

**Policy Brief**  
**Mining and water resources in Botswana**

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**Prepared by Department of Water Affairs  
& the Centre for Applied Research**

## 1 Introduction

Much of Botswana's economic growth and development has been driven by the mining sector, in particular the diamond sector. Coal, copper, nickel, soda ash and gold are also extracted, but on a much smaller and less profitable level. While government seeks to diversify the economy beyond the mining sector, there is no doubt that mining remains important for future economic development through exploration for other minerals and beneficiation. The 2013 Botswana IWRM-WE Plan<sup>1</sup> (DWA, 2013, p. 92) states that "*Further growth in the mining sector is likely and this may require significant water resources*". WRC (2012) estimated that water demands of the mining sector will grow from 55.4 Mm<sup>3</sup> in 2012 to around 100.4 Mm<sup>3</sup> in 2027, before demand may decrease due to closure of existing mines. The IWRM-WE Plan notes that the opening of new mines could significantly increase water demand of the sector.

Given the future perspective of mining, it is important to understand the water resources used in the mining sector so as to facilitate future mining developments. The objectives of this policy brief are to:

1. Explain how water resources are supplied to and used in the mining sector;
2. Show the sector's water use and its efficiency in relation to other sectors;
3. Show the differences in water use productivity within the mining sector; and
4. Make recommendations for improved data availability and analysis of water resources in the mining sector.

The Department of Water Affairs with the Centre for Applied Research have developed water accounts for 2010/11 and 2011/12 focussing in particular on the water flows and stocks in the country<sup>2</sup> (DWA and CAR, 2014).

## 2 Trend in water use in the mining sector

The growth of the mining sector has led to a rapid increase in water use in the 1990s and until 2003; since then water use has fluctuated rather than increased (Figure 1). This reflects the impact of the 2008 global recession, which have led to considerable variations in annual mineral abstraction.

Key figures:

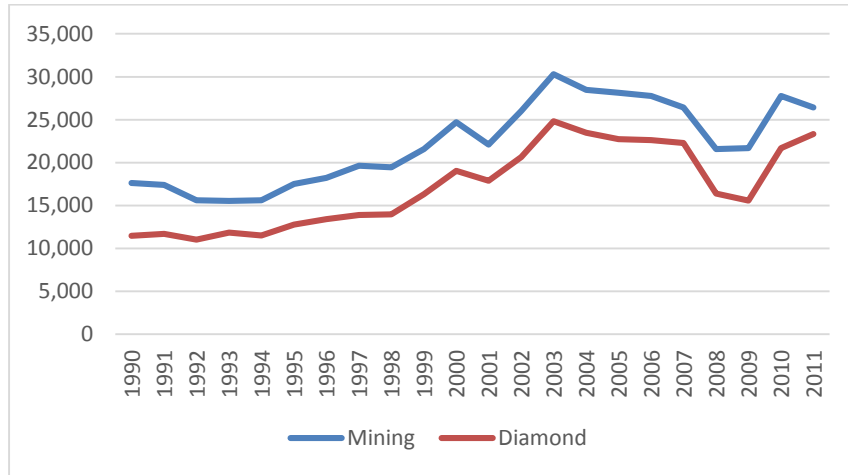
- ✓ *The mining sector is responsible for 10 to 15% of the country's water use*
- ✓ *Diamond production accounts for three quarters of water use in the mining sector*
- ✓ *0.8 - 1 m<sup>3</sup> of water is used to produce 1 carat*
- ✓ *0.125 m<sup>3</sup> of water is used to produce 1 ton of copper-nickel matte*

<sup>1</sup> Department of Water Affairs (2013). Botswana Integrated Water Resources Management and Water Efficiency Plan. Ministry of Minerals, Energy and Water Resources, Government of Botswana.

<sup>2</sup> This brief is based on the work undertaken by Department of Water Affairs (DWA) and Centre for Applied Research (CAR) under the World Bank's Wealth Accounting and Valuation of Ecosystem Services (WAVES) programme. The reference to the full report is: Department of Water Affairs and Centre for Applied Research (2014). Water Accounting in Botswana. WAVES Technical Reports. Available from [www.water.gov.bw](http://www.water.gov.bw), [www.wavespartnership.org](http://www.wavespartnership.org) and [www.car.org.bw](http://www.car.org.bw).

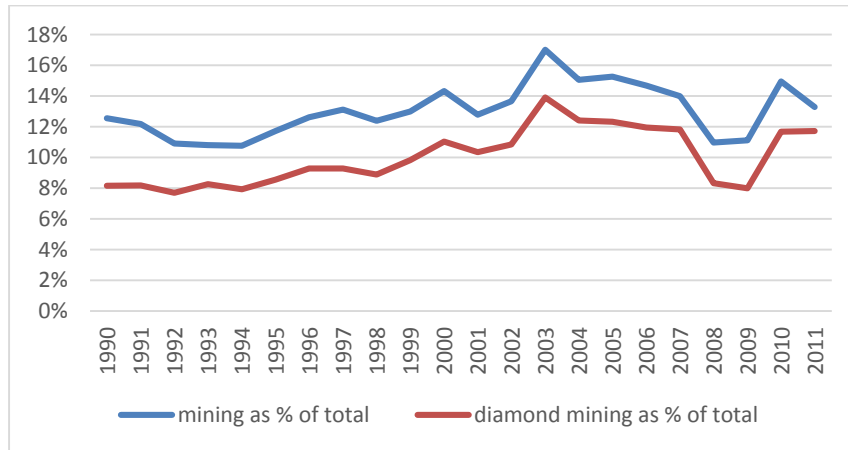
The mining sector's share in the country's water use has ranges from 10 to 15% in the period 1990-2010 with an average of 13.1% (Figure 2). The sector's share peaked in 2003 (to 17%) but has dropped back since then. Diamond mining accounts for just over three quarters of the sector's water use and accounts for an average of 10 % of the country's water use.

**Figure 1: Trend in water use in the mining sector<sup>3</sup> and the diamond sub-sector (000 m<sup>3</sup>)**



Note: the mining sector in this figure covers diamonds cooper/nickel and coal.

**Figure 2: Trend in share of the mining sector of total water use (as %)**



Note: the mining sector in this figure covers diamonds cooper/nickel and coal.

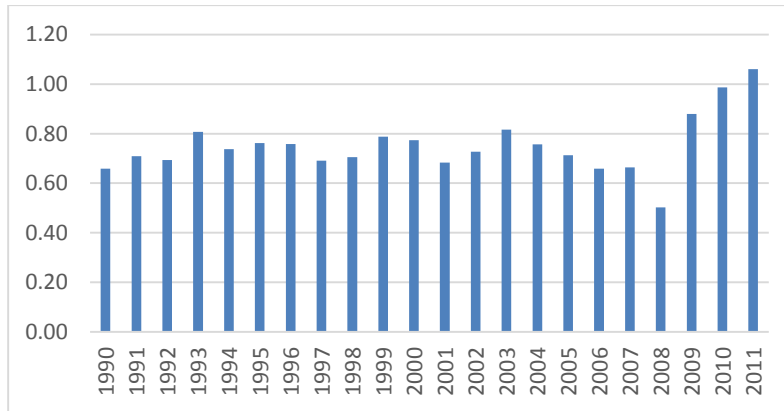
Combining the mineral<sup>4</sup> and water accounts allows the calculation of the trend in the water use per unit of production in diamond mining (carats) and copper/ nickel (tonnes). These are shown in Figures 3 and 4 respectively.

<sup>3</sup> In figures 1 & 2, the mining sector includes diamonds, copper/nickel and coal only.

<sup>4</sup> Jefferis (2014). Mineral Resource Accounts and implications for Development in Botswana. WAVES Technical Report. Available from [www.wavespartnership.org](http://www.wavespartnership.org).

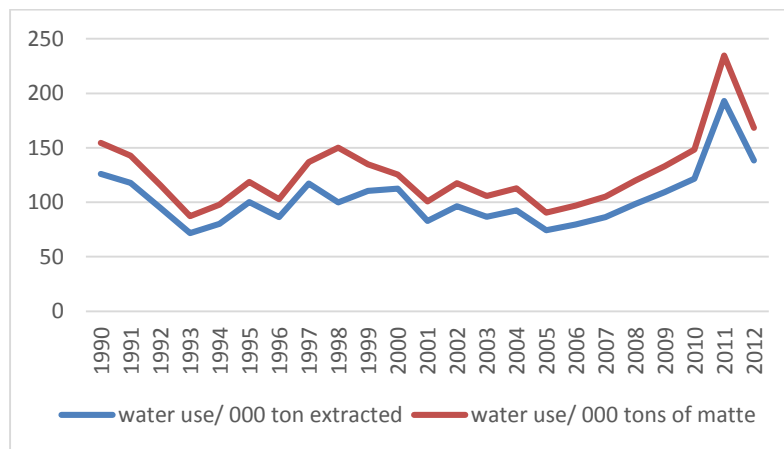
While water use per carat has remained fairly stable in the period 1990 – 2007, it has rapidly increased after 2009 to over 1m<sup>3</sup>/ carat (after an initial high drop in 2008 due to the reduced production); the average water use over the period 1990 - 2011 is 0.75 m<sup>3</sup>. The increase in unit water use may be due to the large drop in production of carats in these years, but warrants monitoring and analysis.

**Figure 3: Trend in unit water use in the diamond sector (m<sup>3</sup>/carat)**



A similar trend is observed in the copper-nickel sector. Water use decreased to under 100 m<sup>3</sup>/ 000 tons in 2005 but has since increased to close to 235 m<sup>3</sup>/ 000 tons in 2011 before falling back to 168 m<sup>3</sup>/ 000 tons in 2012. The average unit use over the period was 124 m<sup>3</sup>/ tons of matte. On average a third of water use is from fissure water, while the remainder is mostly raw water supplied by WUC from Shashe Dam. The reasons for the apparent increase need further investigation.

**Figure 4: Trend in unit water use in the copper/nickel sector (m<sup>3</sup>/ 000 tons; 1990 - 2012).**



### 3 Mining and water resources

Mining operations require significant water resources. Water resources can be obtained from the Water Utilities Corporation at a negotiated price (e.g. BCL and Phoenix mine), or mines develop their own water resources after obtaining water abstraction rights from the Water Apportionment Board (e.g. Orapa/ Letlhakane/ Damtshaa, Jwaneng, Morupule, Botash and Boseto mines). Such mines develop their own

well fields and pay the costs of water supply. Some supply reticulated water to nearby communities or to WUC (e.g. Jwaneng). The mines that abstract groundwater submit annual (ground) water reports to the Water Apportionment Board, which monitor compliance and identifies resource concerns that need to be addressed (e.g. quality, excess abstraction and high losses). In practice, not much is done with the reports and there is need to intensify water resource management in the mining sector together with the mines based on better data collection and analysis.

Below water sources of the various mines are briefly detailed.

| Source of water supply                             | Name of mine                                     | Water source   |
|--|--|--|
| Mines with own water abstraction & supply only     | Jwaneng diamond mine                             | Groundwater and pit water                                      |
|  | Orapa, Letlhakane & Damtshaa diamond mines (OLD) | Groundwater, pit water and some storm water                    |
|  | Mowana copper mine                               | Groundwater  |
|  | Matsitama copper mine                            | Groundwater  |
|  | Boseto copper silver mine                        | Groundwater  |
|  | Karowe diamond mine <sup>a</sup>                 | Groundwater  |
| Mines with water supply by WUC only                | Phoenix cooper/ nickel mine                      | Dam water  |
|  | Mupane gold mine                                 | Dam water  |
|  | Tati Nickel                                      | Dam water  |
| Mines with water supply from own abstraction & WUC | Botash: soda ash & salt                          | Own: Ground water; WUC groundwater                             |
|  | BCL copper nickel mine                           | Own: Fissure water; WUC: dam water                             |
|  | Morupule coal mine                               | Own: groundwater & storm water; WUC: North South Water Carrier |

<sup>a</sup> This mine received water from WUC when the desalination plant did not work adequately.

Mineral deposits and groundwater resources are not necessarily found at the same place and therefore most mines have a strong incentive to use water efficiently in order to maximise extraction and the mine's life time. The high costs of water development for mineral production also provide a strong incentive for water conservation.

The sector has recently developed interest in using more raw and/or non-potable water. By increasing the use of non-potable water, competition with domestic users and economic sectors that need potable water is reduced and overall development opportunities for the country are increased. Increasing the use of non-potable water in the mining sector is a target of the 2013 IWRM-WE plan.

The water accounts show that the diamond, copper/nickel and coal sectors abstract 75% to 85% of their water use themselves, virtually all is groundwater abstraction. WUC provides the balance, mostly from dams. Concerns have been raised about ground water depletion by some large mines.

Resource concerns are not merely restricted to the water volumes used. Maintaining a good water quality is equally important. Mining may lead to water pollution through discharge of effluent or seepage from tailing dams. The reports submitted to WAB report on the water quality. Monitoring of the water quality and a water pollution treatment programme are necessary where water pollution is or may be occurring.

## 4 Productivity of water use in mining sector

### Value added and employment creation per unit of water use by economic sector

The water accounts have generated several indicators for the productivity of water use by economic sector, including the value added per m<sup>3</sup> of water used and employment creation per m<sup>3</sup> of water used.

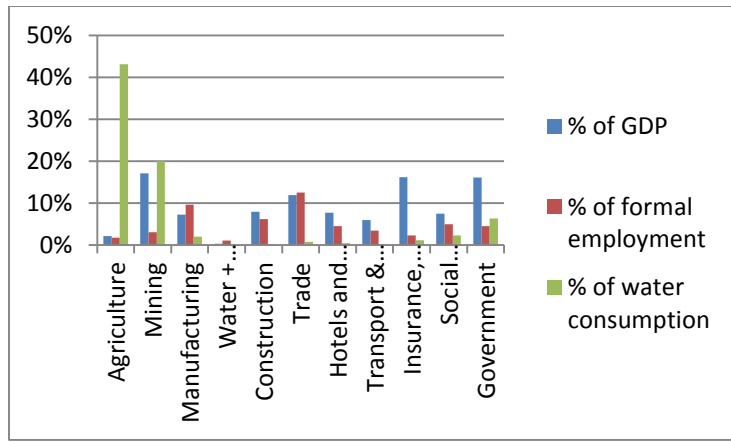
Figure 5 shows how much each economic sector contributes to Gross Domestic Product (value added),

*The mining sector uses water more productively than the agricultural sector. However, service sectors are most productive water uses in terms of GDP and employment generation.*

employment and total water use. It shows that the mining sector's share in GDP and water use are fairly similar. However, the sector contributes much less to direct employment generation, due to its capital intensive nature. The difference with particularly agriculture and service sectors is striking; the mining sector finds itself in between the agricultural and service sectors. On the one hand, the

agricultural sector uses over 40% of the water but contributes less than 3% to GDP; mining is doing much better from a water productivity perspective. On the other hand, the service sectors use relatively little water and generate higher shares of GDP and employment; service sectors do better than the mining sector from a water productivity perspective.

**Figure 5: Sectors' share in water consumption, GDP and formal employment<sup>5</sup>**



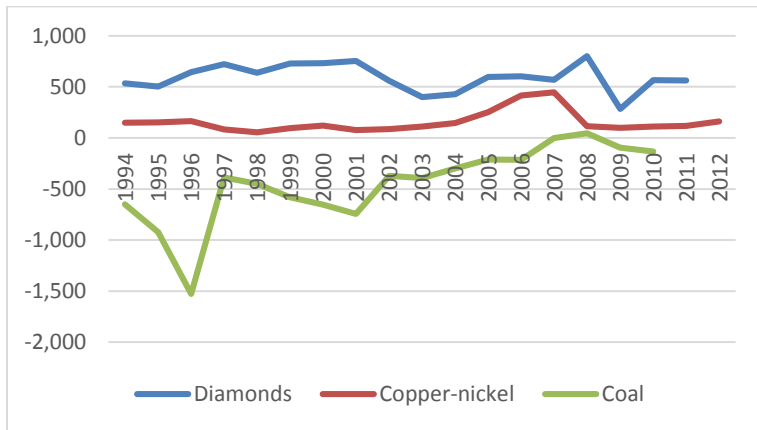
**Resource rent per unit of water use**

The mineral accounts provide figures for resource rent for diamonds, copper/nickel and coal (DEA and CAR, 2007<sup>6</sup>; Jefferis, 2014). Combining these figures with the water use provides figures for generated resource rent by m<sup>3</sup> in the three mining sub-sectors (Figure 5). For the period 1994 – 2012, diamonds generate on average Pula 590.5/m<sup>3</sup>, almost four times the average of copper/nickel (BWP155.5/ m<sup>3</sup>). Remarkably, the average resource rent for coal is negative (BWP-447/m<sup>3</sup>). The resource rents of different mineral are converging a little after 2002. The generated resource rent for diamond appears to stabilise around BWP500/m<sup>3</sup> while the resource rent for coal has improved and is now mildly negative (and was positive in the year 2008). Obviously generated resource rents fluctuate with fluctuations in world market prices.

<sup>5</sup> Inclusion of informal employment does not change the conclusions.

<sup>6</sup> Dep. of Environmental Affairs and Centre for Applied Research (2007). Towards Mineral Accounts in Botswana. Available from [www.car.org.bw](http://www.car.org.bw).

**Figure 6: Trend in resource rent per m<sup>3</sup> for three minerals (P/m<sup>3</sup>; constant prices Pula 2006)**



*Diamonds are a special case, and generate benefits that are not achieved by other minerals. Resource rents in the coal industry have been negative and therefore allocation of more water to this sector should be carefully considered, and depend on the value added and resource rents generated by this sector.*

## 5 Cost of water

The mines pay the full supply costs for their own water abstraction; however, they do not pay a resource royalty for water. Where WUC provides water, several mines benefit from special tariffs, which tend to be below the supply costs, amounting to subsidies to the mines supplied by WUC<sup>7</sup>. In 2013 Water Utilities Corporation introduced a cost recovery payment system nationally including the mining companies. This project has been introduced to gradually reach cost recovery by 2016.

There is no adequate insight in the capital and operational expenditures of water supply for the sector. Therefore the IWRM-WE Plan has recommended a sector IWRM- study of the mining sector, which among others will shed light on the costs and benefits of water supply to the sector. Such a study will also appraise to what extent the potential of water demand management measures and alternative water sources are (and can be further) exploited by the sector.

## 6 Water supply and demand management

Most mines have strong incentives to maximise water use efficiency because of their often remote locations vis-à-vis water sources. It is assumed (but needs to be further established through the development of monetary water accounts) that the costs of water supply are high so that costs constitute an additional incentive for water conservation.

Some of the current water supply and demand management measures are:

- ✓ BCL use fissure water to reduce fresh water abstraction. Fissure water amounts to 35 to 45% of the annual water use;
- ✓ Debswana uses pit sump water and dewater, amounting to 10 to 20% of water use in its mines;
- ✓ Debswana has constructed a storm water dam in Orapa to capture run-off in the town;
- ✓ Debswana is investigating the feasibility of use of saline water for its mining operations. It already has constructed a desalination plant in Orapa for domestic use.

<sup>7</sup> For example, Morupule mine sources some of its water from WUC at a very low price. Despite this the resource rent remains negative.

The purpose of these measures is to reduce fresh groundwater abstraction and in-take from WUC. The loss rates of mines are not known, and there is need to include loss figures in the water reports to WAB.

The IWRM-WE plan recommends that DWA concludes water covenants with the mines to encourage efficient water use. Generally, there is need to increase the use of treated effluent and non-fresh water. The need to do so is highest where mines compete with settlements and other economic sectors for water.

## **7 Main messages and recommendations**

The mining sector accounts for 10-15% of water use in Botswana. Three-quarters of the use is currently for diamond production but that is likely to change in future with new mines opening and diamond mines closing in future. Most mines provide their own water resources, in particular groundwater. Their abstraction, use and consumption as well as the expenditures needs to be carefully monitored through water accounts. A data requirement template needs to be developed by DWA for the annual reports to the Water Apportionment Board so that the required data can easily be incorporated into the water accounts.

Future water abstraction and use of the mining sector is difficult to predict and depends on mine closures and opening of new mines. WRC (2012; quoted in the 2013 IWRM-WE Plan) forecasts that water use of the mining may peak at 100.4 Mm<sup>3</sup> in 2027. The Water Accounts will assist to track of water use in the mining sector as they will annually record the sector's abstraction and use.

Whatever happens in the sector, competition for water will increase in future, for example with irrigation, other industries and settlements. The diamond sector is highly competitive given the large benefits that it generates. This does not necessarily apply to copper nickel and coal mining. Therefore, there can be no doubt that water efficiency needs to be a top priority for all mining operations in Botswana.

Water quality is a growing concern in the Botswana. Therefore, the mining sector needs to ensure that water discharge is of acceptable standard, which requires water treatment as well as monitoring of water quality.

Therefore, a sector-wide study of Water resources and Mining as recommended in the 2013 IWRM-WE Plan should be undertaken soon by DWA in conjunction with the Botswana Chambers of Mines. The study should cover the costs and benefits of water supply and use in the mining sector, opportunities for use of saline water and treated effluent as well as water demand management measures.

Based on the study, it is recommended that DWA and mines negotiate water covenants with clear targets for water supply and demand management interventions as well as responsibilities and duties of government and the mines<sup>8</sup>. The annual Water Reports of mines would report the water situation of each mine as well as progress with the implementation of the water covenants.

DWA needs to carry out annual reviews of water use in the mining sector, based on the submitted annual water reports by mines as well as on the water account up-dates. There is need to intensify water resource management in the mining sector together with the mines based on better data collection and analysis. The reasons for the apparent increase in water use per unit of output need further investigation.

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<sup>8</sup> Some mines already have water conservation plans or sustainable development strategies.