WETLAND MANAGEMENT

Collaborating towards improved Earth observation for wetland monitoring

From satellite technology that enables Earth observation (EO) to muddy boots on the ground, South African scientists are joining forces with collaborators to improve the monitoring of South Africa's threatened wetlands. Through the National Research Foundation-funded EO4Wetlands project, researchers from different disciplines and institutions are combining cutting-edge monitoring technology with hands-on fieldwork to improve wetland monitoring with EO. Article by Dr Heidi van Deventer, Charl Broekman, Abri Broere, Thabiso Choshi, Jonathan Diederiks; Dr Piet-Louis Grundling; Dr Christel Hansen, Nancy Job, Eulalia Jordaan, Marijke Koopmans; Dr Jason le Roux, Hannes Marais, Joshua Meyer, Elijah Mogakabe, Rethabile Mothae; Dr Laven Naidoo, Luther Nthangeni, Regina Mabokachaba, Dr Grace Maponya, Dr Juan Scheun, Collin Silima, Prof Ed Stam, Tshifhiwa Thenga, Stanley Tshitwamulomoni, Natalie Vos, Michele Walters, and Scout Yatt.

We often hear that wetlands are highly threatened and poorly protected; however, few people have had the privilege of walking through the wetlands located in the metropolitan area of the City of Tshwane, South Africa. Realising their beauty and that they are highly functional and provide valuable ecosystem services builds an appreciation of their resilience to the onslaught of anthropogenic and climate change impacts. Accessing these wetlands with a diverse range of people who share a similar passion and keen interest, who exchange and share knowledge and information to optimise understanding, helps to sharpen the persistence and focus towards refined wetland monitoring, and ultimately greatly enhances this experience.

The National Research Foundation (NRF) funded a three-year project, 'Earth Observation for Wetlands' (EO4Wetlands), as part of its Earth Systems Science Research Programme (ESSRP) (project code ESS240507217738). The programme pursued collaboration among various institutions to ensure that science and research are shared, understood, and interactively developed, breaking down silos and the separation of people across institutions and disciplines.

The EO4Wetlands project enabled collaboration between geoinformation and environmental management scientists who focused on ecosystem mapping and monitoring, soil scientists and species experts, as well as local and traditional authorities, to improve the exchange of wetland monitoring in selected study areas. These included six study areas across three provinces: Colbyn Wetland and Rietvlei Dam nature reserves in Gauteng, De Berg and Verloren Vallei nature reserves in Mpumalanga, and Lake Fundudzi and the Mutale wetlands in Limpopo.

So much water emerging in a watershed?

What is fascinating about Rietvlei Dam Nature Reserve is that its southern boundary is about 13,6 km downstream from a major watershed between primary catchments. The main catchment feeding the reserve (known in technical terms as catchment A21A) is drained by two rivers, namely the 20 km-long Grootvlei River in the east and the 25 km-long Rietvlei River in the south. Both flow northwards into the 32 km-long Sesmylspruit, where Rietvlei Dam is located.

Groundwater from this catchment historically contributed up to 16% to the water supply for the City of Tshwane. These rivers converge with the Kaalspruit-Olifantspruit, 2,6 km downstream of the dam, to form the Hennops River, then the Crocodile River, which joins the Limpopo River, a cross-border river between South Africa and its neighbouring countries.

A variety of wetland types are evident so high up in this watershed catchment, of which many are permanently saturated (see Figure 1). Interesting to also note the 'pans' or depression wetlands right on the watershed, and springs emerging at such a high elevation. The contribution of interflow from aquifers

is therefore evident but has not yet been studied to assess its proportion of the contribution to surface wetlands and their ecosystem services. Not only do the wetlands provide habitat for plant and animal species, but they also slow water flow to reduce flooding and erosion, while promoting filtration and infiltration.

This article provides an overview of the collaborators and some of the trips undertaken to date at the Rietvlei Dam Nature Reserve and highlights the value of in-field exchange in complementing workplace and workshop discussions.

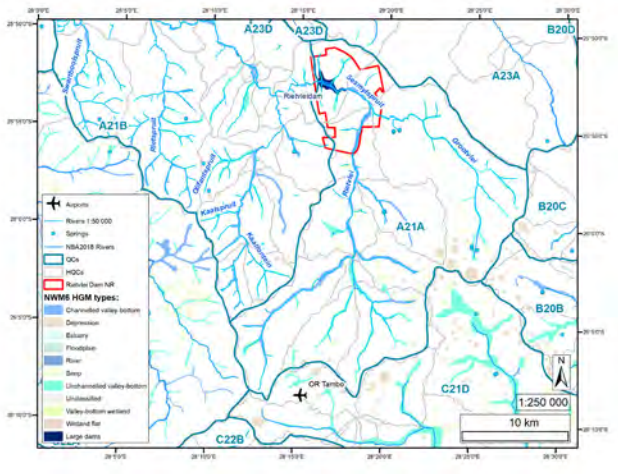


Figure 1: The location of the Rietvlei Dam Nature Reserve (NR) relative to the Hydrological Quinary Catchments (HQC; 5th level; Clark et al., 2024), with many springs and wetlands so high up on a watershed. NWM6 = National Wetland Map version 6 (SANBI, 2024); HGM = Hydrogeomorphic (types).

Beautiful nature in a metropole: Get your feet wet, up close and personal

While many visitors drive through Rietvlei Dam Nature Reserve, kayak on the dam, take a guided hike or have braai opportunities, very few people have had the chance to walk through these wetlands. What appears to many as just 'veld' in South African colloquial language, in fact, is marshland or 'vlei', with different species of sedges (mostly with edges) (see Figure 2).

On a closer walk-through, the differences in depth and species are evident. For example, one of the depressions is only 10 cm deep, as measured with a soil auger, compared to the upper parts of a valley-bottom wetland, reaching depths of 60 cm. The 32 km-long stretch of the Sesmylspruit is a channelled valley-bottom wetland, with patches of ***Phragmites australis*** reeds and homogeneous areas of ***Carex*** spp., likely the lesser pond sedge, which is about 1.5 m high.

Peat soil was historically extracted here, in the southern part of the wetland, before the reserve was declared. Subsequently, Working for Wetlands was officially launched in 2002 and did some of the first restoration along the spruit already in 2000, and vegetation has evidently re-established.

The beauty of the wetlands can be better appreciated when you get your feet wet, and by being able to walk to the ***Kniphofia*** (red-hot pokers or torch lilies) flowers, and to see orchids, and get the names of the species through the iNaturalist app, including flowers, orchids and dragonflies (Figure 3).



Figure 2: Palustrine marshlands at the Rietvlei Dam Nature Reserve between 2025 and 2026 show the variation in plant species ranging from sedges to reeds.



Figure 3: Species observed at Rietvlei Dam Nature Reserve in and close to wetlands: (a) Eulophia welwitschia *(banana orchid); (b)* Palpopleura jucunda *(Yellow-veined Widow) and c)* Habenaria epipactidea *(Epipactis-Like Habenaria or the Lightning Ghost Orchid.*

Collaboration and exchange optimise understanding and sharpen focus towards solutions

The NRF project has facilitated the exchange of information about possible EO methods for monitoring wetlands, with the

Rietvlei Dam Nature Reserve serving as a hub for interaction among people with diverse backgrounds, skills, knowledge, and contributions. In January 2025, participants of the NRF ESSRP EO4Wetlands project were joined by experts from the Department of Forestry, Fisheries and the Environment (DFFE), the Agricultural Research Council (ARC) and UNISA to scout for sites and plan complementarity of projects (Figure 4a).

Subsequently, even students from UNISA in wildlife management joined the outing, where the feasibility of soil moisture probes at sites was investigated based on Charl Broekman's PhD (Figure 4b). The installation of soil moisture probes (also formally called 'continuous logging soil moisture probes' or 'DFM capacitance probes') was facilitated by DFM Technologies in 2026, including Lawrence van der Westhuizen, Jeromeo Mento and Ndiyafhi Muthuhadini (Figure 4c).











Figure 4 - Outings to Rietvlei Dam Nature Reserve since January 2025:

a. Dr Christel Hansen (UP), Dr Michael van der Laan (ARC), Dr Piet-Louis Grundling (DFFE); Ms Michelle Hartslief (WeatherSA. UNISA); Dr Anna de Jager (UNISA), Dr Heidi van Deventer (CSIR, UP), Ms Renée Grundling (UP), and Dr Jason le Roux (ARC).

b. Charl Broekman (UP), Albert Durand (AIE), Dr Heidi van Deventer (CSIR, UP), Luther Nthangeni (CTMM), Ntokozo Shongwe (student at UNISA, Nature Conservation), and Nombuso Nkambule (student at UNISA, Nature Conservation).

c. Ndiyafhi Muthuhadini and Ditshego Maleka (DFM Technologies) installing moisture probes.

d. Charl Broekman illustrating the challenges of the chlorophyll and Leaf Area Index (LAI) meters to record physical values in the palustrine wetlands that are grazed and have little above-ground biomass of vegetation.

e. Ms Rethabile Mothae (TUT), Prof Ed Stam (UNIVEN), Mr Thabiso Choshi (UNIVEN), Ms Tsholofetso Seipone (VUT), Mr Luther Nthangeni (CTMM), Ms Lebohang Borole (VUT), DFM staff Mr, Mr Lesley Rambau (CTMM), Mr Jonathan Diederiks (NRF), Mr Lawrence van der Westhuizen (DFM Technologies).

To our knowledge, this is the first time that these probes are used in wetlands in the temperate climatic region and Grasslands Biome of the country, and the first time for establishing error estimation of various satellites for monitoring soil moisture in wetlands. These probes will play an important role in refining the extent and duration of the hydrological regime cycles, which are very poorly represented and monitored in global datasets.

Most of the collaborators and some of the stakeholders gathered on 21 August 2026, for the last installation of one of the soil moisture probes at the Rietvlei Dam Nature Reserve (Figure 4d). This site visit enabled everyone to share what they are working on and to show in the field the opportunities, challenges, and limitations. All collaborators and the stakeholders could then engage. This enriching experience enabled everyone to ensure cross-pollination of understanding, identify gaps for follow-up, and consider opportunities for improvement.

In addition, Dr Le Roux from the ARC is leading work to refine the classification and assessment of soil types in the wetlands of the study areas. Several students are also contributing to the refinement of EO monitoring of wetlands and rivers (UP team and students), wetlands in the Limpopo Province, which are montane and subtropical (UNIVEN team and students) and associations with faunal species such as Lepidoptera, macroinvertebrates, and amphibians in palustrine wetlands (TUT team and students).

The EO4Wetlands project demonstrates that monitoring and protecting South Africa's wetlands requires more than scientific knowledge and advanced technology; it requires people working together across disciplines, institutions and geographical boundaries. By combining satellite observations, soil moisture monitoring, ecological research and hands-on fieldwork, researchers are building a clearer picture of how wetlands function towards improved protection.

Please see the full list of collaboration participants and stakeholders in Table 1, and their contributions to the overall project aim.

Table 1: List of authors, contributors and stakeholders related to the NRF ESSRP project EO4Wetlands

Name	Position	Department, Organisation	NRF project relation
Dr Heidi van Deventer	Principal Researcher	Sustainable Ecosystems, Council for Scientific & Industrial Research (CSIR)	Project lead and supervisor to geomatics students
Mr Charl Broekman	PhD Student	University of Pretoria (UP); Department of Geography, Geoinformatics and Meteorology	PhD in Geoinformatics;'Refining earth observation methods for the monitoring of soil moisture of palustrine wetland
Mr Abri Broere	Master's student	BioPulse Research Group; Department of Nature Conservation; Tshwane University of Technology (TUT)	Master of Applied Science in Nature Conservation; Macroinvertebrate wetland associations
Mr Thabiso Choshi	PhD Student	University of Venda (UNIVEN): Department of Geography and Environmental Science	PhD in Environmental Sciences; 'Quantifying Vegetation Dynamics and Hydrological Functionality of the Mutale Wetland Using Multispectral and Hyperspectral Datasets'
Mr Jonathan Diederiks	Director: Strategic Science Missions (SSM), Thematic Research Support and Advancement	National Research Foundation (NRF)	Funding organisation
Dr Piet-Louis Grundling	Scientific support staff and Research Associate.	Department of Forestry, Fisheries and the Environment (DFFE) Centre for Environmental Management, University of the Free State	Collaborator
Dr Christel Hansen	Senior lecturer	UP	Collaborator, supervisor of geomatics students
Ms Nancy Job	Lead: Freshwater Biodiversity Programme	South African National Biodiversity Institute (SANBI)	National stakeholder
Ms Eulalia Jordaan	Ecological Technician	Mpumalanga Tourism and Parks Association (MTPA): Scientific Services, Ecological Systems	Provincial stakeholder
Ms Marijke Koopmans	Master's student	BioPulse Research Group; Department of Nature Conservation; Tshwane University of Technology (TUT)	Master of Applied Science in Nature Conservation; Lepidoptera communities across habitat types and altitudinal and seasonal gradients in a high-altitude ecosystem at De Berg Nature Reserve Mpumalanga, South Africa.

Name	Position	Department, Organisation	NRF project relation
Dr Jason le Roux	Researcher	Agricultural Research Council - Natural Resources and Engineering (ARC)	Soil calibration and interpretations, co-supervisor to Mr Broekman's PhD
Mr Hannes Marais	Wetland Ecologist	MTPA (retired)	Provincial collaborator
Mr Joshua Meyer	Honour's student	UP: Department of Geography, Geoinformatics and Meteorology	BSc Hons Geography and Environmental Science; An Assessment of DFM soil-moisture probe accuracy across contrasting soil types in Colbyn wetland, South Africa
Mr Elijah Mogakabe	Scientific Manager and Programme Manager	Department of Water and Sanitation (DWS)	National stakeholder
Ms Rethabile Mothae	Master's student	BioPulse Research Group; Department of Nature Conservation; Tshwane University of Technology (TUT)	Master of Applied Science in Nature Conservation; Environmental and seasonal patterns of amphibian communities in a pristine Ramsar wetland.
Dr Laven Naidoo	Senior Researcher	Gauteng City-Region Observatory (GCRO), a Partnership of the University of Johannesburg, the University of the Witwatersrand, Johannesburg, the Gauteng Provincial Government and Organised Local Government in Gauteng (SALGA), Johannesburg, South Africa.	Co-supervisor of Mr Broekman's PhD study and Ms Mabokachaba's MSc.
Mr Luther Nthangeni	Ecologist	City of Tshwane Metropolitan Municipality (CTMM)	Provincial stakeholder
Ms Regina Mabokachaba	Master's student	UP: Department of Geography, Geoinformatics and Meteorology	MSc Geoinformatics. Title: 'Comparing object-based and pixel-based approaches to quantify changes in palustrine wetlands for the Colbyn Wetland Nature Reserve'
Dr Grace Maponya	Lecturer	UNIVEN: Department of Geography and Environmental Science	Collaborator, Supervision of students working on remote sensing applications for wetland monitoring.
Dr Juan Scheun	Lecturer	BioPulse Research Group; Department of Nature Conservation; Tshwane University of Technology (TUT)	Collaborator, Supervision of students working on wetland faunal associations
Ms Collin Silima	ASD - Provincial Coordinator - Limpopo Assistant Director: Environmental Programmes Non-Infrastructure	DFFE	National stakeholder
Prof. Ed Stam	Associate Professor	UNIVEN: Department of Geography and Environmental Science	Collaborator, EO4Wetlands coordination and supervision of Mr Choshi
Mr Tshifhiwa Thenga	Functional Head: Nature Conservation Operations	CTMM	Provincial stakeholder
Mr Stanley Tshitwamolomoni	Director: Water Sources and Wetlands Conservation	DFFE	National stakeholder
Ms Natalie Vos	Functional Head Nature Conservation Operations | Rietvlei Nature Reserve	CTMM	Provincial stakeholder
Ms Michele Walters	Lecturer	BioPulse Research Group; Department of Nature Conservation; Tshwane University of Technology (TUT)	Collaborator, TUT EO4Wetlands coordination and supervision of students working on wetland faunal associations
Ms Scout Yatt	Honours Student	UP: Department of Geography, Geoinformatics and Meteorology	BscHons Geoinformatics. Title: 'Geomorphic characterisation of waterfalls in southern Africa using available geospatial datasets'