



## Summary

Mining has been the backbone of Botswana's economic growth since the 1970s and continues to be important for future growth. The mining sector's demand for water is expected to double in the next 15 years. In Botswana, water is scarce and with demand increasing from other sectors, as well as increasing uncertainty over supplies as a result of climate change, water efficiency must be top priority.

## Background

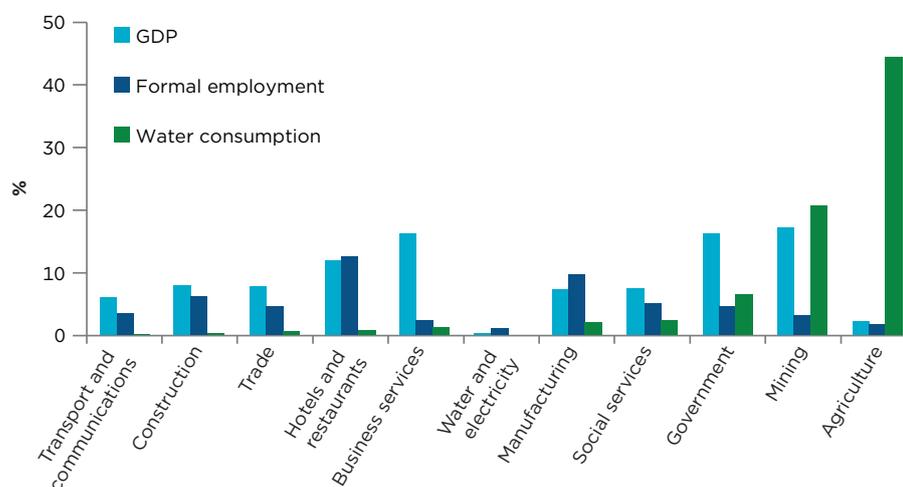
The Department of Water Affairs and the Centre for Applied Research prepared this briefing as part of the World Bank's Wealth Accounting and Valuation of Ecosystem Services (WAVES) programme. This analysis covers diamond, copper, nickel and coal mining.

## Water resources and mining in Botswana

Much of Botswana's economic growth and development has been driven by the mining sector — it contributes 25% of the country's GDP.<sup>1</sup> And although the government is keen to diversify the economy, the sector remains important for future economic growth. At the same time, it is estimated that the water demands of the mining sector may grow to around 100Mm<sup>3</sup> in 2027.<sup>2</sup>

- The mining sector accounts for 10-15 per cent of total water use in Botswana, three quarters of this is currently used in diamond production. As new mines open and diamond mines may close, this is likely to change.
- Most mines have user rights and water accounts can help governments monitor the abstraction, use and expenditure on water.
- Coal mining has been a relatively minor user of water in the past but is poised to expand significantly in the future, as part of an energy security and economic diversification strategy. The growth of coal mining will place additional pressure on already scarce water resources.

 **Figure 1:** Sector shares in water use, GDP and formal employment 2011/2012<sup>3</sup>



## Trends in water use in the mining sector

It is important to understand how the mining sector uses water resources, given the role it plays in the Botswana economy. Does it use water efficiently and productively, and is each mine operating in the same way? The Department of Water Affairs developed water accounts for 2010/11 and 2011/12 to answer these questions for the mining sector in the process of examining the water flows and stocks across the country.

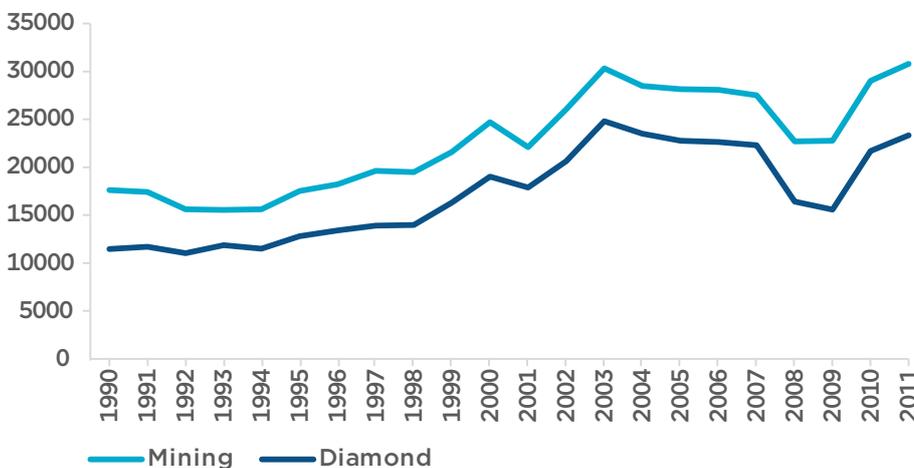
Between 1990 and 2003 the growth of the mining sector has led to a rapid increase in the amount of water it uses. Since then water use has fluctuated rather than increased (Figure 2), reflecting the impact of the 2008 global recession, which has led to considerable variations in annual mineral abstraction.

The mining sector's share in the country's water use has ranged from 10 to 17 per cent in the period 1990-2010 with an average of 13 per cent (Figure 3). The sector's share peaked at 17 per cent in 2003 but has dropped back since then. Diamond mining accounts for just over three quarters of the sector's water use and an average of 10 per cent of the country's water use.

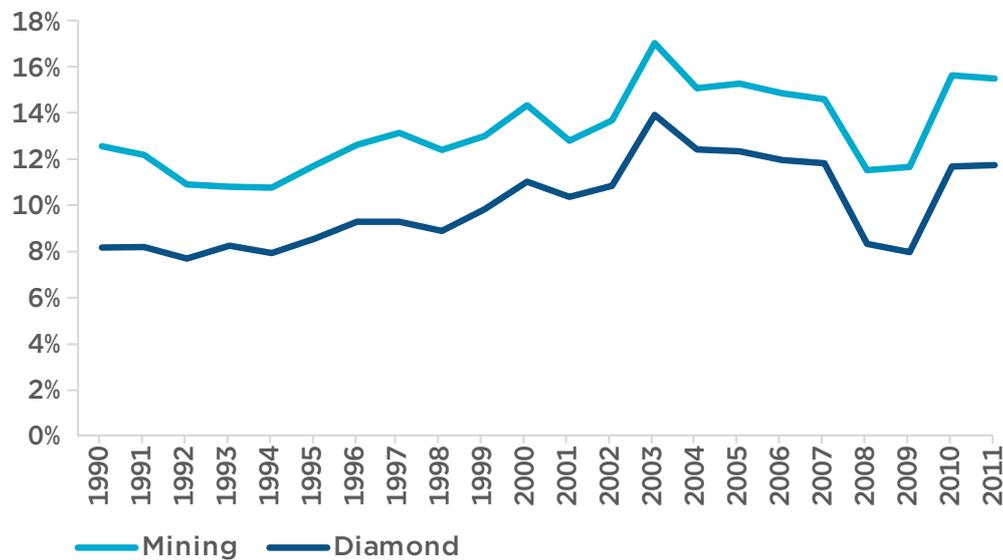
Combining the mineral<sup>4</sup> and water accounts<sup>5</sup> allows the calculation of the trend in the water use per unit of production in diamond mining (carats) and copper/ nickel (tonnes). These are shown in Figures 4 and 5 respectively.

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.

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. The reasons for the apparent increase need further investigation.



**Figure 2.** Trend in water use in the mining sector<sup>6</sup> and the diamond sub-sector (000 m<sup>3</sup>)



**Figure 3.** Trend in share of the mining sector<sup>6</sup> of total water use (as %)

### What water accounting in Botswana includes

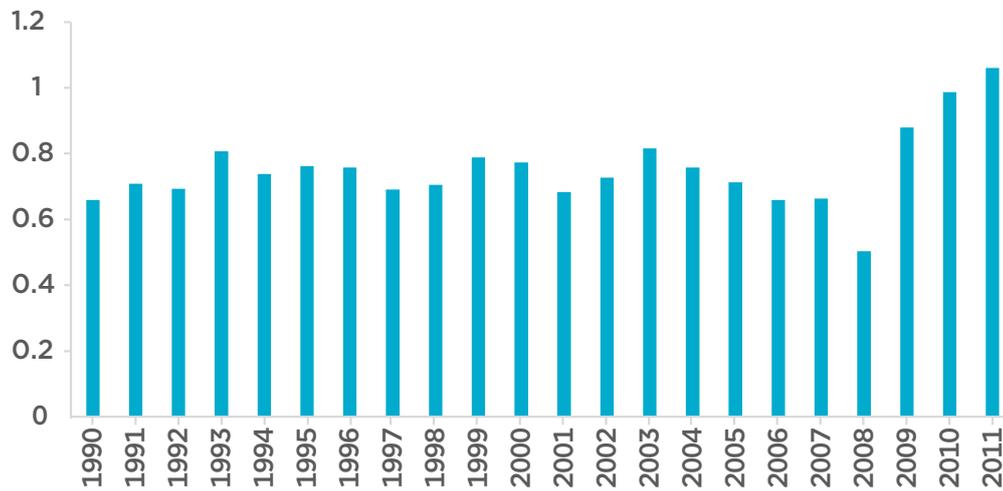
The purpose of water accounting in a water-scarce country like Botswana is to inform better management by understanding the quantity of water stocks in groundwater, reservoirs and rivers; how water is supplied and used in the economy and environment and with what result.

The water accounts adopt the framework of the United Nations' System of Environmental Economic Accounting for Water (SEEA-Water), which is now an international statistical standard. It is designed as a satellite system to the existing UN System of National Accounts linking water data to economic data using the standard classification of economic sectors. SEEA-Water covers stocks and flows of water in physical and monetary terms and also addresses water quality issues through pollution emission accounts.

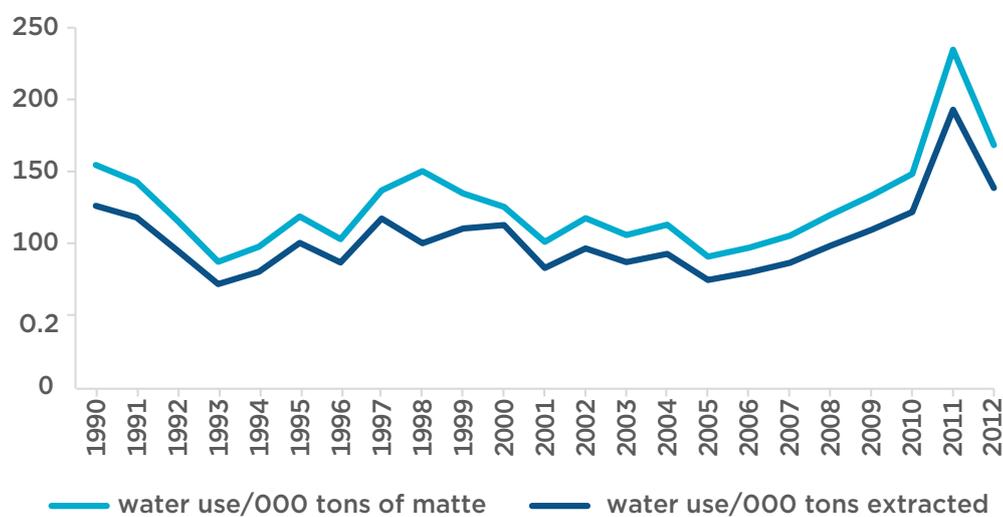
The following water accounts have been developed in Botswana:

- Physical use and supply accounts indicating:
  - Water abstraction by sector and by natural source
  - Water imports and exports
  - Water use and consumption by sector
  - Water abstraction at the sub-national level by Water Utilities Corporation
- Physical stock accounts for reservoirs

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**Figure 4.** Trend in unit water use in the diamond sector (m³/carat)



**Figure 5.** Trend in unit water use in the copper/nickel sector (m³/000 tons; 1990-2012).

## How mines obtain and use water resources

Mining operations require significant water resources. Water resources can be obtained from the Water Utilities Corporation at a negotiated price, such as in the case of Bamangwato Concessions Ltd (BCL) and Phoenix mine, or mines develop their own water resources after obtaining water abstraction rights from the Water Apportionment Board. This has happened at 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 the Water Utilities Corporation – at Jwaneng, for example. The mines that abstract groundwater submit annual (ground) water reports to the Water Apportionment Board, which monitors compliance and identifies resource concerns, such as quality, excess abstraction and high losses, that need to be addressed. 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.

Source of water supply	Name of mine	Water source
Mines with own water abstraction and 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 the WUC only	Phoenix cooper/ nickel mine	Dam water
	Mupane gold mine	Dam water
	Tati Nickel	Dam water
Mines with water supply from own abstraction and the WUC	Botash: soda ash & salt	Own: groundwater; WUC: groundwater
	BCL copper nickel mine	Own: groundwater; WUC: dam water
	Morupule coal mine	Own: groundwater and storm water; WUC: North South Water Carrier

Table 1, above, details water sources of the various mines.

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 Botswana Integrated Water Resource Management and Water Efficiency (IWRM-WE) Plan prepared by the government Ministry

of Minerals, Energy and Water Resources.

The water accounts show that the diamond, copper/nickel and coal sectors abstract 75 per cent to 85 per cent of their water use themselves: virtually all is groundwater abstraction. The Water Utilities Corporation 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 the Water Apportionment Board provide information on the water quality. Monitoring of the water quality and a water pollution treatment programme are necessary where water pollution is or may be taking place.

**Table 1.**

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

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## Productivity of water use in the 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  $m^3$  of water used and employment creation per  $m^3$  of water used.

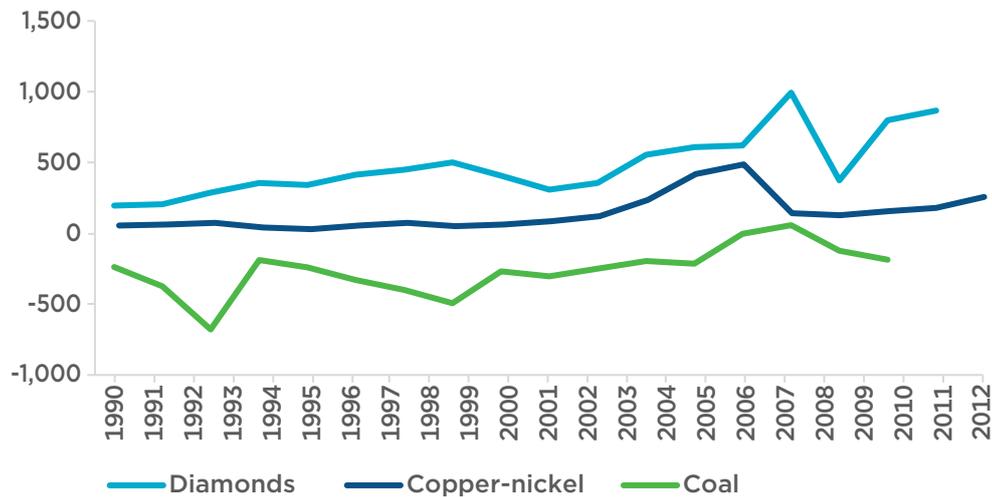
Figure 1 (see page 1) shows how much each economic sector contributes to Gross Domestic Product (value added), employment and total water use. It shows that the mining sector's share in GDP and water use are fairly similar. However, the sector contributes much less to direct employment generation, due to its capital intensive nature. The difference with 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 per cent of the water but contributes less than 3 per cent 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.

### Resource rent per unit of water use

The mineral accounts provide figures for resource rent (the amount the government can tax the producer while still making it profitable to mine the mineral) for diamonds, copper/nickel and coal.<sup>4,7</sup> Combining these figures with the water use provides figures for generated resource rent by  $m^3$  in the three mining sub-sectors (Figure 1). For the period 1994–2012, diamonds generated on average Pula 590.5/ $m^3$ , almost four times the average of copper/nickel (BWP155.5/ $m^3$ ). Remarkably, the average resource rent for coal is negative (BWP-447/ $m^3$ ). The resource rents of different mineral started to converge a little after 2002. The generated resource rent for diamond appears to have stabilised around BWP500/ $m^3$  whereas 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.

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**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.

## Cost of water

The mines pay the full supply costs for their own water abstraction; however, they do not pay a water scarcity charge for water. Where the Water Utilities Corporation provides water, several mines benefit from special tariffs, which tend to be below the supply costs, amounting to subsidies to the mines supplied by the Water Utilities Corporation.<sup>8</sup> In 2013 the Water Utilities Corporation introduced a cost recovery payment system nationally including the mining companies. This project has been introduced to reach cost recovery gradually by 2016.

There is no adequate insight into the capital and operational expenditures of water supply for the mining sector. Therefore the IWRM-WE Plan has recommended a sector IWRM study of the mining sector in conjunction with the Botswana Chamber of Mines, which among other things 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.

***Do we need a sector IWRM study of the mining sector, which among other things will shed light on the costs and benefits of water supply to the sector?***

## Water supply and demand management

Most mines have strong incentives to maximise water use efficiency because of their often remote locations in relation to 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 uses fissure water to reduce fresh water abstraction. Fissure water amounts to 35 to 45 per cent of the annual water use
  - Debswana uses pit sump water and dewater, amounting to 10 to 20 per cent 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.

The purpose of these measures is to reduce groundwater abstraction and supply from the Water Utilities Corporation. The water loss rates of mines are not known, and there is need to include loss figures in the water reports to the Water Apportionment Board.

The IWRM-WE Plan recommends that the Department of Water Affairs 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.

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### Notes

1 Department of Water Affairs and Centre for Applied Research (2014) Water accounting in Botswana, WAVES Technical Report. Available from [www.wavespartnership.org](http://www.wavespartnership.org)

2 WRC (2012). Water Resources Consultants in association with ILISO (2012). Preliminary Design on the Utilisation of Water Resources of the Chobe-Zambezi River: Revised Interim Water Demand Report. Prepared for DWA-MMEWR.

3 Inclusion of informal employment does not change the conclusions.

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

5 The Department of Water Affairs with the Centre for Applied Research have developed water accounts for 2010/11 and 2011/12 focusing in particular on the water flows and stocks in the country (see note 1).

6 In figures 1 and 2, the mining sector includes diamonds, copper/nickel and coal only.

7 Department 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).

8 For example, Morupule mine sources some of its water from the Water Utilities Corporation at a very low price. Despite this the resource rent remains negative.

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