CPWF Innovation Funds Project Completion Report

Project Title: Development of a web based decision support system for agricultural water management of small reservoirs and small water infrastructures in the Limpopo basin

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for submission to the

CGIAR Challenge Program on WATER & FOOD

Andes • Ganges • Limpopo • Mekong • Nile • Volta

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Introduction

Small reservoirs (SRs) are important sources of water for the sustenance of rural livelihoods in the Limpopo River Basin mainly because large parts of the basin endure semi-arid conditions and unpredictable rain fall. While the exact number of small reservoirs is not known, there are indications that they are quite common. For example 256 were found in one district in Zimbabwe. The Challenge Program on Water and Food –phases 1 and 2 -have devoted considerable financial and human resources to finding ways of enhancing food and water security. Research in Mozambique, Botswana, South Africa and Zimbabwe showed that rural people depend on small reservoirs for many uses including domestic water consumption, livestock watering, brickmaking, and food production among others.

Despite wide use of SRs and Small Water Infrastructures (SWIs) in the Limpopo Basin, management thereof remains unsatisfactory for two main reasons. First, many of these installations are undocumented and are therefore 'invisible' to the water managers. They are often too small to be captured in a national dams database, and local authorities lack the requisite material and technical capacity to monitor and manage them. Second, disparate information inhibits information sharing that could improve planning and management - various institutions hold data on different dams and SWIs, and/r available data are often incomplete and in incompatible formats.

In this study, we have used remote sensing data to identify the location and size of small reservoirs in the Limpopo Basin. Through further ground truthing and validation, we developed an interactive database for supporting decision making in the management of small reservoirs.

Objectives:

(1) Determine the location of small reservoirs, estimate their capacities during the wet and dry period, characterize them in terms of environmental degradation through the use of satellite images, GIS, and ground validation;

(2) Create web-based interactive databases and tools for the support of water management interventions;

(3) Establish the location, status of functionality, ownership, use, and possible revitalization measures available for basin SWIs;

(4) Develop a functional SWI database system that will be used as a tool for inventory and monitoring of small water infrastructure (SWI) including interfacing features with SRs;

(5) Train local authorities on how to use the databases; and

(6) Explore ways to disseminate the findings to catchments that not be covered.

Outputs:

Envisaged outputs included interactive maps showing the location and main characteristics of small reservoirs, interactive databases that can be shared across institutions, training manuals on the database and how to use ICTs, and a strategy to disseminate the findings to other interested institutions in the basin.

1. Achievements, Project Implications/Impacts

In order to achieve the objectives of the project, the study was conducted in three separate phases:

- Stage 1 -Generating inventory of SRs and SWIs and related data
- Stage 2-Development of web-based DSS
- Stage 3-Uptake by local users (training)

Achievements:

A web-based interactive Decision support system (DSS) was developed as per the proposal funded through this grant agreement with the CPWF Innovation Fund. It was envisaged to be an inventory and data capture application (database system). The dams information related to the following:

- Dam physical characteristics: location, area, volume, etc
- Contributing watershed characteristics: length, area, slope, landuse/ landcover, etc
- Derived/calculating cells for Universal Soil Loss Equation parameters

Functional Goals of the Limpopo Basin DSS has the following capabilities:

- Enables the user to update the existing information about dams
- Enables the user to enter information about a new dam (reservoir)
- Enables the user to query information about dams
- Enables the user to interact with the map to query information about dams
- Allows new users to register to be able to access some parts of the system (different users will have different access rights)

Project implications/impacts:

One of the major outcomes of this tool is that it can be used to guide management and maintenance of small reservoirs, often silted up by sedimentation. The maintenance plan function was based on the estimated number of years needed to fill up the active storage of reservoirs in selected and modeled reservoirs in the basin—specifically in Lotsane catchment in Botswana and Gwanda district in Zimbabwe. DSS users can extend the problem and use the tool for estimating sediment yield and develop a maintenance plan for any reservoir in the basin. With an assumption of steady increases in annual sediment accumulation in a reservoir, it is possible to estimate the point in time when a significant volume of sediment is accumulated in a dam and hence prepare for sediment removal or dredging activities, which is a common practice in small dams. Furthermore, it can be used to accurately estimate and properly allocate water available in reservoirs.

2. Activities Completed

How did you reach the above described achievements? What activities did you implement and complete? Did you have to change any of the initially planned activities? If so please describe and explain the reasoning for this.

Description	Major Activities
Generating inventory of SRs and SWIs and related data	• Identification and characterization of small reservoirs from Remote Sensing data • An inventory and ground-truthing of small reservoirs and SWIs (in Lotsane catchment in Botswana, and Gwanda and Matobos districts in Zimbabwe as well as Mabalane in Mozambique). Note however that for Mabalane and Matobo only limited ground truthing took place.
Development of web-based DSS	• Development of database for data capture and spatial integration of information (Annex 1) • Estimation of sedimentation rates at selected SR sites in Limpopo included • User-friendly decision support system (DSS) or tool developed and deployed (draft available online for team comment only)
Uptake by local users (training)	• Training of local water managers, agricultural officers and farmers undertaken in Gwanda at district and ward level 23-25 July 2012 (wards Nhwali and Silonga) in Zimbabwe. • First demonstration session of the DSS to L2 members and feedback collected in Gaborone on 14 October 2012 • Presentation for wider audience at the 12th WaterNet / WARFSA/ GWP-SA Symposium, 26-28 October 2011, Maputo, Mozambique • Presentation for wider audience at the 13th WaterNet / WARFSA/ GWP-SA Symposium. 31 Oct-2 Nov, 2012 Birchwood Hotel, Johannesburg, South Africa (Conference programme is attached - **Attachment 1**)

3. Lessons Learned

What did you learn along the course of implementation? What recommendations can you give for future action if asked "if you did this all again?" "What now?" and "What next?"

- ✓ The availability of appropriate satellite images with a high resolution is a challenge –the project could not afford images with a high resolution. This was ameliorated by thorough ground-truthing. It was also important to ensure correct interpretation of results. For example cloud/shadows, if not carefully filtered, could lead to wrong conclusions about the number of small reservoirs.

- ✓ Through participatory training extension workers and farmers are able to identify reservoirs and other SWIs and also investigate problems for devising solutions

- ✓ The users' should be involved in design of the database requirements to better develop plans for dam management.

- ✓ Catchment protection works for mitigating erosion also require the wider community.

- ✓ Community involvement becomes a rational approach for more impact at grassroots level.

Attachments

1. Research publications and communication outputs

List (in the table below) all outputs produced within the scope of the innovation funds project. Please provide a copy of the output or the web link, including links to pre-prints of journal articles. Possible output types are:

a. *Books and Book Chapters*[1]
b. *Journal articles (include articles that have been submitted*[2]
c. *Research Reports (working paper, consultant's report, discussion paper, project reports, etc)*
d. *Student theses*
e. *Conference and Seminar Papers*

Output Type	Reference (Author, year, title/ output name, etc.)	Target audience	How disseminated / promoted / used	Any feedback on its use, or how monitored/ evaluated
a)	Mulengera, P., Manzungu, E. and Kileshye Onema, J. 2012. ICT-based identification and characterization of small reservoirs in the Limpopo river basin in Zimbabwe, Environment and Natural Resources Research, 2(3) 25-42. Doi:10.5339/enrr.v2n3p25. URL:http://dx.doi.org/10.5339/enrr.v2n3p25. Paper is attached-**Attachment 2**) DOI: 10.5539/enrr.v2n3p25	International community	Online journal article	Invitation to submit articles to other journals
e)	B.F. Alemaw; M. Majaule; T. Simalenga (2012) Modeling study of erosion and sedimentation impacts on small reservoirs in a semi-arid environment. Proc. of of 13th WaterNet / WARFSA/ GWP-SA Symposium, Water and Land Theme, pp1-5	Over 60 participants	Conference oral presentation	
e)	Mulengera, P.-M. B., Kileshye Onema, J.-M., Manzungu, E. (2011) *Development of a decision support system for effective management of small reservoirs in the Limpopo basin in Zimbabwe*, In Proceedings of the 12th WaterNet/WARFSA/GWP-SA Symposium, held in Maputo, Mozambique, 26-28 October 2011.	Over 60 participants	Conference oral presentation	

[1] *Please indicate if these are peer-reviewed or not.*
[2] *Please indicate if these are peer-reviewed or not.*

2. Capacity building of people engaged in the project

Please list any people engaged in the project whose capacity has been strengthened (students, trainees, fellows, project staff, key beneficiaries, etc.) built through your Innovation Funds Project.

FAMILY NAME, Given Name (if available)	Gender	Nationality	In case of students level (e.g., MSc, PhD), affiliated University/ type of training otherwise staff category (e.g. researcher, farmer, extension worker, government official)	Research / thesis subject	Outputs (if any)
Mulengera, P. (2011)	M	Zimbabwe	Dissertation submitted as a partial fulfillment for MSc degree in IWRM	*Development and application of an ICT-based decision support system for effective management of small reservoirs: the case of Gwanda district, Zimbabwe*, Unpublished MSc IWRM Thesis, Civil Engineering Department, University of Zimbabwe, Harare.	MSc thesis
Mulengera, P.-M. B., Kileshye Onema, J.-M., Manzungu, E. (2011)	M	DRCongo Zimbabwe	Presentation made by young scientist who had recently graduated	*Development of a decision support system for effective management of small reservoirs in the Limpopo basin in Zimbabwe*, In Proceedings of the 12th WaterNet/WARFSA/GWP-SA Symposium, held in Maputo, Mozambique, 26-28 Oct, 2011.	Refinement of methodology
M. Majaule	F	Botswana	Dissertation submitted as a partial fulfillment for BSc degree in Geology	Thesis: Reservoir sedimentation and erosion impacts on rainwater harvesting structures in Lotsane catchment	Ground truthing of small reservoir sites; sedimentation maintenance plans
C. Motlhala	M	Botswana	MSc researcher in software engineering. He developed and deployed a java based DSS for managing the database with Google map background spatial locator	Research report	Database with access platform for data entry, computation and decision making at different user's access level

3. Outreach to targeted actors or actor groups

Please list any outreach activities carried out during your Innovation Funds Project.

Type of outreach activities (e.g. informal/ formal meeting, stakeholder consultation, seminar, training, forum)	What type of participants (e.g. farmer, researcher, extension worker, NGO, Priv. sector)? How many participants (gender/ diversity distribution)?	Dates, venue (location, country)	Any feedback or how monitored/evaluated? Any evidence that your outreach activities led to some positive change?
First demonstration session of the DSS system	L2 researchers and students	Meeting Room of Mondior Hotel/News Café, Gaborone, on 14 October 2012	• The developed of the DSS system was demonstrating where feedback on the up-scaling of the application of the system to include also other new sites when new/ additional data can be populated. • The database can allow interactive entry of new information and analysis is allowed. • The attendants acknowledge receiving updated version to use it for sediment yield estimation in their selected watersheds.
**2013 LBDC Reflection workshop	LBDC scientists, communications specialists, implementers, water managers	April 2013, tentative	
**Local water management agencies in Botswana and Gwanda, Zimbabwe	Local water managers	First half 2013, tentative	

**Planned dissemination activities

ANNEX 1. LIST OF COLUMNS USED IN THE DEVELOPMENT OF THE D.S.S.

Col. 1	Col. 2	Col. 3	Col. 4	Col. 5	Col. 6	Col. 7	Col. 8	Col. 9	Col. 10	Col. 11	Col. 12	Col. 13	Col. 14
						Table 1. CATCHMENT CHARACTERISTICS							
NAME OF DAM	COORDINATES		C AREA(km²)	DAM VOL(m³)	STREAM or Slope LENGTH (m)	MIN ELEVATI0N (m)	MAX ELEVATION (m)	Mean Annual Rainfall (mm)	Drop in Head (m)	SLOPE(m/m)	SLOPE(%)	SLOPE(?)	(β)

Col. 15	Col. 16	Col. 17	Col. 18	Col. 19	Col. 20	Col. 21	Col. 22	Col. 23	Col. 24	Col. 25	Col. 26	Col. 27	Col. 28
Sediment yield Factors													
M factor	L_factor	S_factor	LS_factor	R FACTOR	K FACTOR	C FACTOR	P FACTOR	SEDIMENTATION RATE(ton/ha/yr)	C AREA(ha)	SDR	SDR (%)	TOTAL POTETIAL EROSION (t/yr)	SEDIMENT YIELD (t/yr)

Date of satellite data										
Dry or wet season?										
Type of satellite data										
reservoir surface area from satellite (m2)										
Avergage depth of the reservoir (m)										
Dam volume (m3)										
Dead storage(% of dam volume <100%)										
Vol of sediment (m3/yr)										
Years (1 dec place)										

Reservoir volume from satellite

Recommended years for dredging

Col. 29 | Col. 30 | Col. 31 | Col. 32 | Col. 33 | Col. 34 | Col. 35 | Col. 36 | Col. 37