Short Report on
Five masters projects from the Mzingwane Catchment, Zimbabwe

a contribution to the WaterNet Challenge Program Project 17

“Integrated Water Resource Management for Improved Rural Livelihoods: Managing risk, mitigating drought and improving water productivity in the water scarce Limpopo Basin”
**WaterNet** is a regional network of university departments and research and training institutes specialising in water. The Mission of WaterNet is to enhance regional capacity in Integrated Water Resources Management through training, education, research and outreach by sharing the complementary expertise of its members. WaterNet member institutions have expertise in various aspects of water resources management, including water supply, sanitation, groundwater, wetlands, irrigation, water law, water economics, community based resource management, flood forecasting, drought mitigation, water conservation and information technology. These institutions are based in Botswana, Kenya, Lesotho, Mozambique, Namibia, South Africa, Tanzania, Uganda, Zambia and Zimbabwe. The WaterNet network is based at the University of Zimbabwe, in Harare, Zimbabwe.

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WaterNet is leading Project 17 under the Challenge Program on Water and Food, entitled “**Integrated Water Resource Management for Improved Rural Livelihoods**”. The project is financed by the CGIAR through the CPW&F and by the partners in the project.

The partners in the project are:

**Project leader:** WaterNet  
**International Research Institutes:**  
- International Crop Research Institute for the Semi-Arid Tropics (ICRISAT)  
- International Water Management Institute (IWMI)  
**Universities:**  
- UNESCO-IHE  
- Universidade Eduardo Mondlane: Faculdade de Agronomia e Engenharia Florestal  
- University of the Witwatersrand: School of Civil and Environmental Engineering  
- University of Zimbabwe: Centre for Applied Social Sciences; Department of Civil Engineering; Department of Soil Science and Agricultural Engineering; Mineral Resources Centre  
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- Instituto Nacional de Investigaciones Agronomicas, Mozambique  
- Mzingwane Catchment Council, Zimbabwe  
- Water Research Commission, South Africa  
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- World Vision Zimbabwe

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Introduction

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In the poverty stricken rural areas of water scarce semi-arid tropics, translating IWRM from concept to action remains largely undone. New policies and structures, developed through water reforms since 1990, do not generally penetrate to the smallholder farmer. Smallholder farmers are generally part of structurally and/or politically marginalised districts, such as distant rural areas (Mozambique), former homelands (South Africa) and communal lands (Zimbabwe), with little voice in natural resource management.

Water policy and institutions in the basin are mainly concerned with water for irrigation, cities, mines and industry. However, blue water resources for irrigation are over-committed in the basin, while the bulk of agricultural produce sustaining lives of resource-poor farmers originates from green water flows in rainfed agriculture. Rainfed agriculture is risky, with recurrent droughts and dryspells. However, there is a large untapped yield potential even in the semi-arid rainfed areas. Water productivity, yields and thereby livelihoods can be improved, through integrated soil and water management for dryspell and drought mitigation. The challenge is to facilitate an adaptive process of participatory farm development, supported by institutions and an IWRM framework that incorporates all facets of managing green and blue water resources.

This report is a summary of findings from initial research carried out in the Mzingwane Catchment, Zimbabwe, during the 2003-2004 field season, prior to formal inception of the WaterNet Challenge Program Project. The research was carried out by five masters students from the University of Zimbabwe, in the study area of (mainly) Upper Mzingwane Subcatchment. The students were supervised by University of Zimbabwe, WaterNet, ICRISAT and UNESCO-IHE staff.

Jean Marie Kileshye Onema studied the effect of land use changes and other human activities on the hydrology of the Insiza sub-catchment, which forms the eastern portion of the headwaters of the Mzingwane system. His results show a decrease in run-off and a decrease in days with no-flow - the latter probably due to dam management practices.

Norman Maisiri studied comparative water efficiencies and crop productivity of low cost drip irrigation compared to conventional surface irrigation, at Zhulube irrigation scheme, south of Filabusi in the upper Mzingwane Subcatchment. His results show a water saving of over 50% under drip compared to surface irrigation, but no significant differences in vegetable yield or labour.

Rosemary Murata studied access to water for vulnerable children in Insiza District. Her results indicate that most (70%) of the children surveyed have adequate access to water, but almost half are accessing unsafe water sources. This figure increases during the dry season. More than half of the children surveyed do not get any income from water-related projects.

Jean-Marc Mwenge Kahinda studied water productivity and yield gap in rainwater harvesting systems in four districts of Mzingwane Catchment - central districts contributing much of the run-off to the Mzingwane River main stem. The survey indicated presence of in-situ water harvesting systems in all the visited districts. Analysis using APSIM showed that combined use of fertiliser and water harvesting systems can reduce crop failure risks from 20% down to 7%. Transpirational water productivity (WPT) was improved with increased fertilization and supplemental irrigation. The results of the study showed that WHS when combined with fertiliser
(nitrogen) application, irrigation components and planned and integrated at catchment scale can achieve effective results.

Lerato Nare studied water quality monitoring systems throughout the Mzingwane Catchment, and the participation of stakeholders therein. His results show very limited stakeholder participation in and awareness of the established government systems. However, there is much indigenous knowledge of water quality surveillance which could be incorporated into the formal systems.

The findings of the five projects whose results are summarised in this report shall be further documented in separate forthcoming papers.
A hydrological assessment of land use changes and human effects on water resources in semi-arid Zimbabwe: The case of the Insiza sub-catchment

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The main objective of the study was to assess and identify changes in flow characteristics over time and their interactions with land use changes and human activity in a semi-arid sub-catchment. The research focused on surface water: groundwater characteristics were not analysed.

The study area, Insiza Sub-catchment is part of the Mzingwane Catchment, draining southwards into the Mzingwane River and thence the Limpopo River. It covers an area of 3400 km² and is divided into two main hydrological zones, the Upper Insiza and the Lower Insiza. Mean annual runoff of the two hydrological zones is 50 mm and 38 mm respectively. This Sub-catchment falls under the District of Insiza, Matebeleland South Province in Zimbabwe.

Hydrological time series (35 years) of four gauging stations of the sub-catchment were analysed. The methodology was a combined analysis of flow characteristics such as flow duration curves, maximum flows, number of days with zero flows, runoff coefficients and with the use of satellite images to track lands use changes. Human influences over water resources were assessed through the effect of hydrological infrastructure mainly the construction of large dams.

The analyses indicate a decrease in flows when comparing the 1960s to the 1980s and the 1990s. Runoff generation increase at a smaller scale (from 2% to 6%) was not felt at the sub-catchment level where the opposite effect happens: runoff coefficients went down from 3.5% to 2%. Dam management affected the flow regime of the river by increasing the flow occurrences. Land use change over the period considered shows a conversion of about 14% mixed impacted lands into fields, as well as a decrease in good natural vegetation and water bodies of respectively 0.4% and 0.5%.

Further research should be carried out at the plot scale as well as at the catchment scale for a better understanding of changes in runoff generation.
An on-farm evaluation of the effects of low cost drip irrigation on water and crop productivity, compared to conventional surface irrigation system

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The dominant agricultural philosophy that views land as a scarce resource and aims to maximise crop yields per unit land through better varieties while removing nutrients and water as constraints needs to be replaced by a philosophy that views land, water, nutrients and genetic sources as an integrated set of scarce resources that need to be managed by stakeholders. This on farm research study was carried out at Zhulube irrigation scheme in a semi arid agro tropical climate of Zimbabwe to determine how low cost drip irrigation technologies compare with conventional surface irrigation systems in terms of water and crop productivity.

A total of nine farmers who were practising surface irrigation were chosen to participate in the study. English giant rape (\textit{Brassica napus}) was grown under the two irrigation systems with three fertiliser treatments in each system. These trials were replicated three times in a randomized block design. Biometric parameters of leaf area index (LAI) and fresh weight of the produce, water use efficiency (WUE) were used to compare the performance of the two irrigation systems. A water balance was performed for analysis of WUE. The economic profitability and the operation, maintenance and management requirements of the different systems were also evaluated.

There was no significant difference in yield between drip and surface irrigation systems: 8.5 ton/ha for drip compared to 7.8 ton/ha for surface irrigation. There were significant increases in yield due to use of fertilisers. The leaf area indices were comparable in both systems with the same fertiliser treatment, ranging between 0.05 for surface irrigation without fertiliser to 6.8 for drip irrigation with fertigation.

Drip irrigation used about 35\% of the water used by surface irrigation systems, thus giving much higher water use efficiencies. However, current irrigation water pricing policy, which is based on area irrigated rather than water abstracted, does not encourage water savings.

Low cost drip irrigation systems did not show any labour savings compared to surface irrigation, especially when farmers have to manually lift the water into the drum supplying the drip system. The gross margin level for surface irrigation was lower than for drip irrigation, but the gross margin to total variable cost ratio was higher in surface irrigation systems. The implication is that surface irrigation systems give higher returns per variable costs incurred.

It is concluded that low cost drip irrigation systems achieved an overall water saving over 50\% as compared to surface irrigation systems.
It was not the type of irrigation but the type of fertiliser that significantly influenced vegetable yield. Accordingly, low cost technologies should be used in conjunction with good water and nutrient management if higher water and crop productivities are to be realised.
Access to water for Improved Rural Livelihoods: An investigation of the perspectives, experiences and strategies of orphans and other vulnerable children: a case study of Insiza District Mzingwane Catchment

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Poverty stricken rural and water-scarce semi-arid tropics such as in the Limpopo basin are global hot spot area in terms of water for food and improved livelihoods. The study area is situated in Zimbabwe, a country characterised by a number of challenges such as HIV/AIDS, a deteriorating economy and hyper-inflation. The impact of HIV/AIDS and generally deepening poverty has undermined the capacity of families to provide care and support for children. Particularly vulnerable groups are orphans and those infected and affected by HIV/AIDS, street children and other working children and the disabled. As more children are becoming heads of households because of the HIV/AIDS pandemic, it is vital to consider their voices when looking at stakeholders in natural resource management, including water.

This study aimed at hearing the perspectives, experiences and strategies employed by orphans and vulnerable children in their quest to secure water. Data was collected through questionnaire interviews, structured in-depth interviews, focus group discussions and observations. The lives of the children, their coping mechanisms and suggestions on how they feel their plight can be alleviated were discussed in the focus group discussions. Observations were also undertaken to reinforce data gathered on the water sources in the area, methods of abstracting water and the distances to the water sources.

The loss of both parents by the children came out as the most devastating aspect of the HIV/AIDS pandemic with 96% of those interviewed having lost their fathers and 90.2% having lost their mothers. 57% of the children were staying in households headed by grandparents who themselves were often too old to handle the household chores, such as looking after the children, sourcing water, undertaking economic activities and bringing food to the table.

Results reveal that 41% of the children get their water from unprotected wells, with 46% saying the source was less than 500 m from their household. 70% of the children got the water they needed themselves for uses such as cooking, drinking and hygiene purposes. Most children responded that their water sources do not have water throughout the year and that they resort to unprotected sources such as dams. Awareness on government and NGO projects that use water to improve rural livelihoods was minimal and of those who responded, 54% were not involved in the projects and, of those involved, 53% did not get an income. This clearly shows a loss of an economic opportunity for water.
Water productivity and yield gap analysis of water harvesting systems in the semi-arid Mzingwane catchment, Zimbabwe

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Water for food is now a global major challenge. In southern Africa's semi-arid tropics, rainfed agriculture accounts for more than 95% of the land used for food. However, high population growth, decline in productivity, scarcity of arable land, irrigation expansion limitations, erratic rainfall and frequent dry spells are causing food scarcity in the region. For this reason, interests are directed at increasing rainfed agriculture crop yields in the semi-arid regions through the use of water harvesting systems (WHS), such as tied ridges.

A survey of existing WHS was carried out in the south-east regions of Zimbabwe in the districts of Insiza, Gwanda, Umzingwane and Beitbridge (four districts of the Mzingwane catchment) as well as Zvishavane and Chivi districts (in the adjacent Runde Catchment). The survey was followed by a study that aimed at analysing the agro-hydrological functions of water harvesting systems, assessing the water balance of the water harvesting systems and also estimating the yield gap between the actual yield and maximum yield considering the water productivity with and without WHS.

The survey indicated presence of in-situ water harvesting systems in all the visited districts. Macro-catchment WHS and micro-catchment WHS are also found but are still uncommon. From the survey, boundaries differentiating storage systems from conventional dam are suggested.

The Agricultural Production System Simulator Model (APSIM) was calibrated on data collected during the survey, and then used to run thirty years simulations for seven different treatments on two soil types of different carbon content with and without carry over effect. APSIM is a one dimension model running on daily time step simulating crop growth. Part of the APSIM output was interpreted using the principle of the Green Water Crop Model (GWCM). The GWCM indicates the fraction of productive water consumed from the fraction of plant water available in the soil profile.

The analysis showed that combined use of fertiliser and water harvesting systems can reduce crop failure risks from 20% down to 7%. There was a substantial increase in crop yield from an average of 371 kg/ha in the control, corresponding to farmer's practice to 2260 kg/ha for a system with nitrogen fertilisation and supplemental irrigation with water harvesting. Increase in crop yield reduced the yield gap from 1867 kg/ha to 637 kg/ha in the latter treatment. Transpirational water productivity (WPT) which normally is considered constant for a given crop under the same environmental conditions was improved with increased fertilisation and supplemental irrigation. A key factor explaining this increase in WPT with management is probably the bridging of critical nutrient and water stress period. Improvements in WPT from 0.86 kg/m³ in the control treatment to 2.31 kg/m³ for nitrogen and WHS treatment are achieved. The results of the study show that WHS when combined with fertiliser (nitrogen) application, irrigation components and planned and integrated at catchment scale can achieve effective results.
Involvement of stakeholders in the water quality monitoring and surveillance system: the case of Mzingwane Catchment

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The world has witnessed a paradigm shift in strategies for managing water resources in recent years. There has been a shift from supply based strategies to demand management. The focus is now on managing as much as possible the available resource. Stakeholder participation is viewed as critical in the current water sector reforms taking place in the region including Zimbabwe. Zimbabwean policies and legislation encourage stakeholder participation and this study aimed at finding out whether indeed on the operational level, there was stakeholder participation in water quality monitoring and surveillance and also assess indigenous knowledge and practices in water quality monitoring communities, extension workers, farmers and NGOs were interviewed.

There is very limited stakeholder participation although there is adequate institutional frame, structures and organisations to support this. For the Zimbabwe National Water Authority (ZINWA), stakeholders are the permit holders, who they give feedback after analysis of samples, since these pay for them. The Ministry of Health and Child Welfare generally only releases information to rural communities when it is deemed necessary for their welfare. There are no guidelines on how a dissatisfied member of the public can raise a complaint - although some stakeholders carry such complaints to Catchment Council meetings.

There are many useful indigenous knowledge and practices used by the communities of the area. Physical parameters such as smell, taste, colour and odour are used to assess the quality of water. Residents are generally more concerned about the physical parameters than the bacteriological quality of water. They are aware of what causes water pollution and the effects of pollution on human health, crops, animals and aquatic ecology. They are aware of ways of preventing pollution and when a source of water is polluted, they prefer to boil the water if it is meant either for human consumption or laundry and bathing. For productive water, they felt that the source had to be abandoned and alternative source found. Many of these knowledge systems could be integrated into the formal water quality monitoring systems, in order to complement the official monitoring networks.

There are partners such as NGOs and Rural District Councils who are willing to fund a more encompassing water quality system.
## Glossary of Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>AREX</td>
<td>Agricultural Research and Extension service, Ministry of Agriculture and Rural Development, Zimbabwe</td>
</tr>
<tr>
<td>CGIAR</td>
<td>Consultative Group on International Agricultural Research</td>
</tr>
<tr>
<td>DA</td>
<td>District Administrator</td>
</tr>
<tr>
<td>MCC</td>
<td>Mzingwane Catchment Council</td>
</tr>
<tr>
<td>NGO</td>
<td>Non-governmental organisation</td>
</tr>
<tr>
<td>RDC</td>
<td>Rural District Council (principal local government structure), Zimbabwe</td>
</tr>
<tr>
<td>SCC</td>
<td>Subcatchment Council (subdivision of a catchment council)</td>
</tr>
<tr>
<td>ZINWA</td>
<td>Zimbabwe National Water Authority (state water management authority)</td>
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</tbody>
</table>
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