

Natural resources accounting: A tool for water resources management in Botswana

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Available online 3 August 2007

Abstract

Natural Resource Accounting (NRA) has become an important environmental/natural resources management tool in recent years. It provides information on stocks of a resource available at a particular point in time and what activities the resource is being used for. The conventional System of National Income Accounts (SNA) normally does not capture the cost of depletion, degradation or pollution of natural resources. This encourages unsustainable use of natural resources since the costs are not reflected when assessing the country's economic performance or development progress. NRA is thus an attempt to integrate environmental issues into the conventional national accounts. The water sector is one sector that could greatly benefit from this natural resource management tool. Botswana has adopted NRA as a natural resource management tool and has so far developed accounts for minerals, livestock and water. The focus of this paper is on Water Accounting (WA) in relation to Integrated Water Resources Management (IWRM). IWRM is concerned with coordinated development and management of water in order to maximise economic and social welfare without compromising the sustainability of ecosystems. WA helps fill data gaps since it provides the required information for IWRM to be achieved. The aim of this paper therefore is to evaluate the Water Accounts of Botswana Report of 2006 to determine the extent to which it can contribute to integrated water resources management. The paper is based on literature review and the results show that: the available water stocks vary depending on rainfall patterns, well fields are over utilised, there has been growth in consumption, and more than 80% of the waste water produced is not being put to use. These results calls for changes in policies, role of institutions and practices pertaining to water resources management which is what IWRM is all about hence the paper concludes that indeed WA can contribute to the realisation of IWRM.

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Keywords: Botswana; IWRM; Natural resources accounting; Water accounting

1. Introduction

Botswana is a semiarid country characterised by frequent and long drought periods. Consequently, there are very few surface water sources in the country, resulting in a very high dependence on ground water resources available countrywide at varying quantities. Temperatures can go up to 40 °C, causing high evaporation rates and thus affecting surface water availability. A combination of these

factors sometime lead to periods of severe surface water shortages as depicted in Table 1 which shows the status of dam levels in Botswana as at 17th November 2005.

The respective rows in the table show the name of the dam, its capacity, level, the estimated time left for the dam to supply (as at 17th November 2005) assuming no further inflow into the dam and lastly the drought status for each dam. The situation however improved with the good rains received in early 2006. Notwithstanding, Chiuta et al. (2005) posit that all the actual potential surface water sources in Botswana will be committed by the year 2020 and that even with the exploitation of the 30 known ground water aquifers, the long run availability of water is under serious threat. Increased population, urbanisation,

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Table 1
Status of dam levels in Botswana as at 17th November 2005

Dam	Capacity (million cubic meters)	Dam level (percentage)	Months of supply without inflow	Drought status
Gaborone	141.4	17.6	Under 3	Severe
Molatedi	201.0	13.2	Half allocation	Severe
Bokaa	18.5	9.7	1	Severe
Nnywane	2.2	41.2	5	Severe
Letsibogo	100.0	61.7	13	Critical
Shashe	85.3	58.7	10	Severe

Water Utilities Corporation Public Notice update on the Drought Situation (The Botswana Gazette, 2005; 19).

industrialisation, expansion of mining and agricultural activities have also increased demand and pressure on water resources. Water is therefore a very scarce and hence precious resource in Botswana. Even though it can be replenished through ground water recharge, it can be depleted if it is used beyond its natural regenerative capacity. In addition, since water is a public good, it is perceived to be a free good leading to wasteful water use manifested among others by taps left running in public places, licks not being attended to and washing cars and paved areas using hose pipes (Hambira and Gandidzanwa, 2006). Underpinning many of these problems is the general perception by people that water will never run out (Swatuk and Rahm, 2004). Sustainable use of water resources has to be encouraged since water is needed for biological and ecological processes that sustain all forms of life.

In view of the above, Botswana water authorities have embarked on the following water demand management strategies to promote sustainable water use and deliberately reduce the demand for water:

- (a) Public education and awareness raising; this is whereby users are sensitised on the importance of conserving water and the consequences of unsustainable water use. Examples include commemoration of the world water day, world wetlands day and the water week where among other activities, students and the public at large are engaged in essay competitions on the theme of the commemoration. Awareness raising is also done through continuous advertising in the media.
- (b) Technical measures which include, leak detection and repair, rain water collection, waste water reclamation systems, replacement of existing plumbing equipment with the kind that uses less water.
- (c) Regulatory tools which include the establishment of mandatory and enabling legislation, policies, standards and guidelines.
- (d) Economic instruments whereby Botswana is also exploring the possibility of adopting appropriate economic instruments which entail the use of value and prices to serve as incentives and disincentives to encourage sustainable use of water resources.

For the above measures to be effective there is need to adopt water conservation through integrated water demand management (IWRM) since different stakeholders play a role in the realisation of these measures. Furthermore, in order for water resources to be effectively and sustainably managed in Botswana, data is needed on how much surface and ground water resources is there, how much is being used by the different users and for what activities is the water being used, how much is being depleted and the rate of pollution. This information should be provided in physical and monetary measures in order for the relevant authorities to be able to gauge how the resource contributes to development processes. This can be achieved through Natural Resources Accounting (NRA), specifically Water Accounting (WA). Therefore, this paper aims at evaluating the Botswana Water Accounts Report of 2006 to determine the extent to which (WA) can contribute to IWRM. The report was prepared by the Department of Environmental Affairs (DEA) in Association with the Centre for Applied Research (CAR). Publications and results of studies carried out in other countries and related literature on IWRM are also reviewed. The findings from the Botswana report are summarised in relation to IWRM.

2. Integrated Water Resources Management (IWRM) and Natural Resources Accounting (NRA) (Water Accounting (WA))

IWRM is defined by the Global Water Partnership (GWP) in *Global Water Partnership (2004)* as coordinated development and management of water, land, and related resources in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. This definition calls for changes in policies, institutions, and practices in order to promote integrated solutions, sustainable management and better decision making. The *Global Water Partnership (2004)* lumps up the required changes into three broad areas, namely: the Enabling Environment, Institutional Roles and Management Instruments. The IWRM change areas and the specific targeted areas for change are summarised in Table 2.

On the other hand, NRA provides information on stock levels of a resource available at a particular point in time and its uses. The conventional System of National Income Accounts (SNA) normally does not capture the cost of depletion, degradation or pollution of natural resources. This encourages unsustainable use of natural resources since the costs are not reflected when assessing the country's economic performance or development progress. NRA is thus an attempt to integrate environmental issues into the conventional national accounts. The water sector is one sector that could greatly benefit from this natural resource management tool in the pursuit of IWRM.

Table 2
IWRM change areas and targets

IWRM change areas	Areas to target for change
The enabling environment	(1) Policies – setting goals for water use, protection and conservation (2) Legislative framework – the rules to follow to achieve policies and goals (3) Financing and incentive structures – allocating financial resources to meet water needs
Institutional roles	(1) Creating an organisational framework – forms and functions (2) Institutional capacity building – developing human resources
Management instruments	(1) Water resources assessment – understanding resources and needs (2) Plans for IWRM – combining development options, resource use and human interaction (3) Demand management – using water more efficiently (4) Social change instruments – encouraging a water conservation oriented civil society (5) Conflict resolution – managing disputes, ensuring equitable sharing of water (6) Regulatory instruments – allocation and water use limits (7) Economic instruments – using value and prices for efficiency and equity (8) Information management and exchange – improving knowledge for better management

Adapted from GWP, 2004.

According to Lange (1997) NRA in the water sector provides information on present state of water management in terms of current use, economic contributions and extent of subsidies if any. In addition, it provides information on future water use and management in terms of future water demand, how the various water policies impact water demand and provision tradeoffs. NRA also provides the assessment of comparative advantage and allows for the monitoring of resource stocks and flows. Botswana has developed water resources accounts after the realisation that with increasing resource scarcity, economic considerations needed to be systematically incorporated into resource allocation decisions and that resources should be used for the most economically productive activities (Department of Environmental Affairs and Centre for Applied Research, 2006). Water accounts have been constructed for each of the major water suppliers in Botswana, namely: Water Utilities Corporation (WUC), Department of Water Affairs (DWA), District Councils (DC), and other users who are mainly self-providers, as well as for different water sources: groundwater, dams, and rivers (Department of Environmental Affairs and Centre for Applied Research, 2006). The data were supplied by the different departments and hence was fragmented in nature and had a lot of gaps. The accounts were discussed at a workshop of data providers and experts in order to identify serious omissions and errors as well as to devise means of improving data availability and accessibility in required formats for purposes of constructing future NRAs (Department of Environmental Affairs and Centre for Applied Research, 2006).

The main objective of Water Accounting (WA) is to account for water use, depletion and productivity, (Molden and Sakthivadivel, 1999). In a similar manner IWRM ensures that social, economic, environmental and technological aspects are taken into account in the development and management of water resources. WA thus blends well with the Integrated Water Resources Management approach to water management. Molden and Sakthivadivel (1999) postulate that WA involves classifying water balance components into water use categories that reflect

consequences of human interventions in the hydrologic cycle. They classify WA indicators into three categories, namely: physically based indicators- which explain the flow paths of water, how much is being depleted and which use is depleting the water; beneficial utilisation indicators which reveal how much water is beneficially utilised; productivity indicators which show how beneficial the water use is. Therefore WA points to where more research is needed, where savings can be made and where productivity can be enhanced. It also analyses use patterns and is as such useful for planning and evaluation purposes in order to guide policy making and inform the development process.

3. The water accounts of Botswana in relation to IWRM

The Botswana water accounts cover physical accounts, some aspects of economic valuation and waste water supply. The physical units consist of stock and use accounts. The stock accounts are defined as annual quantities of water stored in dams, annual run off to rivers and estimated ground water reserves while the use accounts cover use of water for economic activities and by households according to different types of water (Department of Environmental Affairs and Centre for Applied Research, 2006). The waste water accounts cover the waste water stock accounts, waste water supply accounts and waste water use accounts.

Table 3
The surface water reservoir stock account for Water Utilities Corporation (WUC) dams (Mm³)

All WUC dams	2001	2002	2003
Opening volume	289	319	235
Inflows	277	142	149
Abstraction	174	159	79
Evaporation	72	66	60
Closing volume	319	235	146

Adapted from (Department of Environmental Affairs and Centre for Applied Research, 2006, p. 28).

According to the report (Department of Environmental Affairs and Centre for Applied Research, 2006), in terms of water stocks, the amount of surface water stored (dam sub-account) is highly variable depending on rainfall patterns. The surface water reservoir stock account is reflected in Table 3. The table shows the stocks of all Water Utilities Corporation Dams in terms of opening volume, inflows, abstraction, evaporation and closing volume for the years 2001–2003. The Botswana Water Accounts Report of 2006 also revealed that well-fields are over-utilised and ground water resources are likely to decrease. This is shown in Table 4. These accounts however have many data gaps and require further work. Regarding the water use accounts, the report revealed that there is considerable growth in consumption. This is reflected in Table 5 which shows water use by economic sector. The table shows that the mining sector has the highest growth in consumption followed by house holds and government. This has policy implications in terms of identifying areas where savings can be made, promotion of economic sectors that require little water and the consideration of resource rent charge related to consumption level needs. As for waste water accounts, the study revealed that even though the amount of waste water has doubled since 1992, only 20% of waste water is reused while the remainder is discharged into the environment and calls for opportunities for reuse to be explored. Other general issues revealed by the study concern economic aspects and water that is unaccounted for. Regarding economic aspects, the cost of supply increased due to the need for advanced infrastructure, lower productivity of many dams and well-fields and long distance transfers of water. Since IWRM is about strengthening frameworks for water governance to foster good decision making in response to changing needs and situations (Global Water Partnership, 2004), the findings of WA in Botswana provide valuable information in the pursuit of

IWRM. The review thus shows that indeed NRA (WA) is essential to the realisation of the IWRM.

As mentioned before, NRA (WA) is instrumental to the realisation of the different IWRM change areas alluded to in the preceding section. The change area of the Enabling Environment is determined by national policies and legislation that enable stakeholders to play their role in water resources management. According to Swatuk and Rahm (2004), Water policies in Botswana are often done on piecemeal basis and often reactive rather than proactive. The water accounts would provide the information needed for policy decision making as it provides information on the current stocks and use accounts. This data can be used to forecast future trends. Furthermore, other findings revealed in the report such as water losses (water that is unaccounted for) would be counteracted by putting in place appropriate policies aimed at promoting sustainable

Table 5
Water use by economic sector (Mm³)

User categories	1992	1996	2000	2003
Agriculture	72.9	70.6	76.0	63.4
Mining	12.8	14.4	24.1	26.8
Manufacturing	3.9	2.1	4.0	5.1
Water and electricity	0.0	0.8	0.5	0.7
Construction	0.0	0.4	0.4	0.4
Trade	0.2	0.7	1.0	1.2
Hotels and restaurants	0.2	0.5	0.8	0.8
Transport + communication	0.0	0.2	0.2	0.3
Insurance, banking, business	0.0	0.5	0.7	0.8
Social and personal services	0.0	1.2	1.7	2.4
Government	8.7	8.8	11.1	11.5
household use	36.1	41.1	48.1	56.9
WUC private sector	7.7	0.0	0.0	0.0
Grand total	140.3	141.3	168.6	170.3

Adapted from (Department of Environmental Affairs and Centre for Applied Research, 2006, p. 32).

Table 4
Ground water stock accounts (Mm³)

	1992	1995	2001
<i>Opening volume well fields</i>			
Abstraction (–)	46.3	49.8	55.7
Recharge (+)	15.5	15.5	15.5
Other changes to volume of reserves (±)	Not known	Not known	Not known
Closing volume	Not known	Not known	Not known
<i>Opening volume individual boreholes</i>			
Abstraction (–)	42.1	42.6	39.7
Recharge (+)	Likely to exceed abstraction	Likely to exceed abstraction	Likely to exceed abstraction
Other changes to volume of reserves (±)	Not known	Not known	Not known
Closing volume	Not known	Not known	Not known
<i>Opening volume total developed ground water</i>			
Abstraction (–)	88.4	92.4	95.4
Recharge (+)	At least 57.6	At least 58.1	At least 55.2
Other changes to volume of reserves (±)	Not known	Not known	Not known
Closing volume	Not known	Not known	Not known

Adapted from (Department of Environmental Affairs and Centre for Applied Research, 2006, p. 30).

water use and conservation. Regarding the area of Institutional Roles, there is need to put in place mechanisms that will promote coordinated responsibilities between actors. There are several water providers in Botswana with overlapping jurisdictions preventing smooth and rational policy implementation (Swatuk and Rahm, 2004). There is the Water Utilities Corporation (WUC) who are responsible for water supply in urban areas and hence they are the custodians of all the dams listed in Table 1 above; Department of Water Affairs who are responsible for water supply in major rural villages, District Councils, who are responsible for operating and maintaining water schemes in other rural areas, Self Providers who consist mainly of mining companies and in some instances WUC also supply them with water at full cost recovery, and lastly the Ministry of Agriculture (MoA) Water Development Section which develops water resources for agricultural purposes such as livestock watering and irrigation. The NRA (WA) provides consolidated data to all stakeholders and this in a way will help facilitate integrated decision making since information is shared among stakeholders. In the case of Management Instruments there is need to establish methods and techniques that will enable decision makers to make informed choices between available options. One of the targets for change under this area is water resources assessment which requires setting up systems for routine data assembly and reporting on hydrology, demography and socio economic issues (Global Water Partnership, 2004). NRA (WA) would come in very handy in the realisation of this target area. Another target in this area is demand management which requires using water more efficiently. This can be realised when data on available stocks and rates of water use is available and this information as shown above can be availed by the NRA (WA).

4. Conclusion

WaterNet and the Water Research Fund for Southern Africa (WARFSA) have been promoting IWRM in Southern Africa since 2000 (van der Zaag, 2005). The adoption of NRA, specifically water accounting in Southern Africa would go a long way in informing water resources management for sustainable demand and supply. This would help fill data gaps and to prevent fragmented nature of available data as shown by the inconsistency of years of data collection in Tables 4 and 5. Data gaps are a key barrier to

IWRM across the region and a concerted effort to acquire accurate data through water accounting is important not only for Botswana but for the region especially given shared surface water and ground water aquifers. Therefore, there is need to improve the availability and accessibility of data in the required format for purposes of constructing future NRA (WA). The Botswana Government should thus update the accounts on a regular basis taking into consideration the recommendations made in the Water Accounts of Botswana report of 2006. Some of the recommendations are: distinction of international water sources and domestic ones, establishment of amount of water stored in aquifers, distinction between final and intermediate users, strengthening of the economic aspects of the accounts (Department of Environmental Affairs and Centre for Applied Research, 2006). Even though the current available accounts leave a lot of room for improvement, they provide decision makers with a basis to strengthen integrated water resources management in the country.

References

- Chiuta, T.M., Nherera, B., Thamae, L., 2005. Water demand management strategies in Southern Africa: striving to sustain water supply for the future. Report on the water utilities corporation drought planning workshop. Water Utilities Corporation, Gaborone, Botswana.
- Department of Environmental Affairs (DEA) in association with Centre for Applied Research (CAR), 2006. Water Accounts of Botswana. Gaborone.
- Global Water Partnership (GWP), 2004. Catalysing change: a handbook for developing integrated water resources management (IWRM) and water efficiency strategies. Stockholm.
- Hambira, W.L., Gandidzanwa, C.P., 2006. Water pricing: a key to sustainable water demand management and supply in Southern Africa: a comparative study of Botswana and Zimbabwe. Proc. IASTED Int. Conf. Environmentally Sound Technology in Water Resources Management. ACTA Press, Canada, pp. 24–29.
- Lange, G., 1997. An approach to sustainable water management using natural resource accounts: the use of water, the economic value of water and implications for policy. Research Discussion Paper (18), Department of Environmental Affairs, Windhoek, Namibia.
- Molden, D., Sakthivadivel, R., 1999. Water accounting to assess use and productivity of water. *Water Resources Development* 15, 55–71.
- Swatuk, L.A., Rahm, D., 2004. Integrating policy, disintegrating practice: water resources management in Botswana. *Physics and Chemistry of the Earth* 29, 1357–1364.
- van der Zaag, P., 2005. Integrated water resources management: relevant concept or irrelevant buzzword? A capacity building and research agenda for Southern Africa. *Physics and Chemistry of the Earth* 30, 867–871.