



WATERQ2: UNDERSTANDING WATER QUALITY & QUANTITY IN THE LIMPOPO BASIN

Quarterly Report, 29 March – 30 June 2019

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WaterQ2: Understanding Water Quality and Quantity in the Limpopo Basin

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Cover photo: Cape buffalo standing in Shingwedzi River, Kruger National Park, photo credit: Mackenzie Martin.

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Project Information

Project Title Water Q2: Understanding Water Quality and Quantity in the Limpopo Basin
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INTRODUCTION

The transboundary Limpopo River Basin crosses Botswana, Mozambique, South Africa, and Zimbabwe. At over 400,000 km², the Limpopo River Basin is home to 18 million people living in both rural and urban areas. Industries in the Basin include businesses in the urban areas and water-intensive uses such as agriculture and mining; industrial water use is growing rapidly. In addition to the human residents, the Basin contains some of the most biodiverse natural areas on the planet.

The rainfall in the Basin is heterogeneous with some sub-basins receiving less than 400 mm on average and other downstream sub-basins in Mozambique receiving over 750 mm annually. Even meteorological stations located in close proximity demonstrate substantial spatial variation within sub-basins. The Basin has experienced severe droughts in the last decade. In addition to the variation in the amount of rainfall, the timing, especially the start of the growing season, has varied significantly. However, there remain many questions about the reliability of rainfall data and other water measurements due in part to the infrequent calibration and validation of field site measurements. **The limited confidence in these data, combined with the substantial variation through time and space necessitates an integrated approach to improve data collection, validation, and overall Basin water resource management in the Basin.**

The goal of this project is to build resilience through the support of Basin stakeholders, including The Limpopo Watercourse Commission (LIMCOM), to improve governance around water resources management and water security in the Basin. A systems approach, such as integrated water resources management (IWRM) is needed to address such complex, large, and interrelated components of water resources. IWRM is recommended by the United States Agency for International Development (USAID) Water and Development Strategy Implementation Guide (2014). This context will be combined with data collection and validation, data sharing, and continuous evaluation of the interrelations that affect water resources.

This project will support water resources monitoring, and the development of methods for water quality and quantity measurement based on *in situ* sensors and satellite measurements. These **measurements** will enable characterization of water resource dynamics at the whole Basin scale and form the foundation for hydrologic **modeling** that can help estimate hard-to-measure parameters and also provide holistic assessments of Basin scale stocks and flows. To support data sharing, the project will use cloud-based, automated data collection and web-based **data sharing**.

The Development of local capacity to maintain water resources and make proactive, scientifically justified management decisions requires a substantial human capital resource that is currently lacking in the Basin. The project will provide training, workshops, and conferences will focus on integrated water resources management (IWRM) and environmental flow analysis.

The results of the water resources and biodiversity studies conducted will be compiled into a report for the Basin stakeholders. Continued high-quality data collection, training, and general logistics depends on dependable physical infrastructure. To support data collection efforts as well as training and collaboration the Limpopo Resilience Lab at the University of Venda will be established. The sustainability of lab activity will continue with the implementation of a small user fee beyond the duration of the project. Annual training workshops and conferences will be located at or nearby the Resilience Lab.

In this report, the collaborators, Duquesne University (Duquesne), Rensselaer Polytechnic Institute (RPI), and University of Venda (Univen) report their activities and progress in the first quarter (Q1) of project year 2019-20 (PY 2019-20).

PROJECT ADMINISTRATION

PERSONNEL MANAGEMENT AND TRAINING

PERSONNEL

Postdoctoral Research Associate, Dr. McArd Joseph Mlotha, accepted the position supervised by Dr. Rose at Rensselaer Polytechnic Institute (RPI). Dr. Mlotha has experience in remote sensing, GIS, and water quality research and education. As part of his work, he will develop curriculum on these topics for our education and training workshops. Dr. Mlotha will develop materials, present the materials, and iteratively improve content for future workshops and trainings. Additionally, he will collect data on water quality for remote sensing algorithm validation. To create remote sensing algorithms, he will also access and process satellite imagery and process field data to prepare data for algorithm formulation. Duquesne University MS-candidate, Mackenzie Martin, has selected her thesis committee. The committee will be comprised of:

- Joshua N. Edokpayi, Environmental Sciences, University of Venda
- David M. Kahler (chair), Environmental Science, Duquesne University
- Nancy Trun, Biological Sciences, Duquesne University

STUDENTS

Two graduate students have been awarded assistantships through this project. They will be supervised by Dr. Edokpayi at Univen. Mr. Ntwanano Mutleni has received his undergraduate degree from Univen and is now pursuing a Master's degree. Mr. Hilton Thivhionali Shimbabu is an advanced graduate student pursuing a Master's degree.

RESPONSIBLE CONDUCT OF RESEARCH

According to Section 7009 of the America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science (COMPETES) Act, all research activities must “provide appropriate training and oversight in the responsible and ethical conduct of research,” to all trainees. For the purposes of this project, all key personnel (PIs) and students will complete university-coordinated responsible conduct of research (RCR) programs. The course completion documents for Duquesne-based personnel are provided in Appendix A, other sites will provide RCR training verification in subsequent reports.

BRANDING AND MARKING

In accordance with our approved Branding and Marking Plan (contained in the Mobilization Plan), labels were produced by Duquesne's in-house print shop (Figure 1). These labels will be affixed to all instruments and non-consumable supplies purchased through this grant.



Figure 1: USAID branding labels.

MODULES 1&3: WATER MONITORING

SATELLITE ALGORITHMS

Through Planet Labs, Inc. (planet.com) Education and Research Program, staff has been able to acquire satellite images from known stations along the Mutale River near the previously established Mutale River hydrometeorological station at the Mutale River Weir (22° 46.343' S, 30° 32.191' E). This has been done through Planet Labs' *Education and Research Program*, which provides a small number of images for no cost for education and non-commercial research. As the project's needs grow, this will be converted to a paid license for non-commercial research to obtain more images.

WATER POLICY

To support the work on national water laws and policies, and the human right to water in the Limpopo Basin, Duquesne has begun to catalog as many documents as possible in an online library collection. The Gumberg Library at Duquesne has supplied space within the institutional repository at Duquesne. The online library will be included in the website rollout that has been scheduled for August 2019.

MODULE 2: TRAINING, WORKSHOPS, AND CONFERENCES

PROJECT-SPONSORED EVENTS

STAKEHOLDER MEETING

For the first stakeholder meeting of the project, the team targeted the national-level departments of South Africa and LIMCOM. Due to a low response to a meeting in Thohoyandou, the project team relocated the stakeholder meeting to Pretoria to increase attendance. This also provides an opportunity to engage with another collaborator, the Council on Scientific and Industrial Research (CSIR), who has offered to host the meeting. The project team expects that the venue change and partnership with CSIR will increase attendance and demonstrate the opportunities of the project to the national-level departments. The project team is planning similar meetings in Botswana and Mozambique.

The project team has begun planning for the training to be held with the stakeholder meeting in August. Due to the proposed change in the Stakeholder Meeting venue, the training will be split. There will be a training element to the Stakeholder Meeting that will focus on high-level planning and management. To expand the reach of our training, the originally planned technical training will also be held at Univen the following week. Full reports of all of these events will be submitted separately per the Milestone Plan.

OTHER EVENTS

SOUTH AFRICAN SOCIETY OF AQUATIC SCIENTISTS (SASAQS)

The Southern African Society of Aquatic Scientists (SASAqS) Congress 2019 was held 30 June to 4 July 2019 at Zebula Lodge Bela-Bela, South Africa. Dr. Edokpayi attended the conference to meet other professionals in the area. The conference focused on "Aquatic ecosystem health in a changing

environment”. The congress had several interesting talks and presentations linked to the understanding of water quality in the Limpopo River Basin.

Most of the talks were based on the Olifants River catchment, which were very insightful. Knowledge gained during the congress included:

- declining fish population in the Olifant River catchment,
- non-monitoring of heavy metal levels in the Olifant river system and other systems thus providing a data gap in need of research.

Major sources of pollution were identified as:

- mining activities,
- discharge of untreated and poorly treated wastewater,
- runoff from agricultural activities, and
- change in land use and land cover around the river catchment.

Research focusing on wetlands as natural filtration system of various contaminants were identified. The use of indices in reporting river health system was encouraged.

During the course of the congress, Dr. Edokpayi met with several scholars and researchers from South African National Parks, other programs such as AWARD, LEDET, and Resilient Waters and the Water Research Commission. Many of whom are major stakeholders of the Limpopo River basin. Valuable contacts were established and some of them have been included on the mailing list of our future events mostly in August 2019 and January, 2020.

MODULE 4: LIMPOPO RESILIENCE LAB

The collaborators have identified space available at the University of Venda, School of Environmental Science for the Limpopo Resilience Lab. The space will undergo a large cleanup and signage consistent with the Marking and Branding Plan.

The Limpopo Resilience Lab is also taking on an online presence and the staff is looking at various web-based tools that will complement the physical laboratory space and functions.

MONITORING AND EVALUATION

MODULES 1 AND 3: WATER MONITORING

There are two primary research activities that have continued in this quarter that are supported through this project. They all fall into USAID category, *Production Systems Research*, as they are a component of natural resources management: they are both in the *field-testing* phase of research. The two areas of research are:

- Satellite methods to determine river flow
- Satellite methods to determine water quality (e.g., turbidity and chlorophyll)

The investigators have already begun to prepare a manuscript on the river flow method, which will be submitted to USAID when submitted for publication. For the first quarter, no other activities have reached monitoring values.

TABLE 1: MODULES 1&3 INDICATORS

INDICATOR	DISAGGREGATION	CURRENT VALUE	PROJECT TOTAL
Number of technologies, practices, and approaches under various phases of research, development, and uptake as a result of USG assistance	Phase: Under research	0	2
	Under field testing	2	2
	Made available	0	0
	Demonstrated uptake	0	0
Number of peer-reviewed scientific publications resulting from USG support to research and implementation programs	None	0	0
Number of hectares of land under improved technologies or management practices with USG assistance		0	0
Number of datasets shared, which were generated as a result of USG assistance	Basin country	0	0

MODULE 2. IWRM TRAINING, WORKSHOPS, AND CONFERENCES

Module 2 contains two primary components: convene stakeholder workshops and trainings; and convene future collaborators at conferences. The first stakeholder workshop has been scheduled for August 2019 at CSIR in Pretoria.

The project-level goals for these are to identify environmental champions and cultivate partnerships for future collaborations, especially with the Limpopo Resilience Lab. Project staff has been in close contact with CSIR, Kruger National Park, and Endangered Wildlife Trust. These groups will strengthen the network of water resources and biodiversity professionals in the area.

TABLE 2: MODULE 2 INDICATORS

INDICATOR	DISAGGREGATION	CURRENT VALUE	PROJECT TOTAL
Number of people trained in sustainable natural resources management and/or biodiversity conservation as a result of USG assistance	Sex	0	0
Number of water and sanitation sector institutions strengthened to manage water resources of improve water supply and sanitation services as a result of USG assistance	Institutional scale	0	0

PROJECT PROGRESS

WORK PLAN PROGRESS

Table 3 outlines progress on work plan activities (outlined in the Mobilization Plan) and the ongoing research activities. As specified in the Project Description, the following activities were planned.

TABLE 3: PROJECT ACTIVITIES													
#	ACTIVITY	2019			2020				2021				
		2	3	4	1	2	3	4	1	2	3	4	
	Startup activities: Mobilization Plan, Staffing, EMMP												
1	Establish meteorological, river, and groundwater stations, <i>Water Monitoring and Algorithm Development Report</i>		*										
1	Groundwater measurements (ERT), to be included in <i>Water Monitoring Report</i>		*										
1	Develop satellite algorithms												
1	Develop hydrologic and water quality models												
2	Convene stakeholders in workshops												
2	Scientific conferences												
2	Training workshops				*								
3	Publish and present basin report												
4	Launch Limpopo Resilience Lab												
			Completed						In-progress/planned				

The activities marked with a star (*) have been adjusted for scheduling purposes. Hydrometeorological data collection was scheduled for July 2019; however, due to scheduling, has been moved to August 2019. This results in a one-month delay of the first report on the locations and data collection outlined in Milestone 4. Additionally, the staff has decided to add training opportunities in January 2020 following recruitment in the first stakeholder meeting.

MILESTONE PLAN

TABLE 4: MILESTONE PLAN													
#	MILESTONE	2019			2020				2021				2021
	Quarter:	2	3	4	1	2	3	4	1	2	3	4	1
1	Mobilization Plan	Apr											
2	Environmental Mitigation and Monitoring Plan	Jun											
3	Quarterly Report	Jul											
4	Water Monitoring and Algorithm Development Report		Aug*										
5	Stakeholder Workshop Report		Sep										
6	Annual Work Plan		Aug										
7	Quarterly Report		Oct										
8	Quarterly Report			Jan									
9	Quarterly Report^				Apr								
10	LRL Website and Planning				Apr								
11	Scientific Conference					Jul							
12	Basin Report					Jul							
13	Quarterly Report					Jul							
14	Stakeholder Workshop Report						Sep						
15	Annual Work Plan						Aug						
16	Quarterly Report						Oct						
17	Quarterly Report							Jan					
18	Quarterly Report^								Apr				
19	Scientific Conference									Jul			
20	Quarterly Report									Jul			
21	Stakeholder Workshop Report										Sep		

22	Water Monitoring: Two manuscripts	Aug
23	Annual Work Plan	Aug
24	Quarterly Report	Sep
25	Quarterly Report	Jan
26	Basin Report	Mar
27	LRL Continuity Report	Mar
28	Quarterly Report	Apr

Shaded items are completed or pending approval. It is recommended that the Milestone Plan be revised so that the annual cost share report, which was originally marked to occur for the reporting quarters #5, 9, and 12, will be included in quarterly reports, marked with a carrot (^), for reporting quarters #4, 8, and 12. The water monitoring report (Milestone #4) is also marked (*).

FINANCIAL

INSTRUMENTS AND SUPPLIES

Duquesne has ordered an Iris Instruments Syscal R1 Plus Switch Electrical Resistivity Tomography (ERT) instrument from Subsurface Geophysical Solutions and scheduled training for 02 August 2019 in Pittsburgh. Duquesne has also procured the meteorological stations to be installed around the Basin.

Univen has begun procurement for the current meter (MF Pro, OTT, Colorado, USA) and the water quality meter (Professional Plus, YSI, Ohio, USA). RPI has procured the long-term turbidity and chlorophyll sensors for deployment in the Limpopo Basin.

Additional information removed per ADS chapter 508.

APPROVAL

This Quarterly Report has been received and approved by USAID. This satisfies the requirements set forth in the Milestone Plan, item #3: Completion of Quarterly Report (Q1).

Signature: _____

Name: _____
Agreement Officer's Representative

Date: _____

APPENDIX A: RESPONSIBLE CONDUCT OF RESEARCH

More information on the responsible conduct of research (RCR) and Section 7009 of the America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science (COMPETES) Act can be found at the National Science Foundation (NSF):

<https://www.nsf.gov/bfa/dias/policy/rcr.jsp>

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APPENDIX B: STAKEHOLDER WORKSHOP INVITATION LETTER



10 July 2019

Dear Professional Colleague:

We are an international group of scientists that work on natural resource management. We have recently been awarded a grant by the United States Agency for International Development to understand water resources and biodiversity in the Limpopo River Basin and develop the training capacity to support evidence-based management. Based on your position and background, we think that you have important insight into water quality and quantity, and biodiversity, and can help identify training needs.

We are writing to invite you to participate in a two-day meeting in which we plan to discuss water and biodiversity data needs, data availability and sharing, training needs, and best management practices in the Limpopo River Basin with key stakeholder groups. We would like to have your input to prioritize research activities in the Basin and design education and training programs for you and/or your staff. An output of the meeting will be custom-tailored training modules for you and/or your staff, beginning January 2020.

The meeting will be held from 19-20 August 2019 in Pretoria on CSIR's campus in the Kingfisher Room. If you can join us for this meeting, please respond to the survey included in the email, which can also be found online: <https://forms.gle/eyCyCqA4P8fKnwtr6>. Lunch and tea/coffee breaks will be provided. The tentative agenda is:

19 August	08:30	Registration (please allow extra time for security)
	09:00-09:30	Welcome, review of goals, discussion of geographical priorities
	09:30-11:00	Presentations from participants
	11:00-13:00	Small group brainstorming on data needs
		Small group brainstorming on geographic priorities
	13:00-14:00	Lunch
20 August	14:00-16:00	Small group brainstorming on information sharing
	09:00-11:00	Participant presentations
		Large group discussion on data needs and geographic priorities
	11:00-13:00	Discussion on IWRM integration, training needs
	13:00-14:00	Networking lunch

We look forward to your valuable input!

Sincerely,

David M. Kahler, Ph.D.
Duquesne University

Joshua N. Edokpayi, Ph.D.
University of Venda

Kevin C. Rose, Ph.D.
Rensselaer Polytechnic Institute

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