



**Research
Program on
Water, Land and
Ecosystems**



**GEOLOGICAL SURVEY
OF DENMARK AND GREENLAND**



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Department:
Water and Sanitation
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CAPRICORN
DISTRICT MUNICIPALITY

EKOSOURCE

1st Multi-Stakeholder Workshop Establishment of Citizen Science

Enhancing Sustainable Groundwater Use in South Africa - ESGUSA



Bolivia Lodge

Polokwane, South Africa

07 – 08 March 2019

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ABBREVIATIONS

APP	Application
COA	Certificate of Attendance
CREW	Custodian of Rare and Endangered Wildflowers\
CS	Citizen Science
CSIR	Council for Scientific and Industrial Research
DWS	Department of Water Affairs and Sanitation
ESGUSA	Enhancing Sustainable Groundwater Use in South Africa
ESKOM	Electricity Supply Commission
GEUS	Geological Survey of Denmark and Greenland
GRIP	Groundwater Resource Information Project
IWMI	International Water Management Institute
NGA	National Groundwater Archive
NGO	Non-Governmental Organisation
NGS	National Groundwater Strategy
RSA	Republic of South Africa
SANBI	South Africa National Biodiversity Institute
SANSA	South Africa National Space Agency
SSC	Strategic Sector Cooperation
UWC	University of the Western. Cape
WP	Work Package
WSA	Water Service Authority

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BACKGROUND

The 1st Multi-Stakeholder Workshop serves to enhance stakeholder collaboration around groundwater and surface water management within and around Hout River Catchment in Limpopo (Figure 1). The ESGUSA project is a Danish-funded research project led by the University of Copenhagen in Denmark together with the University of the Western Cape in South Africa, and IWMI-SA (International Water Management Institute)–South Africa. Other partners include the Geological Survey of Denmark and Greenland (GEUS), EkoSource-South Africa and the Department of Water and Sanitation (DWS) - South Africa. The project will run for two years (-starting April, 2018) and address the knowledge gaps of aquifer systems, their replenishment and interactions with rivers, wetlands, terrestrial systems and the management of potential adverse impacts of climate change and increasing population, with the involvement of the local community through Citizen Science. The project seeks to support several sustainable development goals, and particularly “Clean Water and Sanitation”, and contribute to integrated participatory water management in the Hout Catchment.

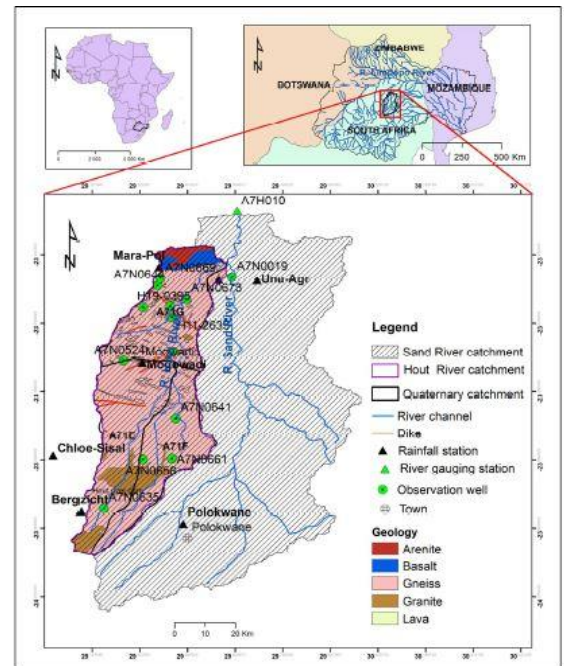


Figure 1: Map of Hout River Catchment in the larger Sand River Basin

PROJECT AND WORKSHOP OBJECTIVES

The objectives of the project are to:

1. Support sustainable groundwater management in South Africa through effective research partnership with Denmark
2. Improve understanding of hydrogeological processes in typical geological settings in South Africa
3. Develop and calibrate integrated hydrological model(s) for the Hout/Sand catchment, Limpopo Province
4. Involve local stakeholders in the research (citizen science)

5. Define sustainable groundwater management schemes based on resource indicators
6. Increase the research and human capacity for groundwater resource assessment and management in South Africa

The objectives of the 1st Multi- Stakeholder Workshop are to:

1. Present the ESGUSA project and its aim to understand water resources and improve water management in the Hout River Catchment
2. Bring stakeholders together around water management in the Hout Catchment for consultation and participatory approaches (Citizen Science)
3. Share and discuss stakeholder knowledge and concerns around water in the catchment
4. Understand current monitoring of water resources in the catchment and gaps
5. Identify scope for citizen science and work out practical approaches to involvement of stakeholders in water monitoring

SECTION ONE

DAY 1 • Thursday 07 March 2019

1.1 Target audience

The target audience of the first stakeholder workshop were grassroots participants from the Hout Catchment (see appendix one), Department of Water Affairs and Sanitation officials (DWS), Department of Agriculture and the private sector.

1.2 Presenters and facilitators

The presenters are listed in the programme attached (see appendix two).

1.3 Topics covered

The topics covered on Thursday 7th March were:

- Project background and objectives
- Overview of catchment resources

- Water resources and monitoring
 - Stakeholder knowledge and concerns around water in the Hout Catchment;
 - Existing data and information sharing platforms among stakeholders
 - Groundwater use, domestic water supply and local water management in Hout Catchment
 - Opportunities and Challenges for Better Water Management in Hout Catchment

Citizen Science was the focus of Friday 8th March and the topics covered were:

- Introduction to concepts, definitions and approach to Citizen Science
- Monitoring equipment and data sharing tools
- Proposal for monitoring
- Citizen Science practical involvement
- Idea of volunteers and selection of volunteers

1.4 Programme approach

The programme was developed in an interactive way with discussions, panel sessions and three interactive participatory exercises

- River of life – including emoticon exercise
- Actor network mapping
- Mapping and identification of hydrological ‘hot spots’ in the catchment

1.5 Participants profile

In total there were forty stakeholders who attended the workshop. Of these ten stakeholders were from DWS, one was from Dept of Agriculture and Forestry, two were from local municipalities, two were residents of Dendron, five were residents of Mamadila, five were residents of Moletjie, one was a resident of Ramkgaphola, five were from the private sector and the remaining nine participants were part of the project team.

1.7 Outputs

- Workshop report
- Baseline questionnaire
- Workshop evaluation sheet
- Mapping and identification of known and ‘unknown’ boreholes
- Actor network mapping
- Identification of involved stakeholders
 - Missing stakeholders
 - Levels of engagement of stakeholders
 - Importance of roles and responsibilities

All presentations, exercises and photos from the workshop are available at the project website

https://cgia-my.sharepoint.com/:f:/g/personal/iwmisa-helpdesk_cgia_org/EtWi-80JanNDitKEJqha8jkBY1YhleNEv-f0LRZBmcTYMg?e=3i4Fo3.

The workshop report will be emailed to all participants and a Certificate of Attendance (COA) will be handed to each participants as a hard copy

SECTION 2

DAY 1 • Presentations and discussions

2.1 Introduction and Current Knowledge of Hydrogeology of the Hout Catchment (Karen Vilholth, IWMI)

2.1.1 Target audience

The Catchment is part of the Limpopo River Basin and the main landmarks are the Hout River Dam, Dendron and Mogwadi. The Hout River is a tributary to the Sand. The river flow is ephemeral or from discharges – when rivers are flowing in dry season its being fed by discharge (e.g. waste water).

2.1.2 Dikes

Dikes are important geological features and they are used to target drilling for successful boreholes. They function either as a barrier to groundwater flow, perpendicular to them, or they can facilitate flow alongside them. When a dike crosses a river it can influence the water flow.

2.1.3 General information on catchment

We know about the subsurface from drilling which gives us detailed information about groundwater and tells us about the geology. The biggest user is irrigation by commercial farmers who typically pump groundwater into small dams before using it for irrigation. Irrigation creates labour and livelihoods for small and large farmers and farm workers. Small scale irrigation is also practiced by farmers, mostly for vegetable crops. Irrigation is by a central pivot systems in the central part of the catchment while in the north and south, rainfed agriculture, or small-scale irrigation is more common. Livestock is a significant water user. Domestic use is also important (but of less extent in terms of volume). Water is obtained from the Hout Dam and from household and community supply schemes based on groundwater.

The river flow is intermittent. There are also issues with contamination and with water infrastructure.

2.1.4 Recharge

It is important to understanding groundwater recharge which is defined as a process of adding water to the saturated zone. There are number of methods used to measure recharge. There is a recharge zone and a discharge zone. Recharge is in the higher area where there are mountains. The volume of water increases in the river as it goes downstream. Even if it doesn't rain in the Hout River there might still be water in an

area further away. Recharge is an uncertain component. There are three aspects to note:

- Diffuse recharge
- Focussed recharge
- Preferential recharge
- Managed recharge
- Recharge, which varies in space and time as groundwater is replenished on an irregular basis

2.1.5 Main Concerns

There is contamination of water from agri-chemicals, poor sanitation and salinity naturally occurring in deeper groundwater. Alien vegetation is also a problem as it produces nitrates and blocks the flow of water. Over a period of several years there is climate variability. Water infrastructure can also be a problem as it is often only partially operational or poorly maintained. Over several years there is significant variability in rainfall, which affects recharge and groundwater storage. Groundwater storage can decline over an extended number of years with limited rainfall and then renounce in years of extreme rainfall. Rainfall occurs every year but there is not always the annual recharge which occurs only if there is flooding or extreme rainfall.

2.1.6 Emerging challenges and knowledge gaps

- Indigenous knowledge is important and needs to be integrated into the project
- How can we collectively monitor groundwater?
- How can we share data for management?
- How can we get accurate population figures at the community level?
- Need to involve WSA's (Capricorn is involved but must bring Polokwane Municipality on board – they were invited but did not come)
- Engage with Venda University as they engage with water resources management and some aspects of ground water

- Possible involvement with Venda University by inviting a student to choose CS as their topic of research provided that the student has his/her own funding
- Should the Limpopo groundwater monitoring network be monitored by both government and citizens (CS)?
- Critical to know where the boreholes are because groundwater availability is measured through boreholes
- How can we collectively monitor the water resources, in particular groundwater?
- In what way will shared data improve the management of the water resources?

2.2 ESGUSA Project: vision, objectives and timeframe (Prof Karsten Jensen, University of Copenhagen)

2.2.1 Project background

The ESGUSA is funded by DANIDA to the value of DKK 5 million. It is administered by the DANIDA Fellowship Center. There are close relationships with the Strategic Sector Cooperation (SSC) programme between South Africa and Denmark. The life cycle of the project is 1st April 2018 to 30th September 2020. As this is a pilot project there is also, potentially, an opportunity for an extension and eligibility for future funding.

2.2.2 Project motivation

The fact that groundwater is increasing in use in the RSA is significant. Groundwater is generally better protected than surface water and normally has year-round availability. It is a resource that is vulnerable to exploitation, depletion and degradation. Sustainable use of groundwater requires knowledge of aquifer settings, recharge, interaction with river systems, impacts of human interactions and options for mitigation of adverse effects.

2.2.3 Project objectives

- Establish research partnerships between RSA and Denmark

- Improve the understanding of hydrogeological conditions in typical geological settings and farming communities in RSA, exemplified by the Hout/Sand river catchment in Limpopo Province
- Develop modelling and resource indicator tools for integrated groundwater management
- Promote stakeholder involvement in development and promotion of sustainable groundwater management options
- Increase the research capacity in RSA within integrated groundwater resource assessment and management

2.2.4 Project components

- WP4: Development of integrated groundwater management options for present and future climate conditions
- WP5: Capacity strengthening: postdocs and national/local stakeholders

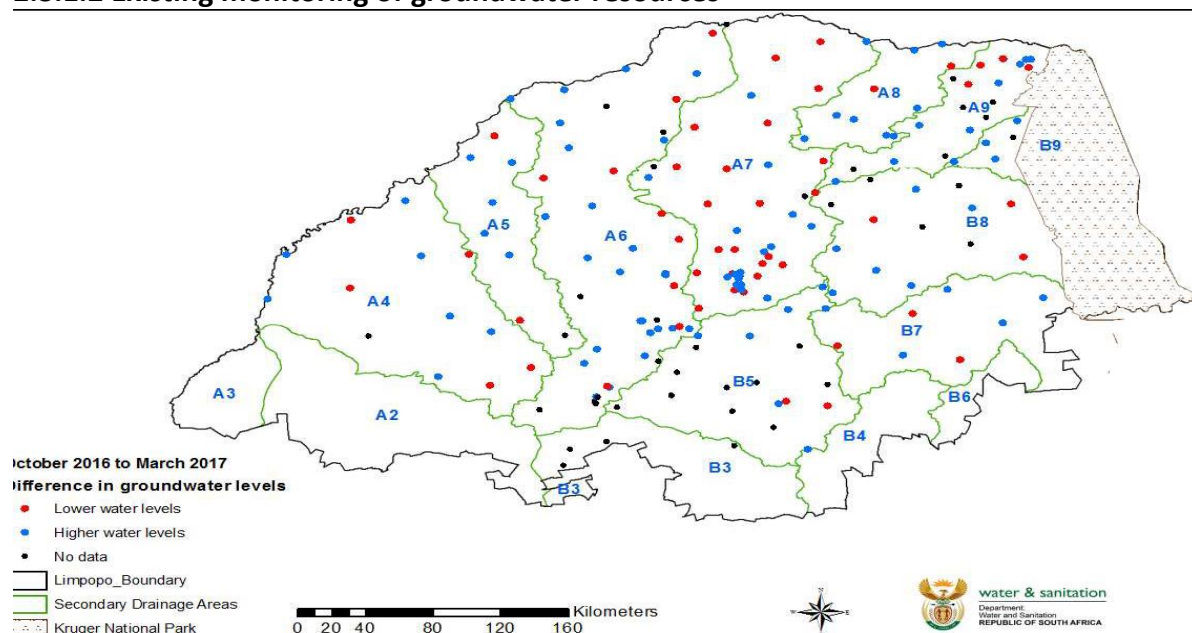
2.3 Introduction to surface water – groundwater overview and existing monitoring (Dr Thokozani Kanyerere, UWC and Piet Tshelane, DWS)

2.3.1 General introduction

2.3.1.1 Surface water and groundwater overview

- In Limpopo, surface water resources are expected to exist mainly in rivers, wetlands and dams and the major source for such water remain rainfall which is on decline
- The rivers in the study area (Sand and Hout) are non-perennial river system which do not flow throughout the year and in some years they do not flow
- In such environment, groundwater resource becomes fundamental resource
- Groundwater exists in aquifers. Therefore understanding aquifer systems in the area together with the geological conditions where such water resides is essential.
- Groundwater is better understood through boreholes and springs. Therefore monitoring the levels and quality of groundwater remains critical in the area

2.3.1.2 Existing monitoring of groundwater resources



- The map shows levels of groundwater in the area where some boreholes show low water levels while other show boreholes with high water level and yet some boreholes show no data. Such overview suggest the need to explore ways of ensuring that all data are captured, hence the need to involve the citizens in collecting such scientific information.

2.3.2 Current status of groundwater resources

- Deep groundwater levels occur in an area from A7Buysdorp towards the south and south east, hence the need for having a collaborative monitoring of the resource
- The deep levels are related to abstraction thereby placing stress on the aquifer.

- The groundwater levels at two of seven monitoring stations kept on declining since September 2012. There is a need to establish the causal effect for intervention
- The date for decline of deep water levels in the area is not known but it did not deteriorate over the past 7 years at A7Buysdorp (since 2011).
- Seasonal fluctuations in groundwater levels are virtually absent over the monitoring period suggesting that recharge only occurs at high rainfall incidents. Such incident seems only to have occurred in January 2015 since monitoring started.
- The area would need one or a succession of exceptionally high rainfall seasons with high precipitation incidents for good recharge to occur.
- Rainfall up to January 2018 was low and the season would probably not contribute to recharge.
- The importance of understanding groundwater recharge mechanisms and the role of groundwater recharge for improving water level for utilization. Hence, water level monitoring remains a crucial for sustainable utilisation of water resource

2.3.3 Emerging challenges and knowledge gaps

- Shortage of monitoring staff
- Borehole vandalism
- Lack of aquifer tests in DWS boreholes
- Shortage of instrumentation for replacements and installation
- Field data collection in harsh weather conditions which include heavy rains and flooding, high grasses and bushes remain a challenge to get the required data

2.4 Catchment mapping exercise (Karen Vilholth)

2.4.1 Introduction to interactive mapping

This is an interactive exercise where each group was given a laminated A1 page depicting the catchment area. The purpose was to 'fill' in landmarks/features on the map using different colours

- Dam/pond (blue)

- Significant smallholder irrigation with GW (green)
- Wells running dry temporarily (red)
- Contamination source (black)
- Water transfer scheme (purple)
- River stretch - running every year (gold)
- River stretch - always dry (orange)
- River stretch - running dry most years (yellow)
- Homestead – place where participant is domiciled (pink – with no on sticker)



Maps with stickers identifying key features of catchment

2.4.2 Emerging challenges and knowledge gaps

- Municipal boundaries and catchment boundaries don't always match
- Area divided into broad zones: different land uses impact on groundwater
- In 2001 groundwater resources in area were examined

- Important to reference information that is existing already
- Groundwater assessment evaluated the recharge and different uses

2.5 Water resources and monitoring: stakeholder knowledge and concerns around water in the Hout River Catchment, existing data and information sharing platforms among stakeholders (Piet Tshelane DWS, Walter Mathidi African Farmers Association, Kwena Victor Mashiane Local Farmer, LD Makwela Sand Catchment Management Forum)

2.5.1 General overview

In the catchment the recharge is less than use which means that boreholes are over utilized. Since the 1950's the water table has dropped because of agricultural use around Dendron (heavy irrigation and commercial farmer activity). Polokwane Municipality have developed a Groundwater Master Plan and all existing boreholes have been identified. The municipalities have divided the area into water supply zones but the catchment boundaries don't match water supply zones. Furthermore, existing borehole yields are not known. There is a mismatch as water supply inquiry shows that there should be enough water for the communities but in fact the communities suffer water shortages

2.5.2 Borehole management

There has been extensive development for villages around Molete South at the top of the catchment. There is existing data on population size and estimated demand up to 2045 at a given water supply zone level. However more boreholes have been developed than what the resource can supply. It is critical to understand that in instances where there is a borehole in a village that does not work, the response should not be to drill another borehole. Rather those that are not functioning need to be rehabilitated. Boreholes have also in certain instances been drilled in clusters in close proximity but they should not be all pumped.

2.5.3 Licensing

The current status allows for a drilling operator to drill ad borehole on a private farm but these boreholes are not always registered. Although there is a licensing system information on quality and quantity of water use is not being systematically captured and in cases where it is being captured it is not always done scientifically and in a uniform manner. The National Water Act (NWA) stipulates that schedule one (individual use) does not require licensing - other users need general authorization and water use licenses.

2.5.4 Data management

DWS does have guidelines on how to develop groundwater resources and stipulates that records must be kept but the big issue is that records are not being kept and that there is a lack of data on quality and quantity to evaluate the state of the aquifer. It would not be too difficult to produce simple graphs depicting what is happening with the water level and how much water is being pumped if this data were available. This would mean that a crisis could be anticipated in advance – and a contingency plan made to cope with the impending crisis. The GRIP project captured data that have been lost.

2.5.5 Emerging challenges and knowledge gaps

- Get DWS guidelines on groundwater maintenance and development
- Ascertain where GRIP data is accessible and in what format

2.6 Ground water use, domestic water supply and local water management in the Hout River Catchment (Mr MW Kganyago, Polokwane Municipality, Mr Aubrey Miyahbu, Capricorn Municipality)

2.6.1 General overview

There are approximately 40 settlements in the catchment and there are two municipalities – Capricorn and Vhembe. The Hout River Scheme is divided into two

areas. The issue of licensing has become important to farmers as they do not qualify for a loan without it. To obtain a license the farmer needs to undergo a test but small-scale farmers – who might have only 1 or 2 hectares of land, are unable to pay for the test. These presenters confirmed that the abstraction of water is not being measured and that there is no equipment available to do this measuring. The depth of the boreholes varies but the information on this is not being captured.

2.6.2 Contamination and protection of boreholes

Water quality – due to pollution – is a challenge. Some farmer have pigs for instance and the waste seeps into the groundwater. The presenters stressed the importance of promoting a culture of recycling to avoid plastics and waste that affects the water quality and its flow.

Boreholes should not be tampered with and the vandalism of boreholes is a concern for DWS. Instrumentation are assets of the DWS but a data logger can cost about 8 000 rand.

The Sand River Catchment River Agency has a role which is to empower citizens by providing knowledge and skills. It also has a role of intermediary between DWS and water users in the catchment. For the purpose of this project, the Sand River is of interest but it lies beyond the boundaries of the project. It's a river that is full of water and does not run dry. Even if the water is not visible there is a lot of water under the surface. Commercial farming interrupts the flow of the river. Water from the Dam is currently pumped into two reservoirs. ESKOM supplied a smaller plant than is needed for the treatment works so pumping is operating at a lower capacity than it should. DWS and ESKOM have had bilateral meetings to address challenges that arise – for instance water flows that are restricted because water treatment plants are not able to supply enough water and there is more than a 50% deficit with a mismatch between supply and demand.

Two hundred and twenty nine boreholes have been refurbished to augment water supply around the treatment works. However, water coming from the treatment plant is polluted. If there is reduced output from a borehole it could mean that the pipes underground are leaking. In instances where there is population growth – it is important to drill away from the village so that the borehole is able to supply several villages

2.6.3 Emerging challenges and knowledge gaps

- Data is not being shared within DWS
- It is important to know what power is necessary – if twice the amount of power that is required is used the pump would have a shorter lifespan
- Follow protocol of licensing and of monitoring
- If volunteers are to be collecting data they need to be carefully introduced to people in the area so that everyone is clear about their role and when and why they are measuring data at a particular site
- For a person to drill deeper than 80 meters a special license is required
- The borehole is owned by DWS (and not by the individual – even if an individual has drilled it)
- Placement of a borehole depends on the hydrogeological conditions – a pump test cannot be taken on its own as it needs to fit into the ground water system as a whole
- Is there information sharing between upstream and downstream farmers?
- Who do you go to if you have water concerns in the village?
- What incentive would a farmer have to collect data?
- Why should data be collected?
- An individual is likely to ask a very logical question: what is there in it for me?
- Who should collect the data?

2.7 Stakeholder engagement activity (Jaqui Goldin, UWC): River of Life and Emoticon Exercise

2.7.1 Introduction to River of Life

The River of Life is a personal reflection tool. Participants were given 15 minutes to draw their river on an A3 sheet of paper provided. They were invited to think about their life as a river – meandering up to this workshop event. Participants were encouraged to consider the metaphor in the fullest possible way – considering their life with off shoots, rapids, waterfalls or still time in ponds etc. The meandering river might have flowed to this particular point – where they find themselves at the workshop

Key questions to consider when depicting their river include:

- What different streams and tributaries helped you get here?
- Consider fast moving (easy) times in your life
- Consider challenging times (indicated by rocks or stones in the river)
- What are the stumbling blocks and what are the facilitating moments?
- What emotions come to the fore when thinking about different stages or events that shape your river (fear, anger, hope, pride)?



Pic one: participant presenting her River of Life – showing emoticons, streams, hurdles and flow of river

2.7.2 Key challenges and knowledge gaps

- How does this exercise feel for you?
- Where did your journey start?
- Where would you like it to lead?
- How did you feel doing this exercise?
- What emotions came to the fore?
- What have you learnt from other River of Life stories presented by participants today?
- Would you consider using the River of Life exercise with people you work with as an ice breaker or to learn more about a particular event or process?

SECTION 3

DAY 2 • Presentations and discussions

3.1 Actor Network Mapping (Karen Vilholth)

Participants were invited to engage in an interactive exercise of actor networking mapping in the Hout Catchment. The idea of the mapping exercise is to identify key stakeholders and their role in the catchment. Some decisions are taking outside of the catchment – these stakeholders need to be identified even if they are not in the catchment as they influence decision that affect the catchment. The lower axis – on the map (see pic below) shows stakeholders who have less influence than those who are placed higher up on the map.

3.1.1 Key actors

Key actors in groundwater management include:

- Government
- Private sector
- Civil society/NGOs
- Technical
- Donors
- Other (specify who they area)

The map shows how actors are linked and how strongly they can influence policy making agenda and decisions around groundwater. Coloured sticky papers were places higher or lower on the page to indicate the level of importance in decision making and management of groundwater

- Yellow: very important
- Orange: somewhat important
- Pink: not very important
- Purple: stakeholders not present or considered in management



Pic two: actor networks

3.2 Citizen Science (Jaqui Goldin and Resego Mokomela)

3.2.1 Defining Citizen Science (CS)

- CS is not science about citizens and it is not a science that takes place in a laboratory. It is **real** science done by everyday people who observe, question, plan, analyze and communicate. CS is about creating, planning, connecting and collaborating with experts. A CS is anybody who voluntarily contributes his or her time and resources toward scientific research in partnership with professional scientists

3.2.2 Importance of CS

Research programs benefit from working with volunteers. CS programs work to incorporate observations and the everyday lives and experiences of citizens. Citizen scientists can provide important real site specific context and observations and

contribute meaningfully to research programs. CS projects have a genuine science outcome. CS can inform conservation action, management decision, environmental policy etc.

3.2.3 Reliability and CS

Accuracy of observations and data from individual volunteers varies depending on task difficulty and citizen experience. CS results in co-creating technology, knowledge and empowerment for and by concerned communities. Datasets produced by volunteers can be as reliable as those produced by professionals. Most types of bias found in CS datasets are also found in professionally produced datasets

3.2.4 Status of CS

Currently there are more than 1500 active and searchable projects globally and these have been listed on SciStarter which is a website where all known CS projects are captured. SciStarter monitors active and non-complete projects. Currently there are more than 1500 CS projects globally that are registered and are active. From these 1500 projects about 200 are CS projects that are practiced in Africa. There is no exact number of recorded CS projects in RSA, but many projects are being implemented through:

- CSIR- Council for Scientific and Industrial Research
- SANSA- S.A National Space Agency
- SANBI- S.A National Biodiversity Institute
- CREW- Custodian of Rare and Endangered Wildflowers
- iNaturalist
- rePhotoSA
- Cape Citizen Science

3.2.5 Using CS

CS is used to monitor biodiversity, ecology and hydrology

- Wetlands

- Deforestation
- Types of plants
- Types of birds
- Groundwater levels
- Rainfall
- Dams
- Wildlife and insects

3.2.6 Hydrology and CS

For CS on hydrology, volunteers are trained on how to install and use different hydrological instruments. Measuring instruments include:

- Rain gauges
- Deep meter (to measure groundwater levels)
- Map readings
- Flow gauges to measure river flow
- Water sampling and testing equipment, etc

3.2.7 Significance of CS

Volunteers are trained on operating mobile apps to capture, store and share observations weekly/ monthly/yearly depending on the project demand. This creates a relationship between scientists, farmers and local citizens. In so doing boundaries are broken through the sharing of data from privately owned land

CS provides a tool for scientific education and capacity building. Skills are taught to achieve accurate data collection, critical thinking and scientifically informed decision-making thus providing many scientific eyes for research and decision making. Locals are empowered to respond to ground level challenges such as water contamination and in the process they develop a sense of ownership of their resources. This increases environmental democracy (sharing of information) whilst at the same time it can provide an early warning/detection system. The involvement of citizens at the

grassroots makes it more possible to check for failure in water supply infrastructure. Other advantages are that theft and vandalism to monitoring equipment can be reduced. In the long run proactive changes to policy and legislation are supported because new data is made available.

3.2.8 Motivating for CS and Groundwater Monitoring

CS is significant as citizens are able to learn more about the climate and water flows and storages above and below ground. Citizens can learn more about whether or not they are safe in terms of water contamination and can acquire knowledge about whether or not there is enough water and/or whether it is diminishing over a period of time. Such knowledge allows for better planning

Knowledge also means that mitigating measures can be taken – e.g. changing crops, using more mulch, sharing water from functioning wells, etc.

The data can be depicted in simple graphs plotted over a period to better follow the annual and seasonal changes that occur in a given area.

3.2.9 Emerging challenges and knowledge gaps

- What is it as a CS that you would like to know?
- Why would you like to know it?
- Would you share already captured data with others?
- How do you collect what you need?
- How often do you collect it
- Are there enough boreholes in your ward?
- Do people know where the boreholes are?
- Are the boreholes in good condition?
- How can a volunteer get more involved?
- Do I want to get more involved?
- Who (from a broad range of catchment stakeholders) wishes or requires to be informed about groundwater?

- What types of information is needed?
- What is the purpose (use) of that information?
- What format should information be provided in to meet various purposes?
- How accurate must the information be?
- How quickly do stakeholders require the information?

3.3 Monitoring equipment and data sharing tools (Manuel Magombeyi)

3.3.1 Significance of groundwater

Seventy five percent of communities in Limpopo rely on groundwater (griplimpopo.co.za). The Hout River Catchment is one of the most agriculturally productive regions in Limpopo - mostly supplied by groundwater

South Africa has a national network of monitoring boreholes and a national groundwater database (National Groundwater Archive: NGA). See DWA website for documents of interest to this project: <http://www.dwa.gov.za/Groundwater/Documents.aspx>

Platforms for data include:

- The NIWIS database which is found in DWS website under the projects and program tab.
- The NGA , which can be searched directly as "DWS NGA" (requires sign in and name of the borehole)
- The groundwater strategy can be retrieved from google

The National Groundwater Strategy (NGS) reported a need for more monitoring sites for resource assessments (the availability and abstraction potential of groundwater) at quaternary catchment scale. It also stressed the need for a culture of individuals who monitor groundwater. Regular and systematic monitoring of groundwater resources is necessary for its effective management to support the water needs for environment and socio-economic development. Importantly, as groundwater is an 'invisible' asset the one way to make it more visible is to monitor. Groundwater monitoring is a formal process of regularly collecting groundwater data in space and

time to do analysis and evaluation of one or more elements of the groundwater resource for (a) specific objective(s)

3.3.2 Location for monitoring

Locations are selected in relation to:

- Geology
- Land use
- Water user
- Chemical use
- Proximity to sewer lines
- Farming activities or other potential pollution source

3.3.3 Variables to be monitored

The variables that can be monitored include:

- Groundwater levels
- Water quality (e.g. turbidity, pH, alkalinity, conductance, total and faecal coliforms, nutrients)
- Rainfall - daily
- Water abstraction – typically measured by flow meters

3.3.4 Frequency of monitoring

The frequency of monitoring varies as follows:

- Water levels can be monitored weekly or monthly.
- Water quality (turbidity, pH, alkalinity, conductance, total and faecal coliforms, and nutrients) - monthly
- Rainfall
- Water pumping or rate of pumping and time of pumping per irrigation period (daily)

The analysis of monitoring data that is collected during a given time period can help decide whether to increase or decrease frequency of sampling of wells. The bi-annual frequency of sampling is sufficient for the deep subsurface but not for the shallow subsurface, which is influenced by seasonal variations

3.3.5 Data storage

Data should be systematically stored for future use however there are many cases of monitoring data being lost. Cloud-based and web-based methods are now used for storing and sharing data

3.3.6 Hurdles in monitoring

There are reasons for not monitoring – or inadequate monitoring and these include:

- No culture or interest in tracking and knowing the groundwater level
- Keeping within pump test limits is assumed to be enough
- Boreholes not automatically equipped with a monitoring device as standard
- Boreholes do not have an inspection hole in the borehole cap, which would allow for the use of a dip meter
- No requirement for an inspection hole
- Equipment may be simple (as in the case of the dip meter), but is not readily available on the market
- No statutory requirement to monitor and record borehole water levels
- Knowledge and capacity to monitor is low

With respect to the size of groundwater monitoring networks they can be either large ‘regional’ (sub-national) networks which are designed to characterise and monitor regional groundwater systems of large extent or they can be small ‘local’ networks. Here the focus is on detailed observations of the local groundwater situation (well fields or point sources from landfills or industrial sites)

3.3.7 Types of monitoring

There are various types of monitoring:

- Routine (to establish a culture of monitoring where the water level of every borehole is measured and recorded on a regular basis)
- Strategic (where there is a certain risk of overexploitation or contamination)
- Operation and maintenance (typically a wellfield for public water supply)
 - Monitoring of water levels
 - Monitoring of water quality
 - Monitoring of pumping rates
 - Monitoring of electricity consumption
 - Monitoring of water demand

3.3.8 Considerations when monitoring

All monitoring efforts need to be prioritised but no existing monitoring programme provides the data needed for all actual or potential issues related to groundwater management and protection. Low available budgets are major constraints. There needs to be a balance between the value of data collected, labour and costs involved in collecting.

3.3.9 Apps to use for monitoring

MyWell App is a Smartphone and SMS app for tracking water data on well, rainfall and checking dam readings by volunteers. This app was developed in Australia and has been successfully (happy farmers) applied in India to 410 wells in 25 villages. There is a possibility of piloting MyWell App in the catchment with slight modifications if required.

3.3.10 Monitoring equipment

Monitoring equipment includes:

- Model 101 Water Level Meter
- Manual rainfall gauge
- Global flow meter (rivers flow)

3.3.11 Emerging challenges and knowledge gaps

- Who wants to be informed?
- What types of information should be collected?
- What is the purpose of the information?
- How accurate should the information be?
- How often should the information be shared with the user?
- In what format does the user need info (sms, graph, excel spreadsheet)?
- Decide on four data variables that are important in the Hout Catchment

3.4A proposal for a monitoring approach for Hout (Resego Mekomela)

3.4.1 Overview

Is there in fact a need to monitor? If so, what are the gaps that need to be covered?

There are water shortages and these need to be analysed – what causes them? It is also important to decide what parameters are feasible to be measured by citizens?

3.4.2 Parameters to be measured

- Groundwater Level
- River flow
- Rainfall

3.4.3 Main concerns

There is a shortage of monitoring staff and a lack of testing in DWS of the aquifer.

There is also borehole vandalism. And theft and a shortage of instruments to measure.

3.4.4 Emerging challenges and knowledge gaps

- Can we identify people who live near boreholes – match volunteer with borehole
- Are the boreholes accessible for monitoring (open)
- Are the existing boreholes municipality boreholes, government or community boreholes
- Is there a difference in monitoring these different categories
- How often should monitoring take place
- Is there a possibility for joint monitoring – collaboration between DWS and volunteers
- Can the data be integrated with DWS

SECTION 4

Way forward

4.1.1 General

There has been a very positive response from citizens and a willingness of community – and DWS - to monitor boreholes and participate in the CS component of the project.

4.1.2 Volunteer profile

Seven volunteers came forward (3 male, 4 female) (see Annex 1 for list of volunteers). Innocent and Resego will liaise with DWS after the workshop. Both IWMI and DWS will train volunteers and provide them with instruments which IWMI will purchase in consultation with DWS

4.1.3 Opening gates

It is critical to 'open gates' in the correct way and get the right process going from the start. Resego and Innocent will liaise with local chiefs and solicit the green light from them regarding the CS project in general and the role of the volunteers in particular.

4.1.4 Steps forward

- Contract will be drawn up for volunteers
- Report to be sent to all participants
- Laminated certificates of attendance to be handed out to all participants
- Produce a map of all boreholes within the Hout catchment (government, community and private boreholes)
- Locate monitoring boreholes and wells using the catchment mapping exercise maps and match location site with place of abode of champions (volunteers) within close proximity to the boreholes
- Volunteers to receive approval from tribal authorities
- Provide volunteers with consent form delineating their tasks and equipment to use
- Ongoing liaison with Mr. Piet Tshelane (DWS) on a strategic way to incorporate volunteers in groundwater monitoring and assist DWS effectively where there is no monitoring or inadequate monitoring
- IWMI to produce/procure monitoring instruments and equip all volunteers for monitoring
- Check the proficiency of MyWell app, and how it can be incorporated in groundwater monitoring and capturing farm ponds
- Liaise with Mr. Piet Tshelane to finalise training program
- IWMI to provide rain gauges and other monitoring equipment to measure river flows, rainfall, dam levels , mapping of wells etc.
- The Hout catchment will be divided into three sections to cover upper (Section 1), middle (Section 2) and lower catchment (Section 3) 1) smallholder farmers 2) commercial farmers and 3) local communities and farmers

ANNEX 3: Workshop Program



1st Multi-Stakeholder Workshop Establishment of Citizen Science Enhancing Sustainable Groundwater Use in South Africa - ESGUSA



Bolivia Lodge
Polokwane, South Africa
07 – 08 March 2019

BACKGROUND

The 1st Multi-Stakeholder Workshop serves to enhance stakeholder collaboration around groundwater and surface water management within and around Hout River Catchment in Limpopo (Figure 1). The ESGUSA project is a Danish-funded research project led by the University of Copenhagen in Denmark together with the University of the Western Cape in South Africa, and IWMI-SA (International Water Management Institute)–South Africa. Other partners include the Geological Survey of Denmark and Greenland (GEUS), EkoSource-South Africa and the Department of Water and Sanitation (DWS) - South Africa. The project will run for two years (-starting April, 2018) and address the knowledge gaps of aquifer systems, their replenishment and interactions with rivers, wetlands, terrestrial systems and the management of potential adverse impacts of climate change and increasing population, with the involvement of the local community through Citizen Science. The project seeks to support several sustainable development goals, and particularly “Clean Water and Sanitation”, and contribute to integrated participatory water management in the Hout Catchment.

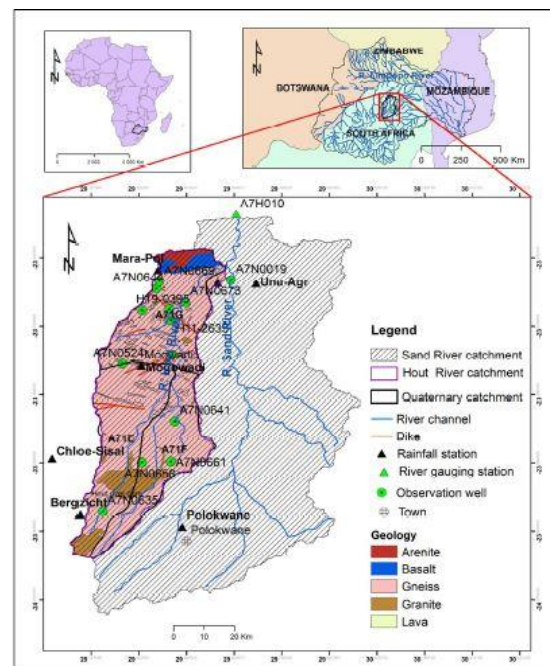


Figure 1: Map of Hout River Catchment in the larger Sand River Basin

OBJECTIVES

The objectives of the project are to:

7. Support sustainable groundwater management in South Africa through effective research partnership with Denmark
8. Improve understanding of hydrogeological processes in typical geological settings in South Africa
9. Develop and calibrate integrated hydrological model(s) for the Hout/Sand catchment, Limpopo Province
10. Involve local stakeholders in the research (citizen science)
11. Define sustainable groundwater management schemes based on resource indicators
12. Increase the research and human capacity for groundwater resource assessment and management in South Africa

The objectives of the 1st Multi- Stakeholder Workshop are to:

6. Present the ESGUSA project and its aim to understand water resources and improve water management in the Hout River Catchment
7. Bring stakeholders together around water management in the Hout Catchment for consultation and participatory approaches (Citizen Science)

8. Share and discuss stakeholder knowledge and concerns around water in the catchment
9. Understand current monitoring of water resources in the catchment and gaps
10. Identify scope for citizen science and work out practical approaches to involvement of stakeholders in water monitoring

DAY 1 • Thursday 07 March 2019

08:00-08:30	Registration
08:30-09:55	Opening of the Meeting (Moderator : Prof Jaqui Goldin)
08:30 – 09:00	Introductions and welcome remarks by Government of South Africa (Martha Komape, Department of Water and Sanitation, South Africa) and self-introduction by all participants
09:00 – 09:20	ESGUSA Project: Vision, objectives, and time frame (Prof Karsten Jensen, University of Copenhagen, Denmark)
09:20 – 09:40	Introduction and current knowledge of hydrogeology of the Hout Catchment (Dr Karen Villholth, IWMI)
09:40 – 09:55	Questions
09:55-10:15	Tea and coffee break
10:15-12:00	Overview of Catchment Water Resources (Moderator: Ntobeng Mello, DWS)
10:15 – 10: 45	Introduction to surface water-groundwater overview and existing monitoring (Dr Thokozani Kanyerere, University of the Western Cape)
10:45 – 11:20	Questionnaire on stakeholder catchment knowledge (facilitated by Jaqui Goldin)
11:20 – 11:50	Catchment mapping exercise (facilitated by Karen Villholth)
11:50 – 12:00	Discussion (facilitated by Karen Villholth and Jaqui Goldin)
12:00-13:00	Lunch
13:00-15:30	Synergies and Linkages (Moderator: Dr Manuel Magombeyi, IWMI)
13: 00 – 14:45	Water resources and monitoring: 1) Stakeholder knowledge and concerns around water in the Hout Catchment; 2) Existing data and information sharing platforms among stakeholders <ol style="list-style-type: none"> 1. Piet Tshelane, Department of Water and Sanitation 2. Walter Mathidi, African Farmers Association S.A, 3. Kwená Victor Mashiane, Local farmer 4. Solomon Monyepao, Dept. of Agriculture, Forestry and Fisheries 5. L.D. Makwela, Sand Catchment Management Forum 6. Carel Haupt, WSM Leshika Consulting
14:45 – 15:20	Groundwater use, domestic water supply and local water management in Hout Catchment: <ol style="list-style-type: none"> 1. M.W. Kganyago, Polokwane Municipality 2. Aubrey Miyambu, Capricorn Municipality

15:20 – 15:30	Discussion
15:30-15:40	Tea and coffee break
15:40-17:00	Opportunities and Challenges for Better Water Management in Hout Catchment (Moderator: Mr Chuene Letsatsi, Sand CMF)
15:40 – 16: 30	Breakout discussion: Stakeholder engagement activity (facilitated by Jaqui Goldin) <ul style="list-style-type: none"> • River of life • Emoticon exercise
16:30 – 17:00	Discussion

DAY 2 • Friday 08 March 2019

08:30-10:00	Monitoring Aspects (Moderator: Ms. Esther Moloto, Dendron)
08:30 – 09:45	Actor network mapping (facilitated by Karen Villholth, IWMI)
09:45 – 10:00	Discussion
10:00-10:15	Tea and coffee break
10:15-11.30	Citizen Science (Moderator: Ms Ledile Setati, Polokwane)
10:15 – 10:40	Introduction to Citizen Science (Resego Mokomela and Jaqui Goldin)
10:40 – 11:00	Monitoring equipment and data sharing tools, including cloud-based (Manuel Magombeyi)
11:00 – 11:20	A proposal for a monitoring approach for Hout Catchment (Resego Mokomela)
11:20 – 11:30	Discussion & Evaluation
11:30-12:30	Lunch
12:30-14:00	Citizen Science Practical Involvement (Moderator: Dr Thokozani Kanyerere, UWC)
12: 30 – 13:30	Moving forward with Citizen Science - next steps, roles, accountability, sustainability, (Jaqui Goldin, Karen Villholth, Manuel Magombeyi, Resego Mokomela) - Panel Session
13:30 – 13:40	Closing remarks
13:40 – 14:00	Instrumental demonstration and practice (Manuel Magombeyi and Resego Mokomela)
14:00	Departure

ANNEX 4: ESGUSA flyer



Enhancing Sustainable Groundwater Use in South Africa ESGUSA

Groundwater is an increasingly important source of water supply for agriculture, households, and industry. Generally, groundwater is naturally protected against pollution, can be exploited anywhere depending on the local conditions, and has a year-round availability. With population growth and increasing climate variability, groundwater plays an increasingly important role in the Republic of South Africa (RSA) to enhance water and food security. More than 50% of communities in RSA, especially living in the arid and semi-arid areas, depend on groundwater for their domestic and livelihood needs. However, with increasing pressure on groundwater and intensive land-use, the resource is vulnerable to depletion and degradation. This is compounded by limited capacity and inadequate resources allocated to its protection and sustainable management. Intensification of use and poor management potentially leads to adverse impacts on ecosystems, water access, human health, and agricultural production.

Managing groundwater resources for sustained and high-value uses requires knowledge of the aquifer systems, their replenishment and interactions with rivers, wetlands and terrestrial systems. It also requires knowledge of the human interaction with the resource, potential adverse impacts, e.g. from excessive abstraction or from poor agricultural or land-use practices.



Community locals taking groundwater for domestic use

Overall goal:

The overall objective of the project is to develop sustainable groundwater management in South Africa

Specific objectives:

To establish an effective research partnership with Denmark

To improve the understanding of hydrogeological conditions in typical geological settings and farming communities in South Africa, exemplified by the Hout/Sand river catchment in Limpopo Province

To develop modelling and resource indicator tools for integrated groundwater management

To involve stakeholders in development and promotion of sustainable groundwater management options

To increase the research capacity in South Africa within integrated groundwater resource assessment and management

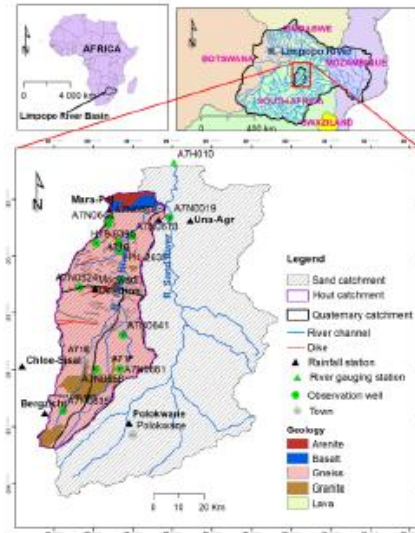
To contribute to Danida's Strategic Sector Cooperation program in South Africa

Funding:

Danish Ministry of Foreign Affairs - Danida

ESGUSA collaborating partners:

- University of Copenhagen, Denmark – project lead
- University of Western Cape, Cape Town, South Africa
- International Water Management Institute (IWMI), Pretoria, South Africa
- Ekosource, Johannesburg, South Africa
- Geological Survey of Denmark and Greenland, Copenhagen, Denmark
- Department of Water and Sanitation, Polokwane, South Africa
- Capricorn District Municipality, Polokwane, South Africa



Study Area:

The research is focusing on the Hout catchment (about 2500 km²), which is part of the Limpopo River Basin in South Africa. The study area will be expanded to the Sand catchment, to which Hout is a tributary, in order to better close the water balance using the only discharge station in the area, which is downstream of the confluence of the two rivers.

Project Coordinator

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Pumping groundwater for irrigation



Potato production in Hout

ANNEX 5: Evaluation Form Analysis

Establishment of Citizen Science - EVALUATION FORM – Polokwane 7 – 8 March

1) Rate the 2 day stakeholder workshop by ticking/circling one option below for each aspect

Please rate	1 = poor	3 = average	4= good	5 = excellent	
On-screen presentations	1	2	3	4	5
Speakers subject knowledge	1	2	3	4	5
Session length	1	2	3	4	5
Translation exercises	1	2	3	4	5
Speakers interaction with participants	1	2	3	4	5
Participants engagement with issues	1	2	3	4	5
Value of discussion sessions	1	2	3	4	5
Choice of venue (accessibility, comfort)	1	2	3	4	5
Overall session evaluation/were all your expectations met?	1	2	3	4	5
Would you recommend a stakeholder workshop such as this one others?	1	2	3	4	5

Please give any comments, suggestions on your experience of the workshop:

2) Any additional comments (e.g. what should be done differently next time?):

Questions	Total	Poor	Average	Good	excellent	Total
Q1	22	5%	14%	23%	59%	100%
Q2	23	0%	9%	26%	65%	100%
Q3	20	0%	20%	45%	35%	100%
Q4	22	5%	5%	68%	23%	100%
Q5	23	0%	0%	57%	43%	100%
Q6	23	0%	9%	57%	35%	100%
Q7	22	0%	9%	45%	45%	100%
Q8	23	0%	0%	35%	65%	100%
Q9	23	0%	9%	26%	65%	100%
Q10	22	0%	5%	23%	73%	100%

