWF; WSA division – field visit for collaboration in water conservation activities April 2022	Okhahlamba Local Municipality manager visiting Stulwane/Costone Spring Protection site May 2022	

















"Water village walks" Nov 2021

Water committee meetings from Jan 2022

Community meetings from Jan 2022

> Designing & constructing from March 2022



#### Community engagements (innovations)







"Water village walks" Nov 2021

> Community Water meeting March 2022



Community meeting May 2022

#### Community engagements



#### E.Coli testing



Results from the E.coli testing. A green colour indicates the sample is positive for E.coli, a yellow sample indicates Coliforms Bacteria





#### Youth training: EcoChamps – from both communities

4-day Training in Bulwer and cross-visit to sites led by INR



Training by SAEON on MiniSASS and Alien Invasive Species

#### Activities:

- River Ecology (Clarity tubes, MiniSASS, Velocity plank)
- Clearing Alien plants
- Building check dams
- Brush packs
- Planting on bare lands
- Spring protection
- Ad hoc work in communities





#### Way forward

Upper Thukela Multi-stakeholder workshop: Adaptive Planning Process (concerns, shared vision, values, STEEP, objectives hierarchy) 14 June 2022

Feedback/co-learning workshops (rainfall & water quality, resources mapping and veld assessment, ppt mapping & transect walks, decision-making and equity)

For extended learning exchange: cross-study visits between the participating communities

Sustainability and co-learning evaluation

Spring protection Ezibomvini

## 3. Work programme

Del. No.	Del. Title	Deliverable and Tasks	Due date and Status
3	Second Annual Progress Report	Report on progress to date including findings and reporting back on community engagement	Deliverable due: 30 June 2022
		Field work by MSc student M Ngwenya: village walks and in-depth interviews	June - September 2022
		Series of community engagements: spring protection innovations, focus group discussions	June 2022 onwards
		Multi-stakeholder co-learning workshop. Adaptive Planning Process. Co-hosted with the INR (uThukela SANBI Living catchment Project co-learning conveners)	14 June 2022

Del. No.	Del. Title	Deliverable and Tasks	Due date and Status
4	Interim Report: Policy Brief	Policy recommendations based on methodological advancements and findings	Deliverable due: 15 November 2022
		Policy user needs assessment: Consult stakeholders (decision and policy makers) on format and content of policy brief	July 2022
		Field work by MSc student M Ngwenya: village walks and in-depth interviews	June - September 2022
		Finalize community engagement (focus group discussions and thematic co- learning workshops, participatory games, interviews)	July - October 2022
		Development of GIS decision tool: combining maps	August – September 2022
		Cross-study visits between communities for enhanced co-learning	October 2022
		Develop policy brief according to user needs	September - October 2022

## 4. Capacity Building

- Communities (Costone and Ezibombini):
  - increased understanding of the natural resource base
  - increased the awareness of their surrounding landscapes and the use and management of these resources
  - technical and financial support for spring protection and reticulation
  - Eco-champs
- Organization
  - strengthened capacity to address complex issues from an inter- and transdisciplinary approach
  - incoporation into the teaching and learning at UKZN
  - increased understanding among the project team of the natural resource base and the processes that influence community decision making and management of resources
- Postgrad students
  - Two MSc students: Mdoda Ngwenya and Sachin Doarswamy, both with increased insight and skill development into working in a transdisciplinary project to address complex sustainability challenges

## 5. Community/Institutional Empowerment

- Communities empowered to
  - Plan, design and test innovation
  - Make informed sustainable management decisions
  - Address issues of power imbalances and inequity
- Institutions empowered to
  - Co-design transdiciplinary action research projects
  - Address complex sustainablility challenges together with local stakeholders

## 6. Knowledge Dissemination

- Presentation Southern African Mountain Conference (SAMC) in March 2022 "Community based climate change adaptation in the Central Drakensberg improves resilience of smallholder farmers" (authors: **E Kruger**, R Henriksson and M Toucher)

- Non-academic knowledge product: Brief information video during SANBI 2<sup>nd</sup> Catchment-based Indaba, field visit. Innovation presentation in communities.

Planned Knowledge Dissemination:

- MSc thesis
- Academic journal articles
- Policy brief
- Learning workshop /feedback sessions in communities
- Information/learning material for communities (isiZulu)
- Ongoing updates in CWRR and SAEON newsletters
- CWRR Research on Tap Webinar
- International/national conferences

## Siyabonga!

Thank you!