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# Mainstreaming wastewater through water accounting: The example of Botswana

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**Abstract**

Botswana is moving towards integrated water resource management, but wastewater is still not treated as an economic good. This is surprising as water scarcity is growing, the costs of conventional supply sources are rising and wastewater becomes more abundant due to improved sewerage and sanitation systems. Mainstreaming wastewater makes economic, social and environmental sense. Botswana first developed water accounts (WA) in 2000 as a resource planning tool. However, wastewater was excluded from the WA.

This paper demonstrates how wastewater can be incorporated into the WA and what the results are for the period 1992–2003. The paper further explores the possible benefits of several re-use and recycling options. While re-use for irrigation may be the safest short term destination for re-use, it does not yield the highest economic returns, and therefore additional re-use and recycling options need to be explored. The paper argues that re-use of wastewater is likely to reduce future water tariff increases, increasing international competitiveness. Finally, the paper shows that WA can be used to identify essential data gaps and focus future data collection on key Integrated water resource management issues.


*Keywords:* Botswana; Integrated water resource management; Natural resource accounting and wastewater

## 1. Introduction

The 2003 National Master Plan for Wastewater and Sanitation (NMPWWS) concluded that wastewater is not yet considered to be an economic resource (SMEC and Shand, 2003). This is the case despite the fact that the 1991 Botswana National Water Master Plan (BNWMP) called for studies on the potential re-use and recycling of wastewater more than 10 years ago, particularly in urban settings (SMEC et al., 1991). Clearly, valuable time has been lost in the mainstreaming of wastewater in integrated water resource management (IWRM).

The United Nations published a handbook on Natural Resource Accounting (System of Environmental and Economic Accounting or SEEA) in 1993, the operational manual in 2001 and a revised handbook in 2003. In 2003, a special application for fisheries was developed followed by a special handbook for water accounts in 2005. Water accounting is increasingly recognised as an important IWRM tool as it treats water as an economic good and provides insights into the stocks and uses of water resources, including the efficiency of use (Lange et al., 2003; United Nations, 2003, 2005 and Lange and Hassan, 2006). The latter makes it valuable for the water efficiency plans that countries pledged to prepare during the 2002 World Summit for Sustainable Development held in Johannesburg. Mainstreaming wastewater could be facilitated by incorporating wastewater in existing water accounts. This paper presents the result of a study that aimed to incorporate wastewater into Botswana's water accounts and to explore the potential benefits of re-use and recycling of wastewater. In southern Africa, Namibia, Botswana and South Africa have developed partial water accounts; Tanzania and Mozambique are in the process of constructing such accounts. Internationally, countries such as Australia, New Zealand, France and Chile have

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established water accounts (Statistics New Zealand, 2004; Lange and Hassan, 2006 and www.isa.org.usyd.educ.au).

This paper discusses the methodology, data sources and constraints (Section 2), discusses the main findings of the water accounts (Sections 3 and 3.2) and makes concluding remarks (Section 4).

## 2. Methodology, data sources and constraints

The National Accounts (NA) ignore what happens to natural resources during the development process. Natural Resource Accounts (NRA) correct this shortcoming by showing the resource stocks and uses of natural resources. In particular, water resource accounts consist of stock and use accounts in physical and monetary units. The stock accounts indicate the amount of water available at the start of the year (1st of January), inflows and outflows during the year and the end stock (31st of December). Traditional stock accounts refer to (1) water resources stored in reservoirs/dams; (2) water in rivers and wetlands and (3) groundwater. Traditional use accounts indicate the use of water for economic purposes (household consumption and production). These accounts may be prepared by economic sector, by types of water (reservoir, river or groundwater) and by institution (different water suppliers).

The accounts are first expressed in physical units ($m^3$). Subsequently, the value of water resources is determined and monetary accounts are prepared by multiplying physical units by monetary units.

Water accounts are prepared for a period of years, the length of which depends on the available data. The longer the time series data are, the more valuable the water accounts become as trends and shocks can be observed and analysed. Water accounts also permit international comparisons and benchmarking. For example, figures on per capita water consumption and the value added per $m^3$ by economic sector can be compared with those of other countries to provide insights about water use efficiency.

Prior to this study, Botswana's water accounts covered 10 years (1992–2001). The study updated the accounts to 2003 and added physical stock accounts for reservoirs and three wastewater accounts.

### 2.1. Fresh water accounts

According to the System of Environment-Economic Accounting (SEEA), stock accounts should be developed for surface water (EA 131), sub-divided into reservoirs/dams (EA 1311), lakes (EA 1312) and rivers (EA 1313), and groundwater resources (EA 132). EA 1312 and 1313 are not a priority for Botswana as the direct abstraction from rivers and the delta is currently very low.

The surface water sub-accounts were constructed for the country's main reservoirs (EA 1311: Gaborone, Bokaa, Nnywane, Shashe and Letsibogo). The Water Utilities Corporation (WUC) records the stored water volumes as well as abstraction. Surprisingly, the inflows into the dams are not recorded, but the average evaporation rates are known for each dam. Therefore, the annual evaporation was estimated by multiplying the evaporation rate for each dam[1] by the average annual amount of stored water. Subsequently, the inflow was estimated as:

$$\text{Inflow} = \text{Closing volume} + \text{Abstraction} + \text{Evaporation} - \text{Opening volume}$$

To reflect the growth in inter-dam water transfers,[2] the inflow should be separated into natural inflow and inflow from other dams (as well as inflows from treated wastewater that is recycled). Similarly, abstraction should be divided into abstraction for treatment and distribution and transfers into other dams. Transfer inflows would then equal transfer outflows minus transfer losses. Unfortunately, current WUC data do not permit the separation of natural and inter dam inflows and abstractions.

The study did not attempt to improve the existing, incomplete stock account for groundwater (EA 132; Arntzen et al., 2003). The existing account shows the abstraction and recharge of operational well fields as well of individual bore-holes. The opening and closing volumes are unknown, making it impossible to estimate when well fields could run dry. Other limitations of the groundwater stock account are:

- Lack of knowledge about the amount of groundwater that can be abstracted in an economically viable way.
- Incomplete recharge rates.

Arntzen et al. (2003) estimated the recharge for a number of well fields and concluded that abstraction exceeds the estimated recharge in 14 out of the 20 operational well fields, for which adequate data were available. The analysis further showed that resting of well fields leads to rapid recovery of groundwater levels.

The water use accounts are prepared for: (1) institutions (WUC, Department of Water Affairs or DWA, District Councils or DC and self providers); (2) water source (ground or surface water) and (3) economic sector. The classification of economic sectors is the same as the classi-

[1] Gaborone dam 1.6%, Letsibogo and Bokaa 2%, Shashe dam 2.26% and Nnywane dam 2.3% (source: WUC). Evaporation exceeds abstraction in all dams. It would have been better to estimate evaporation by multiplying the evaporation rates by the average surface area. However, surface area is not regularly recorded; hence this method could not be used.

[2] Two inter-dam transfers occur: Gaborone dam receives water from Bokaa dam and Molatedi dam in South Africa. NSWC from Letsibogo dam destined for Gaborone does not enter Gaborone dam but reaches end-users after treatment in Mmamashia plant north of Gaborone. Part of the water transfers from Bokaa and Molatedi dams is channelled directly into the treatment plant while another part is stored in Gaborone dam. No figures were available for the size of each part.