Wetland monitoring and assessment system for Transboundary Basins in Southern Africa (WeMAST)

Mashiyi N.N*.[1]; Kganyago M.L.[1]; Mapurisa W.[1], Marambanyika T.[2], Dube T.[3], Banda K.[4], Maango S.[5], Kenabatho P.[6], Hamukwaya P.[7], Helmschrot J.[7], Thompson S.[7], Matasane C.[8]

1. South African National Space Agency, 2. Midlands State University, 3. University of the Western Cape, 4. University of Zambia, 5.National Remote Sensing Centre of Zambia,6. University of Botswana, 7.SASSCAL, 8. Cape Peninsula University of Technology

Abstract

Wetlands in Southern Africa are highly productive and biologically diverse ecosystems that contribute significantly to livelihood and economic development. They are, however, undergoing significant pressure from both human activities and natural phenomena, including agriculture, land cover and land use change, human settlements, water harvesting, invasive species infestation, climate change and unsustainable development practices. The future of the wetlands is therefore dependent on effective wetland assessment and monitoring initiatives that can inform policy and decision making to promote sustainable development (Rebelo et al, 2018).

The WeMAST service is an integrated wetland assessment and monitoring system that will deliver actionable earth observation (EO) products to support wetland authorities for informing policy and to sustainably manage wetland ecosystem in four basins (Cuvelai, Limpopo, Okavango and Zambezi) in the SADC region. See *Figure 1*.

WeMAST will host and promote state-of-the-art satellite-based EO services and products to enhance inter-sectorial co-ordination and regional cooperation, increase capacity building, and will create an enabling technical, policy and institutional environment.

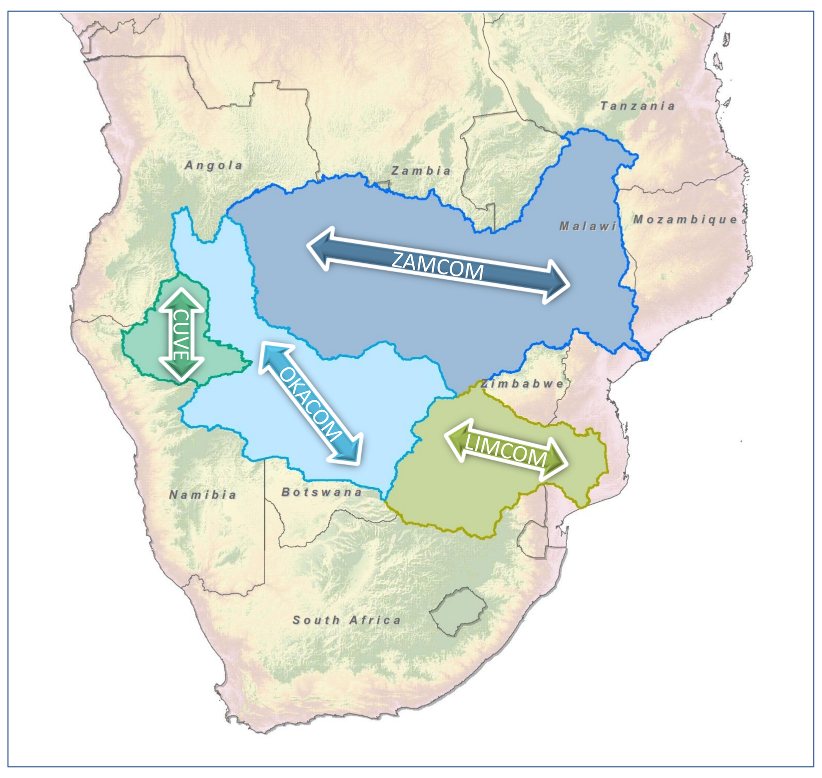
The products will include wetland information such as wetland inventory and flood regime mapping, wetland vegetation dynamics and water quality products integrated with climate and weather information. In line with the project's capacity development agenda, a series of training programs and skills transfer opportunities will be offered in the participating countries.

Introduction

The WeMAST project is developing an EO-based platform that supports Sustainable Wetland Assessment and Monitoring Services, promote policy and management practices in the four transboundary basins (Cuvelai, Limpopo, Okavango and Zambezi). To this end, it utilises open source satellite-based EO data and existing free software to explore:

- hydrological and wetland models applicable to the selected basins across Southern Africa

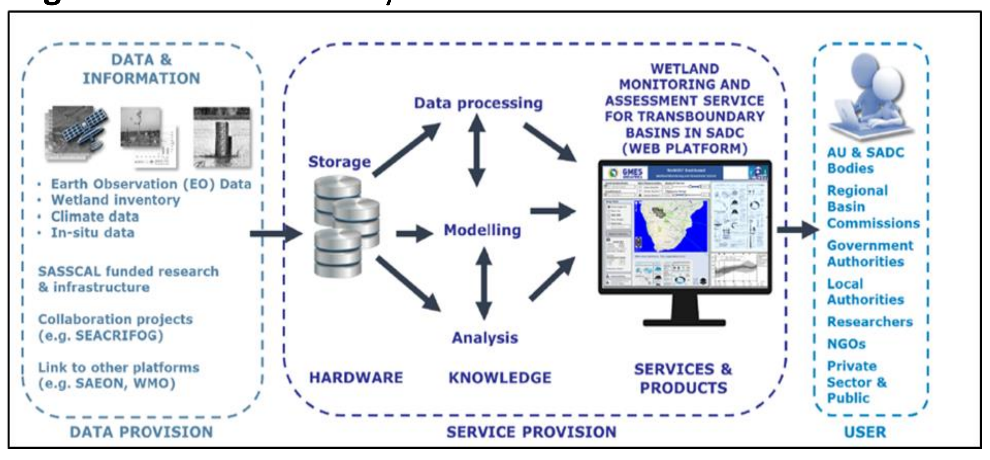
Figure 1. WeMAST study areas.



- in situ data gathered from the four basins: flood regime (duration, extent, and timing), wetland inventory and land-use, vegetation dynamics (cover, density, and phenology).
- weather and climate information from free and operational climate services
- archived satellite-based EO data e.g. provided by the Copernicus missions, Landsat series, MODIS Aqua/Terra products.

The data will be fused using machine learning techniques and will be made accessible to the users through an online platform, including web mapping services. The WeMAST system is shown in *Figure 2* .

Figure 2. The WeMAST system.



Methods and Materials

User needs assessment

WeMAST is conceptualised "with the user – for the user" to ensure the efficient and effective use of WeMAST products and services.

The user needs assessment process will identify challenges with existing wetland observation, monitoring and assessment systems and processes. It will henceforth inform the development process of the WeMAST online platform.

EO products and services development

The WeMAST platform will leverage high and medium spatial resolution satellite data from the Sentinel and Landsat series, MODIS Aqua and Terra satellites and any other suitable EO data for Wetland Assessment and Monitoring Services.

Spectral and temporal variability of vegetation responses will be retrieved to map and monitor wetland areas. The vegetation, soil and water indices time series will be calculated and calibrated with data from field campaigns(Kaplan et al, 2019). Time-series analysis will be used to assess wetland vegetation phenology characteristics of dominant vegetation types in all selected river basins.

The use of freely available satellite images enables the seamless, continuous provision of spectral-based indicators like LAI (leaf area index) and NDVI (normalized vegetation index). The efficacy of processing in near-real-time, as satellite images become available for the wetland assessment and modelling, will be tested at a basin scale. The data processing, storage and accessibility will be done in an Open Data Cube (ODC) as illustrated in *Figure 3*.

Data integration, visualisation and access

The integration methodologies will extract information via machine-learning models from multi-source data (Chang and Bai, 2018). Existing wetland productivity and early warning prediction models will be enhanced through the fusion of EO data and a climate model.

The products will be validated with ground-based measurements and high resolution images with the targeted users. The WeMAST service, as illustrated in *Figure 4*, will consist of a data layer(for data archiving and ingestion), service layer (for processing) and application layer (for information and data access).

The wetland data and information products will be made available through an online WeMAST platform, that will include web mapping services in the form of maps, statistics and dynamic reports.

Figure 3. WeMAST architecture.

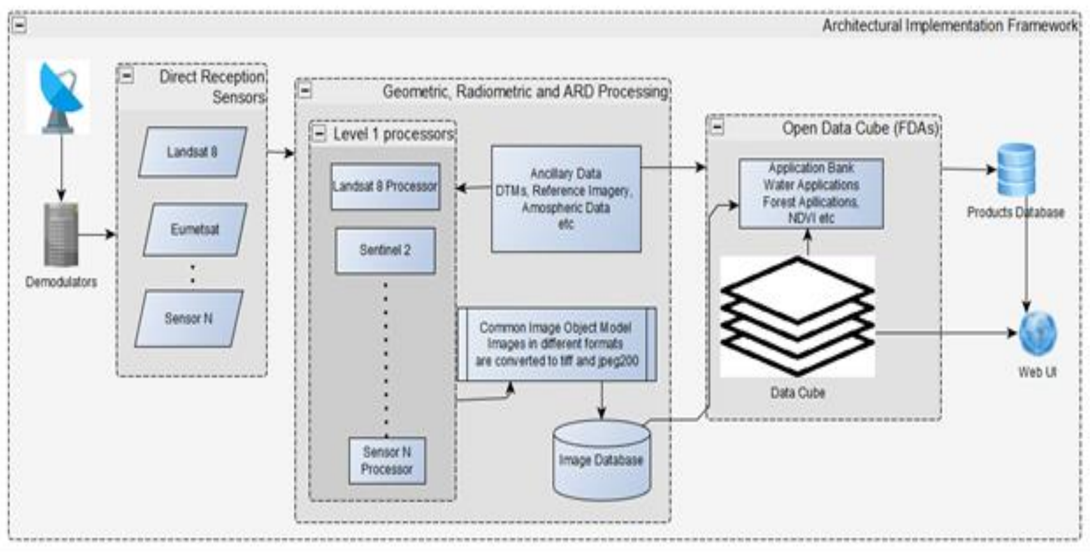
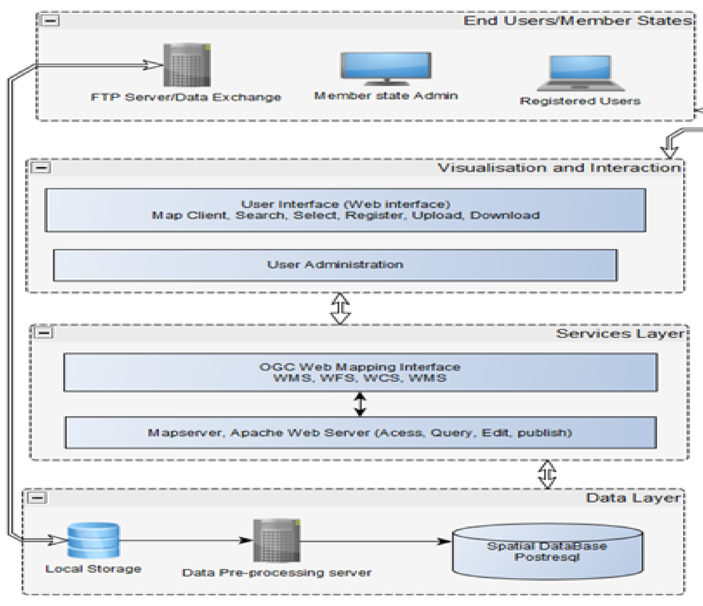


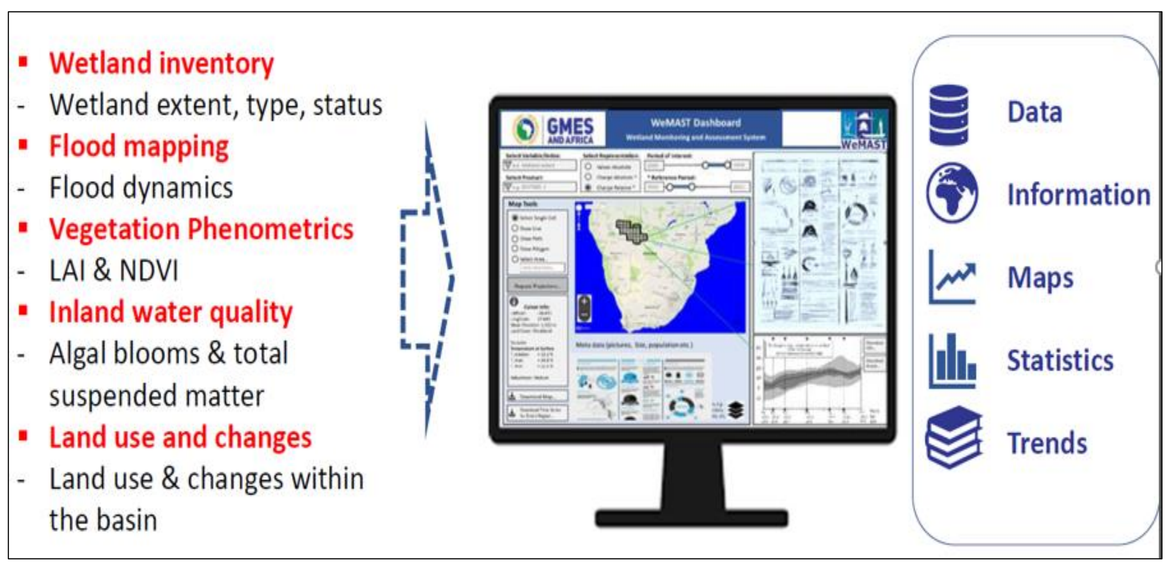
Figure 4. WeMAST service logic



Expected Results

The data and information products will include wetland inventories, flood regime mapping, wetland vegetation dynamics and water quality products integrated with climate and weather information as shown in *Figure 5*. This information will be accessed through an online WeMAST platform, that will include web mapping services in the form of maps, statistics and dynamic reports. Training on how to use the WeMAST system and interpret its products will be given to the identified wetland stakeholders.

Figure 5. WeMAST system.



Contact

Nosiseko Mashiyi
South African National Space Agency
E-mail: nmashiyi@sansa.org.za
Phone:+27 12 844 0499

SPONSORED BY African Union

References

1. Chang N.B. and Bai K. 2018.Multisensor Data Fusion and Machine Learning for Environmental Remote Sensing. Taylor and Francis Group, DOI: 10.1201/b20703. Available at : https://www.researchgate.net/publication/325347741_Multisensor_ data_fusion_and_machine_learning_for_environmental_remote_sensing
2. FAO.2000. Hydrological basins in Africa. http://www.fao.org/geonetwork/srv/en/metadata.show?id=296&currTab=simple
3. Kaplan G, Avdan Z.Y. and Avdan U .2019. Mapping and Monitoring Wetland Dynamics Using Thermal, Optical, and SAR Remote Sensing Data, Wetlands Management - Assessing Risk and Sustainable Solutions, Didem Gökçe, IntechOpen, DOI: 10.5772/intechopen.80264. Available at: https://www.intechopen.com/books/wetlands-management-assessing-risk-and-sustainable-solutions/mapping-and-monitoring-wetland-dynamics-using-thermal-optical-and-sar-remote-sensing-data
4. Rebelo, L.M.; Finlayson, C.M.; Strauch, A.; Rosenqvist, A.; Perennou, C.; Tottrup, C.; Hilarides, L.; Paganini, M.; Wielaard, N.; Siegert, F.; Ballhorn, U.; Navratil, P.; Franke, J.; Davidson, N. 2018. The use of Earth Observation for wetland inventory, assessment and monitoring: An information source for the Ramsar Convention on Wetlands. Ramsar Technical Report No.10. Gland, Switzerland