

An Integrated Water Resources Decision Support System for the Olifants Catchment

Facilitating real-time monitoring, early warning & systemic decision-making for water resources
[INWARDS]

The collage illustrates the INWARDS system's components. The smartphone shows the 'award' app interface with sections for 'River Flows', 'Dam Levels', and 'Rainfall Forecasts'. The background monitor displays a GIS map of the Olifants catchment with monitoring points (e.g., B7H010, B7H015) and a data table. The bottom of the collage features a decorative border with orange, black, and green patterns.



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Acknowledgements

This document reports on work funded by the United States Agency for International Development, under a USAID Southern Africa grant - RFA-674-12-000016 RESilience in the LIMpopo Basin Program (RESILIM).

The RESILIM-O part of the programme is implemented by the Association for Water and Rural Development (AWARD), in association with project partners.

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August 2019

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Introduction

Internationally, water resources are facing increasing pressure due to over-exploitation and pollution. Integrated Water Resource Management (IWRM) has been accepted internationally as a paradigm for integrative and sustainable management of water resources.

However, in practice, the success of IWRM has been hampered by the lack of integrative decision support systems (DSS) and tools for good governance, especially within the context of limited resources and observed data. This is even more apparent in the context of large transboundary systems where individual countries use different data management systems that are often incompatible - a situation hampered also by language differences (such as between Anglophone and Lusophone countries). Moreover, system compatibility needs to be supported with open communication and agreed systems for data sharing and use so as to facilitate the sustainable, efficient and equitable management of shared water resources.

This is true for the joint water resources of the eastern basins of Southern Africa including the Olifants River Basin shared between South Africa and Mozambique. In many respects, great strides have been made in terms of IWRM in the region and yet truly integrated transboundary management remains elusive. Despite the array of data sets, models, methods and monitoring programmes within Southern Africa, access to this information is extremely difficult as there is no centralised platform (although elements of this are emerging).

A number of additional gaps are apparent:

1

Even where data systems exist, country-specific data and analytics are often narrowly focused on water balance (availability and use) without a wider systemic ability to incorporate broader socio-economic and environmental data that have bearing on longer term water management.

2

Groundwater resources are often poorly understood and integrated into IWRM management and data systems.

3

Available data analytics are severely limited in their conceptualisation and inclusion of climate change.

4

Decision-support platforms may be available and widely used globally, but they incur high financial and technical costs and maintenance for the water management institution. This is a major constraint in the resource-limited SADC region.

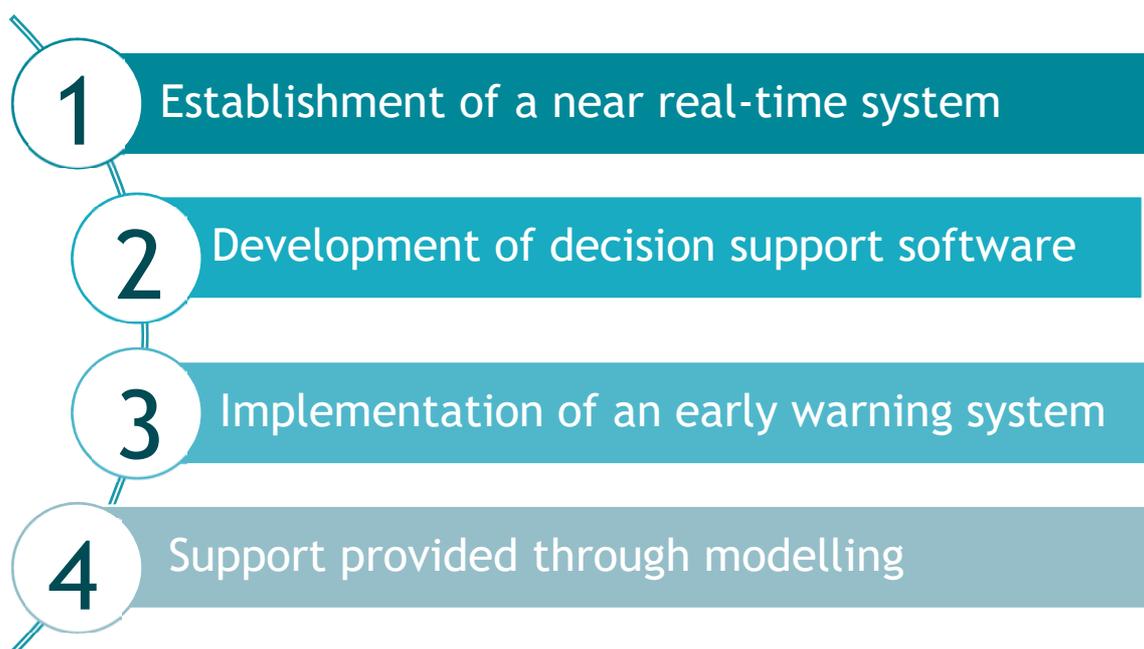
Together with issues related to good governance, the lack of tools and state-of-the-art decision support systems, makes it extremely difficult for water resource managers to detect, prioritise and monitor water related issues. These constraints severely limit a reasonable understanding of water resources in dynamic, water-stressed systems and hence medium and longer-term planning.

In addition to responding in real-time, AWARD has been developing the first Integrated Water Resources Decision Support System (INWARDS) for the Olifants River Catchment (ORC).

Through RESILIM-O, AWARD has developed the building blocks for an integrated approach that allows monitoring, in real-time, the compliance of water quality and quantity against benchmarks that have been established thereby facilitating a rapid response. Without this ability, water resource managers are severely constrained in being able to take mitigatory action because verified data are only available after 14 days by which time the cause or culprit would be hard to identify.

INWARDS is management and response orientated and comprises a suite of tools developed to either be used to directly influence decision making or indirectly supporting key role players (e.g. capacity through training, ease of access to information, awareness, sparking dialogue etc.).

These tools and models include:



The objective of installing real-time gauges was to increase the reliability of real-time water resources monitoring data, to support the response process related to transboundary water governance and water resources management in the Olifants Catchment. The project focused on the Lower Olifants Catchment to protect the Kruger National Park, Massingir Dam in Mozambique and other surrounding communities. The increase in reliability of data collected was achieved by combining monitoring efforts between the Department of Water and Sanitation (DWS) and the Association for Water and Rural Development (AWARD) under RESILIM-O Program by installing additional backup data loggers, probes, communication system and data servers alongside the existing DWS data loggers at flow gauge stations.



A Memorandum of Understanding (MoU) was drafted between DWS and AWARD on use, maintenance and the final takeover and operation of the data loggers by the Olifants-Letaba Catchment Management Agency.

This increase in reliability of collected data can assist in timely decision-making processes thereby strengthening the management and resilience of the Olifants River Catchment. The data loggers are not designed to modify weather conditions in any form but contribute to climate change adaptation, improve biodiversity and water resources management. A similar water resources (quality and quantity) monitoring arrangement has been implemented in the Inkomati-Usuthu Catchment between the DWS and the Inkomati-Usuthu Catchment Management Agency (IUCMA). This collaboration has resulted in improved reliability of monitoring data and timely maintenance of the data collection equipment. The existing DWS monitoring system in the Olifants Catchment is constrained due to high staff turnover and budgetary constraints as they can only repair existing equipment and put it back to service. Hence, during the repairing period no data is collected, thereby posing risks to the management of water resources and catchment resilience. In light of this data gap challenge, the new equipment acquired under the RESILIM-O project has provided backup data to existing DWS data loggers at three selected sites (see Figure 1). Thus, if these backup data loggers are not implemented, the responsiveness to catchment management and resilience building will be greatly compromised.

The key resilience outcomes from the installation of additional water monitoring equipment are:

1. Improved responsiveness and collective action between DWS and AWARD
2. Improved ability to appropriately plan and act systemically in the catchment (taking the bigger picture into account)

The data collected from real-time water quantity and quality stations is valuable as a source of long-term information. The data can help to:

- Provide insights for climate change related work,
- Enhance public safety by providing data for forecasting and managing floods and droughts,
- Monitor compliance with minimum flow or the environmental water requirements (EWRs) to protect biodiversity,
- Set permit requirements for discharge of treated wastewater,
- Apportion the water resources at our international borders (e.g. with Mozambique),
- Track diurnal variations in various water characteristics,
- Detect spills and seasonal variations in pollutant concentrations to allow the judgement of the health of the aquatic ecosystems in our catchment for different users.

Information obtained from the real-time systems was used for day to day catchment management (e.g. De Hoop), improving management of water resources, environmental values and biodiversity in the Olifants catchment.

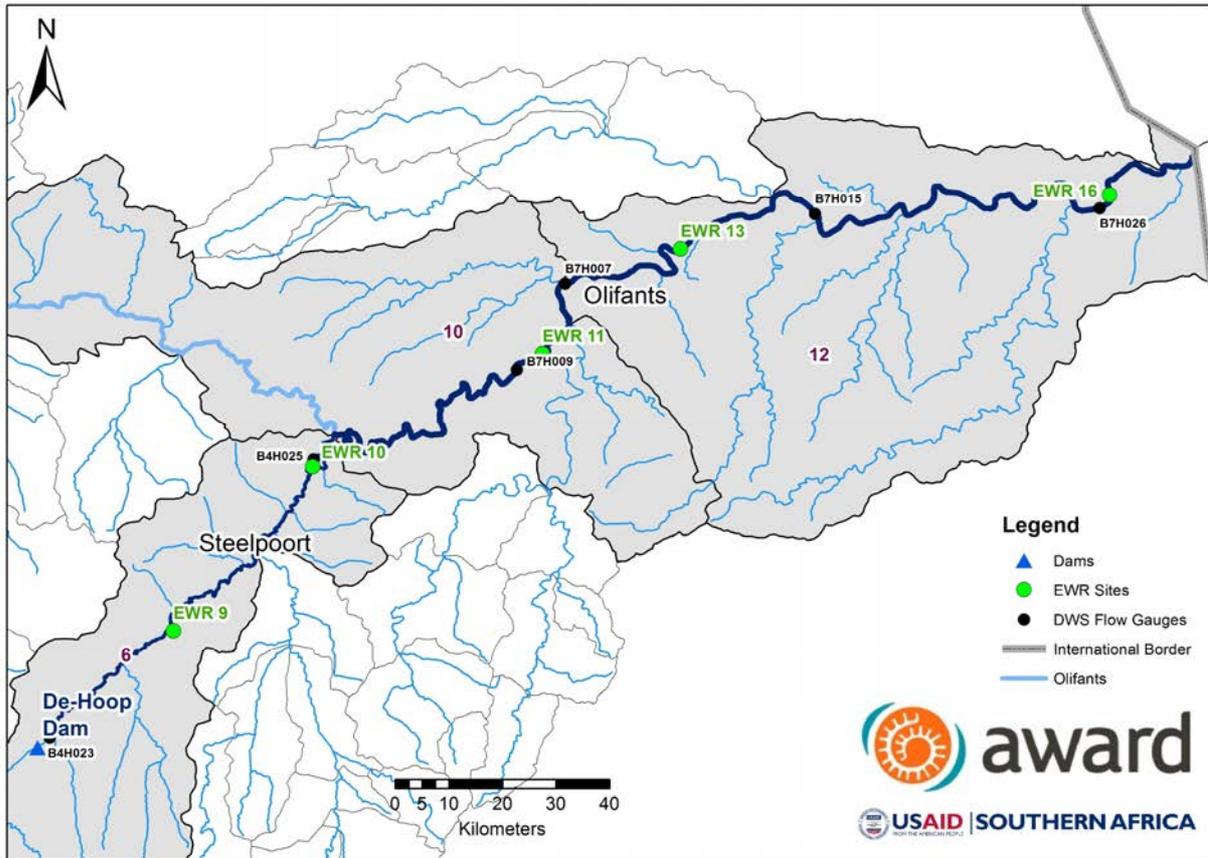


Figure 1: Map of the Lower Olifants showing the locations (red circles) where AWARD has installed real-time gauging systems





INWARDS: Software

A suite of integrated water resource decision-support tools has been developed to guide water resource managers in making short- and long-term strategic adaptive operational decisions. Both the tools and training have been trialled in the Olifants River Catchment during 2016 through to 2020. These currently include a mobile app and a desktop application. The work has been undertaken in the context of declining water security in the transboundary, easterly-flowing rivers of South Africa. In order to address problems that are systemic in nature (both through multiple-causality and in terms of impacts), it was clear at the start that as much data as possible needs to be mobilised and in a manner that fosters co-operative decision-making. This meant supporting both qualitative and quantitative data and ensuring that existing approaches could be complemented (e.g. by incorporating different analytics). Aside from providing a robust, flexible and ‘user-friendly’ platform with good visualisation options, INWARDS is designed to address a number of key issues:

- The need for a systemic approach which considers multiple data sources (water resources, socio-economic and environmental data) for decision-making;
- The need for an open-source shared repository that provides consistency for data capture and analytics with good visualization options;
- The need to monitor against benchmarks in real-time so as to facilitate rapid action (e.g. Resource Quality Objectives, water quality standards in South Africa and Mozambique);
- The need to integrate water quality and quantity (through loads) so that these are managed as one system (as envisaged in the NWA and in the Integrated Water Quality Management System);
- The ability to complement and integrate other data platforms; and
- The need to consider climate change scenarios.

Please see the following site for an overview and more details on INWRDSS: <http://award.org.za/INWARDS/>

Desktop Application

Hydrology

The Department of Water Affairs currently utilises a proprietary platform for hydrological data storage and analysis. This off-the-shelf commercial product has been utilised for many years; however, as it is propriety software very few have access to it. Thus, it was decided to develop an interface which would allow a user to retrieve and analyse hydrological data collected by DWS (see Figure 2). The way in which it has been coded allows a user to fetch data from the DWS and store it locally. The user can then either analyse the data within the application or export it. Currently this interface allows the user to:

- Plot Verified and Unverified discharge data
- Overlay percentiles
- Overlay multiple sites
- Overlay different hydrological years or periods of time
- Overlay both Static or Dynamic Environmental Water Requirements
- Plot Discharge Duration Curves
- Box plots
- Extract monthly statistics
- Dam operational models
- Operational models

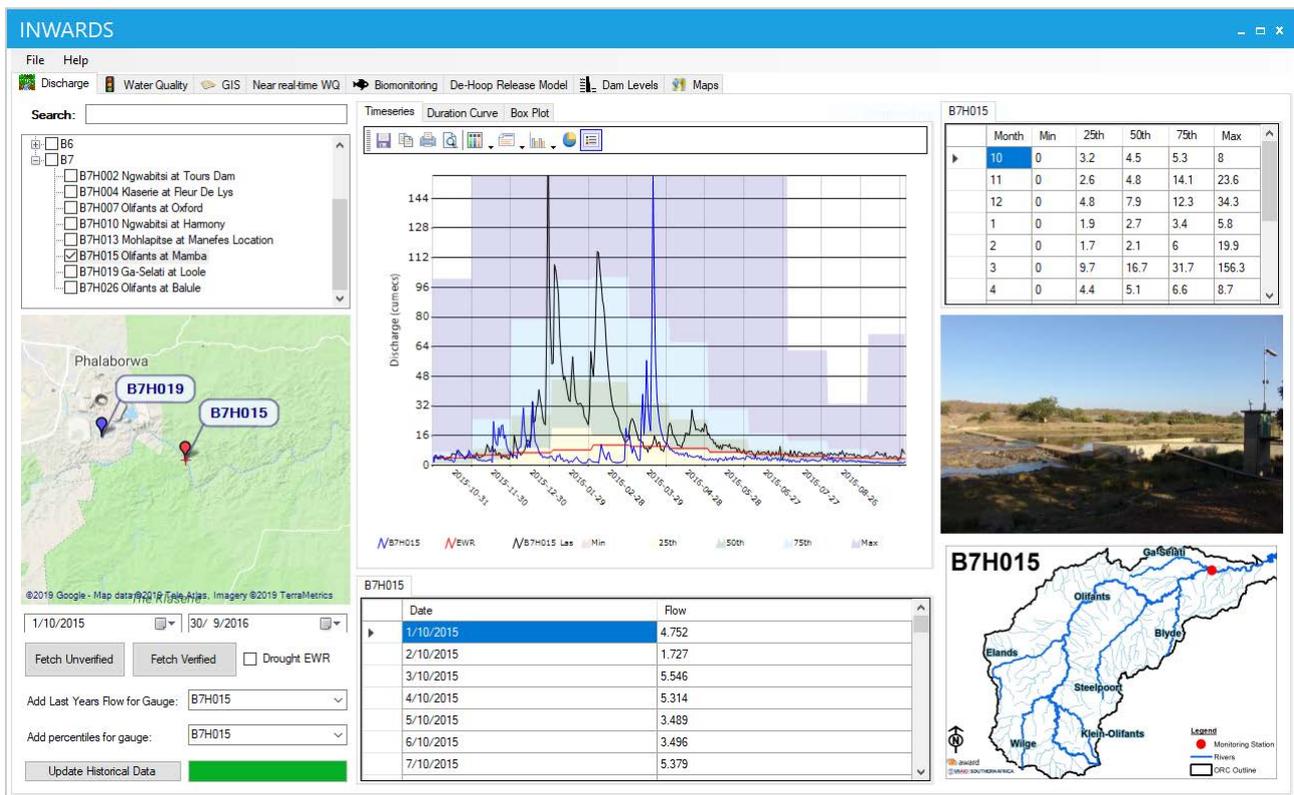


Figure 2: Screen shot of INWARDS desktop application showing the discharge interface

The benefits for developing this interface are:

- Opensource and therefore distributable to both key stakeholders and government
- Local data storage allowing a user to access information regardless of internet connectivity
- The freedom to add new features when needed

Water quality

Currently the Department of Water Affairs utilises the Water Management System to store water quality related data which has been utilised for several years. The water quality interface (Figure 3) within INWARDS was developed not to replace the WMS, but rather to support it. To gain access to the WMS a user needs to be connected to a specific DWS gateway, therefore making remote access a challenge. The INWARDS interface has been designed to store data locally. The local database will be updated on a regular basis from a remote server database.

Currently the interface allows the user to:

- Plot time series with a trend analysis
- Overlay Resource Reserve Limits, Water Quality Objectives, Integrated Water Quality Planning Limits or EPA limits
- Plot Concentration Duration Curves
- Plot Load Duration Curves
- Plot Concentration Boxplot

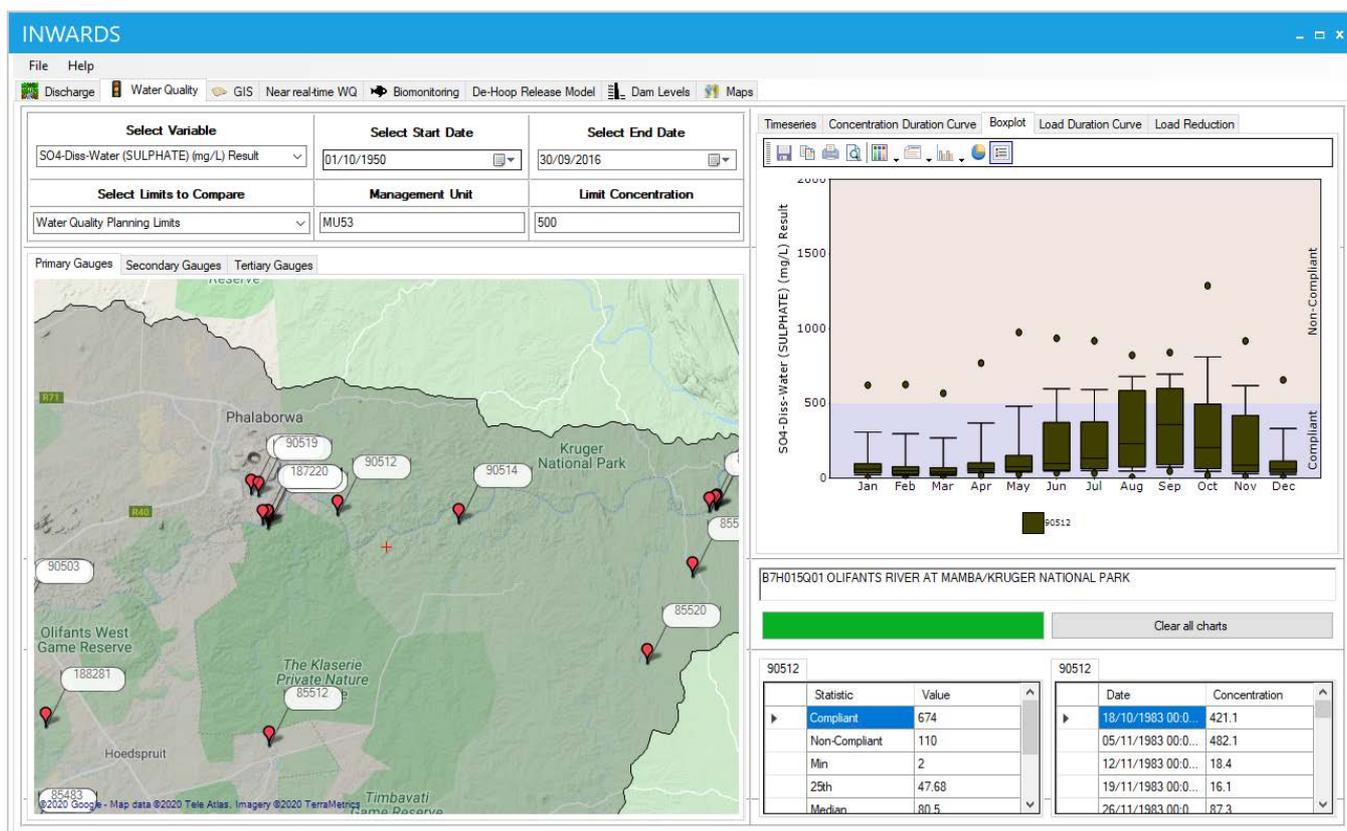


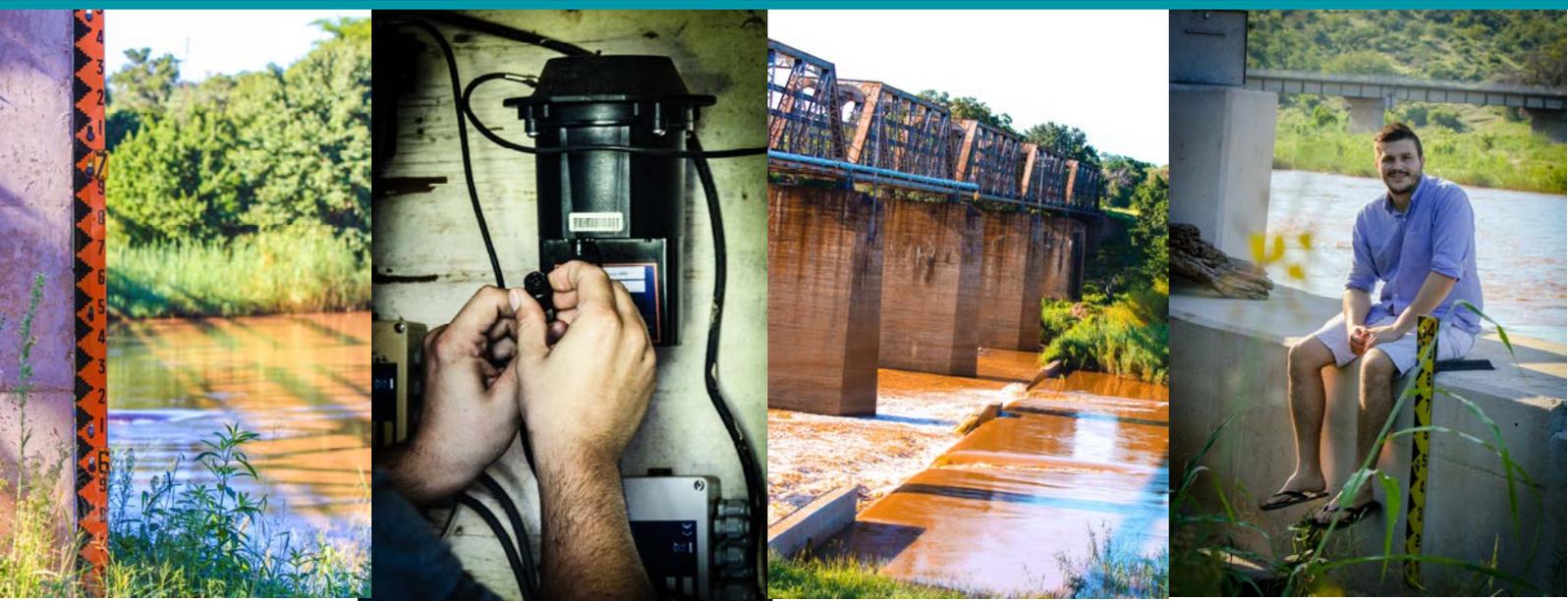
Figure 3: Screen shot of the water quality Interface of INWARDS

Near real-time water quality

The INWARDS near real-time water quality component (Figure 4) allows a user to view water quality data for the following constituents on a daily basis:

- Dissolved Oxygen
- Electrical Conductivity
- pH
- Temperature

The data is measured every hour by an In-Situ AquaTroll probe installed within Kruger National Park downstream of the Phalaborwa mining complex and the Phalaborwa barrage. This data has been paramount in the early detection of spills and the impacts of releases from the barrage.



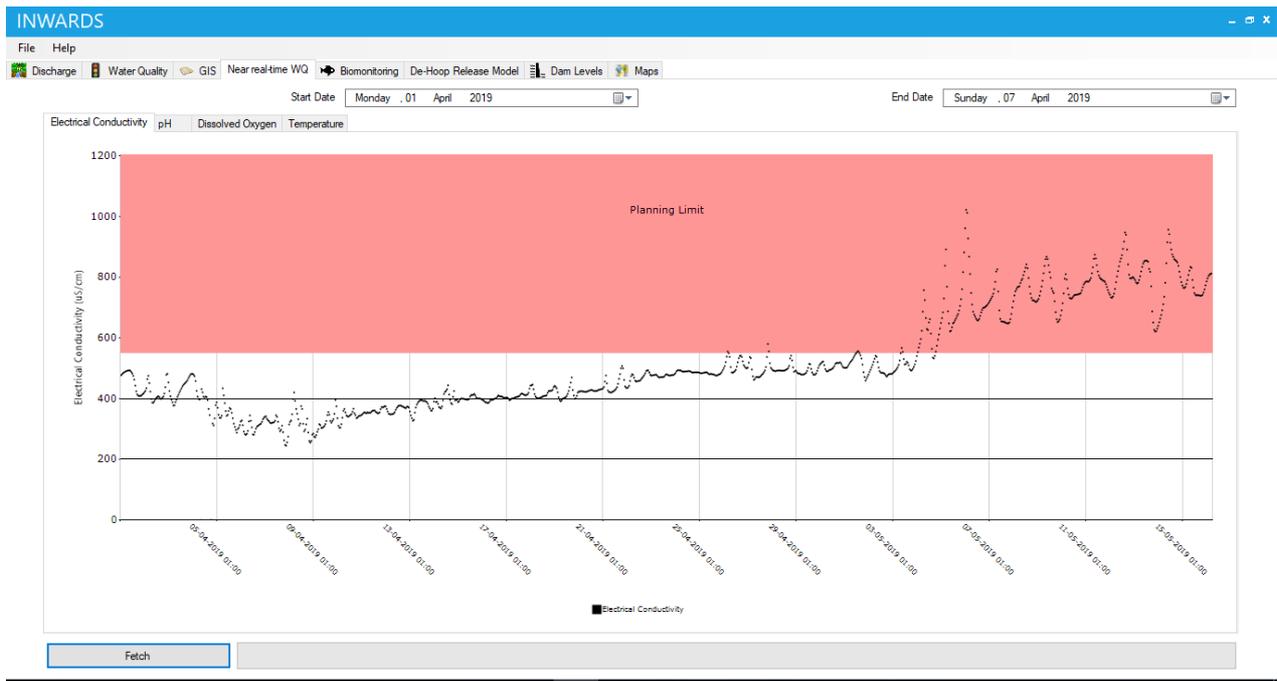


Figure 4: Near real-time water quality component of INWARDS

Dam levels

The INWARDS user-friendly dashboard enables the latest real-time measurement for each major dam in the Olifants River Basin (see Figure 5).

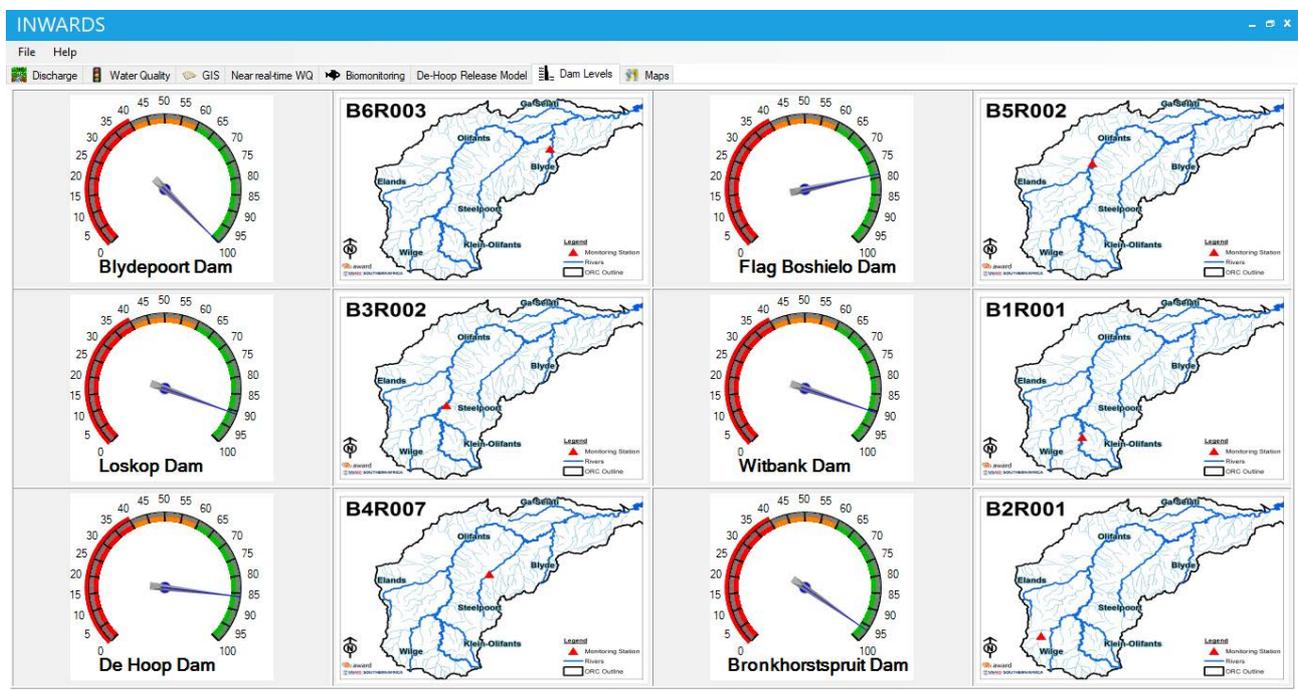


Figure 5: Real-time measurement of major dams



INWARDS Mobile: Flow Tracker

In addition to the desktop application AWARD has also developed a user-friendly mobile application, Flow Tracker, that allows users to track river flows and dam levels in real-time (Figure 6).

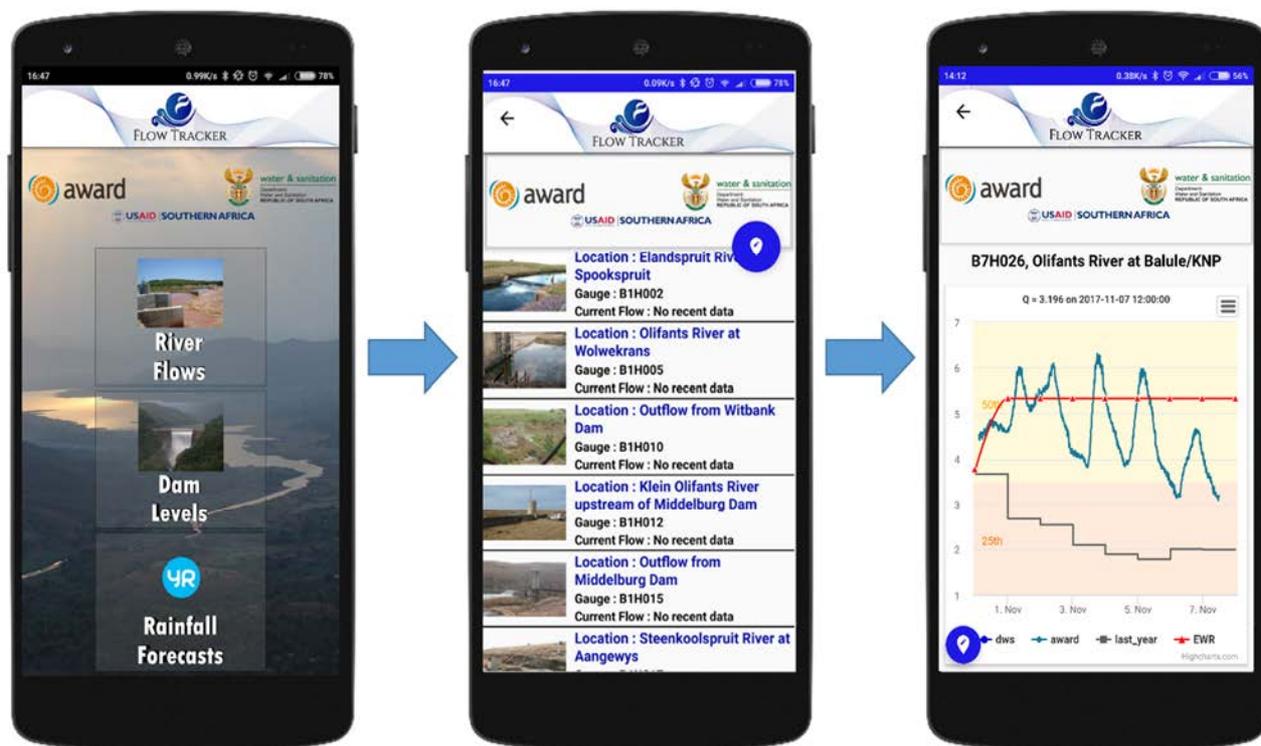
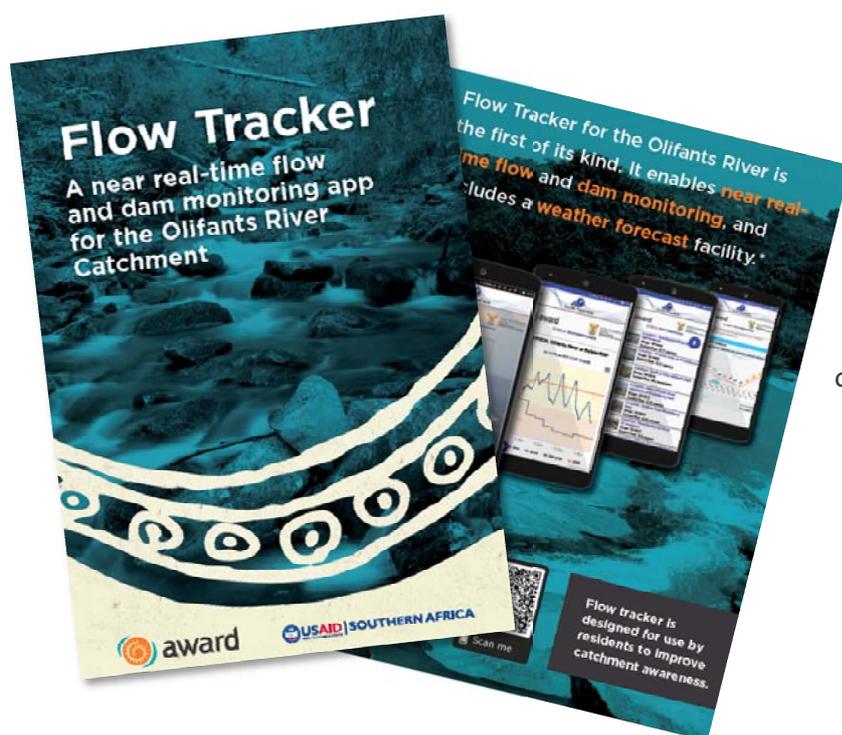


Figure 6: Android application Flow Tracker



Flow Tracker is available free for download from any app store. For more details on how it works, see the FlowTracker flyer which can be downloaded from the AWARD website.



award

The Association for Water and Rural Development

AWARD is a non-profit organisation specialising in participatory, research-based project implementation. Their work addresses issues of sustainability, inequity and poverty by building natural-resource management competence and supporting sustainable livelihoods. One of their current projects, supported by USAID, focuses on the Olifants River and the way in which people living in South Africa and Mozambique depend on the Olifants and its contributing waterways. It aims to improve water security and resource management in support of the healthy ecosystems to sustain livelihoods and resilient economic development in the catchment.

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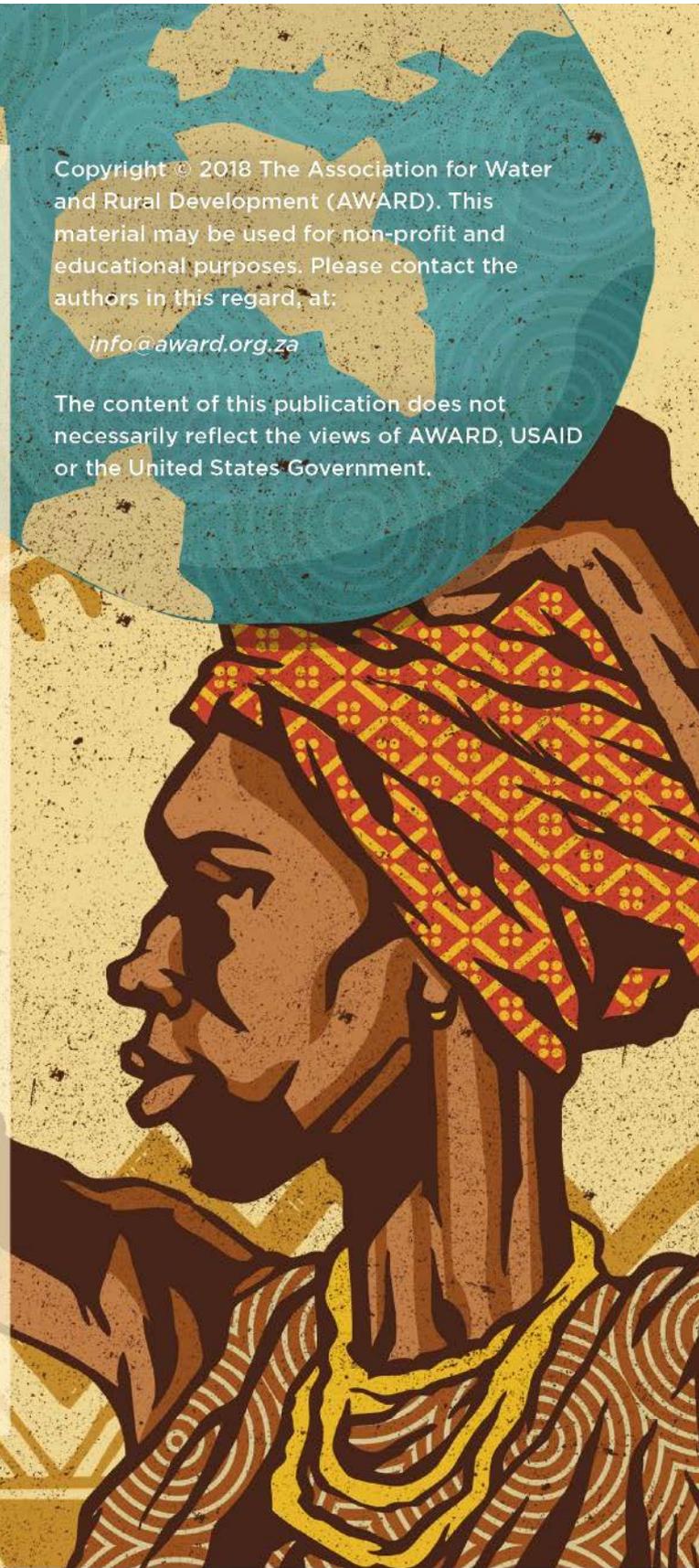
About USAID: RESILIM-O

USAID: RESILIM-O focuses on the Olifants River Basin and the way in which people living in South Africa and Mozambique depend on the Olifants and its contributing waterways. It aims to improve water security and resource management in support of the healthy ecosystems that support livelihoods and resilient economic development in the catchment. The 5-year programme, involving the South African and Mozambican portions of the Olifants catchment, is being implemented by the Association for Water and Rural Development (AWARD) and is funded by USAID Southern Africa.

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Acknowledgements: Project funding and support

The USAID: RESILIM-O project is funded by the U.S. Agency for International Development under USAID/Southern Africa RESILIENCE IN THE LIMPOPO BASIN PROGRAM (RESILIM). The RESILIM-O project is implemented by the Association for Water and Rural Development (AWARD), in collaboration with partners. Cooperative Agreement nr AID-674-A-13-00008



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