

Columbia Center on Sustainable Investment

A JOINT CENTER OF COLUMBIA LAW SCHOOL
AND THE EARTH INSTITUTE, COLUMBIA UNIVERSITY



CCSI Policy Paper

Perrine Toledano and Clara Roorda **, **
March 2014

Key Points

- 1 Mining is increasing in moderate to high water risk areas and there mining operations are exacerbating the water stress of local communities and the environment, generating social disruptions and disputes.
- 2 The modalities of the allocation of water rights, coupled with strong environmental regulations advocating zero mine waste water discharge, will determine the potential for shared use.
- 3 Shared use of water-related infrastructure means both: Diminishing the water footprint of mining companies (in quantity and/or quality), and increasing the water supplies to the community from alternative sources.
- 4 By reducing its footprint, a mining company would be better prepared for a scenario of water scarcity, stronger regulation, higher water rights prices and communities' opposition.



Leveraging Mining Investments in Water Infrastructure for Broad Economic Development: Models, Opportunities and Challenges

Table of Contents

Background.....	2
Understand current and future water resources	9
Assess the "actual demand" for water from the mines.....	12
Allocate water rights to satisfy the unmet demand	18
Ensure extra-capacity for the communities with a sustainable operational model.....	19
Ensure an adequate institutional framework to regulate and enforce water rights.....	26
Further Research.....	29


* Authors: Perrine Toledano is CCSI's Head of Extractive Industries and Clara Roorda is intern at CCSI.

**Acknowledgments: The authors are very grateful to Jacky Mandelbaum, Lisa Sachs and Sophie Thomashausen for their thorough review.

Background

Access to a secure and stable water supply is critical to a mining operation. Water is used in practically all stages of the mining process. Generally, the most water intensive activities are the separation of minerals from host rocks, the cooling of drilling machinery and dust suppression. Nonetheless, the level of water consumed is case specific and varies greatly depending on factors such as climate, water chemistry, geology, ore mineralogy, mine management and practices, and the commodity being mined. In general, the lower the grade of ore, the more water intensive the mining process to extract the ore.¹ Increased reliance on low ore grades means that it is becoming necessary to extract a higher volume of ore to generate the same amount of refined product, which consumes more water.² According to a Frost and Sullivan study,³ the average water intensity of some minerals and metals is the following:

Figure 1: Water intensity of key minerals and metals

Mineral/metal type	Water use
Coal 	
Copper 	
Diamond 	
Gold 	
Nickel 	
Iron ore 	
Platinum 	

Key:  High  Medium high  Medium low

Source: Frost & Sullivan⁴

At the same time, water scarcity⁵ is becoming more widespread, and there is an increased awareness among governments about the need to guard against broader environmental risks of mining.

¹ "Water Scarcity the next big challenges for miners," *Business Monitor International* (March 01, 2013), available at: <http://www.businessmonitor.com/news-and-views/water-scarcity-the-next-big-challenge-for-miners#sthash.5bHjMokr.dpuf>

² "Mining a rich seam for water companies," 12(7) *Global Water Intelligence* (July 2011), available at: <http://www.globalwaterintel.com/archive/12/7/general/mining-rich-seam-water-companies.html>.

³ Paulina Szyplinska "CEO 360 Degree Perspective of the Global Mining Water and Wastewater Treatment Market," Frost & Sullivan (May 11, 2012).

⁴ Ibid.

⁵ The definition used by the UN Water Thematic Initiative refers to water scarcity as "the point at which the aggregate impact of all users impinges on the supply or quality of water under prevailing institutional arrangements to the extent that the demand by all sectors, including the environment, cannot be satisfied fully." UN Water Thematic Initiative, "Coping with Water Scarcity: A strategic issue and priority for system wide action" (August 2013), available at: <http://www.unwater.org/documents.html#policy>

Figure 2: Intensity of the mining risk for water

Water Risk Framework For The Mining Sector		
Surrounding Environment	Commodity	Type Of Operation
High Risk	Arid/semi arid environments	Low grade ore Open pit that reaches below water table
	Presence of other competing uses (agriculture, ranching)	Precious metals Dewatering required
	High seismic hazard	Diamonds High acid drainage potential
	Very high rainfall/frequent storm events	Copper Tailings disposed in rivers
	High permeability aquifers	Nickel Energy derived from hydropower Large water withdrawals
Medium Risk	Moderate seismic hazard	Coal Open pit above water table
	Moderate rainfall with distinct dry season	Uranium Dewatering water recycled
		Zinc Potentially acid generating material capped and controlled
		Lead Tailing stored in impoundment
		Iron Ore Energy derived from coal/natural gas Moderate water withdrawals
Low Risk	Moderate rainfall	Other industrial minerals Energy derived from renewable sources
	Low seismic hazard	Old mine workings capped and covered Low acid generating potential
		Water flows carefully controlled at site Water discharges meet ecosystem requirements
		All water consumed is reused/recycled

Source: BMI, World Resources Institute

Source: Business Monitor International⁶

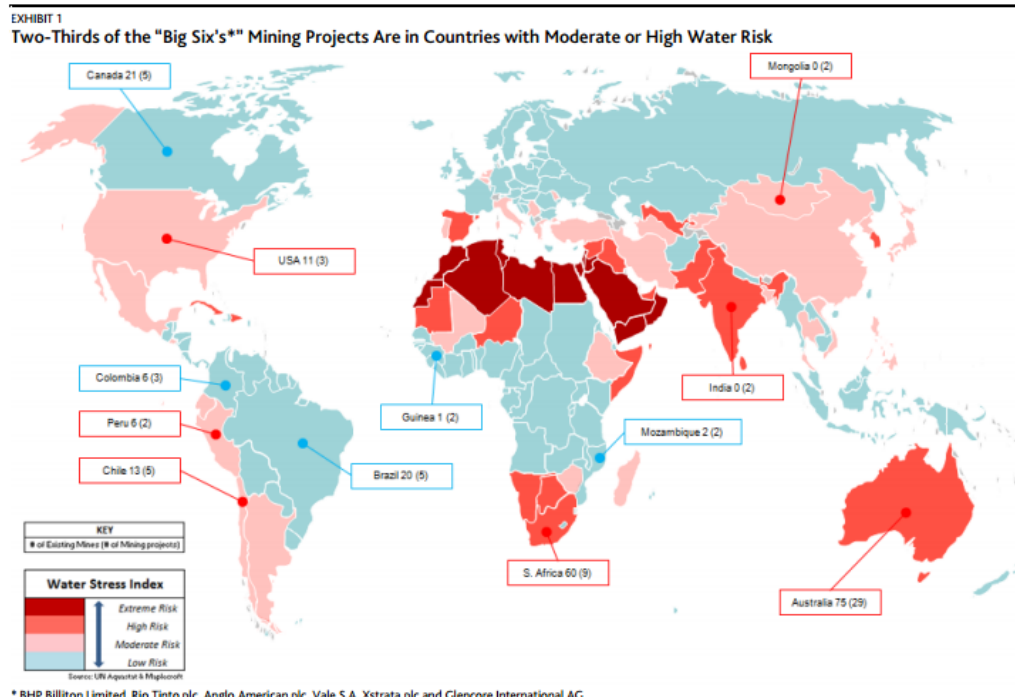
Moreover, as ore reserves decline, mining companies have to expand operations into increasingly remote and arid regions, which require new ways of managing water. About 70% of the mining operations of the “Big Six” mining companies,⁷ for example, are located in countries where water stress is considered a risk (see Figure 3).⁸

⁶ “Water Scarcity the next big challenges for miners,” *Business Monitor International* (2013), op. cit.

⁷ BHP Billiton, Rio Tinto, Anglo American, Vale S.A., Xstrata plc and Glencore International.

⁸ Andrew Metcalf, “Water scarcity to raise capex and operating costs, heighten operation risks,” Report number 149714, Moody's Investor Service, Special Comment (February 2013), available at: [http://op.bna.com/env.nsf/id/avio-94wss7/\\$File/Global%20Mining%20Industry%20-%20Water%20Scarcity%20to%20Raise%20Capex%20and%20Operating%20Costs%20Heighten%20Operational%20Risks.pdf](http://op.bna.com/env.nsf/id/avio-94wss7/$File/Global%20Mining%20Industry%20-%20Water%20Scarcity%20to%20Raise%20Capex%20and%20Operating%20Costs%20Heighten%20Operational%20Risks.pdf)

Figure 3: Mining is increasing in moderate to high water risk countries



Source: Moody's Investor Service⁹

In water scarce areas, mining operations are exacerbating the water stress of local communities and the environment. In Mongolia, for example, a total of 852 rivers, 1,181 lakes and 2,277 springs have dried up due to reckless management of the land and natural resources.¹⁰

In addition to reducing supply, mining operations have also been responsible for water contamination. In Papua New Guinea, for example, "about 1,300 km² of vegetation died in the Fly River watershed and fish stocks have fallen 70-90% due to the disposal of riverine waste from the OK Tedi mine."¹¹ In Peru, in 2008, the government declared a state of emergency at a mine in close proximity to Lima, out of fear that its tailings dam would release arsenic, lead and cadmium into the main water supply of the capital.¹²

Situations such as those described above result in community opposition to mining projects, which causes delays, production losses, additional capital expenditures, and damage to the corporate reputation of mining companies, further increasing production costs. In September 2012, Barrick Gold Corporation's Peruvian Pierina was temporarily suspended as a result of a deadly clash between police and protestors, who accused the mine of exacerbating local water shortages.¹³ After months of protests and road blockades by local protesters concerned about the

⁹ Ibid.

¹⁰ "Mining in Mongolia: Engaging local communities to help reduce the impacts of mining," International Union for Conservation of Nature (IUCN) (2010), available at: <http://cmsdata.iucn.org/downloads/dauriamining.pdf>

¹¹ Marta Miranda, Philip Burris, Jessie Froy Bingchang, Phil Shearman, Jose Oliver Briones, Antonio La Viña, Stephen Menard, "Mining and critical ecosystems: mapping the risks," World Resources Institute (2003), available at: http://essc.org.ph/content/wp-content/uploads/2007/02/mining_chapter1.pdf

¹² Sarah Thomas, "Water and mining: a love/hate relationship?," 27(3) *Water World* (2012), available at: <http://www.waterworld.com/articles/wwi/print/volume-27/issue-3/regional-spotlight/latin-america/water-and-mining-a-love-hate.html>

¹³ Metcalf, "Water scarcity to raise capex and operating costs, heighten operation risks," (2013), op. cit.

effects the mine would have on local water resources, Minas Conga in Peru, announced in June 2012 that it would spend around US\$200 million on building reservoirs to support water supply to the local population, who only has had access to water during the rainy season.¹⁴ In September 2011, Rio Tinto addressed governmental concerns over local water shortages in the Pilbara district in Australia by announcing an investment of US\$310 million into a new borefield and pipeline system to procure coastal waters for its expansion program, instead of using its water rights to the local water supply.¹⁵ Examples are many.

As a result, mining companies are increasingly investing significant amounts in water infrastructure and management systems to reuse water, improve metals recovery and treat effluents before discharge, thereby minimizing competition with the ecosystem. In fact, over 90% of mine water can be reused if treatment technologies such as reverse osmosis and microfiltration are applied.¹⁶ Some mines even use treated residential waste/sewerage water in their operations.

Furthermore, mining is one of the few industries that are able to use water of lower quality than that desirable for human consumption in parts of the process.¹⁷ Seawater can be used for some mineral processing and equipment cooling. For example, in Chile, at the Michilla Mine, untreated seawater is used for leaching and agglomeration,¹⁸ and at the Minera Esperanza mine, such water is being used in the copper flotation process.¹⁹ For the mineral processing that would suffer from the salt in the water, companies can also increase the water sources available by resorting to desalination.

The total annual spend²⁰ on water-related infrastructure serving the mining industry in 2011 has been estimated to be US\$7.7 billion²¹ (see Figure 4). The top 10 mining countries comprise nearly 80% of that expenditure. Australia leads the list with almost 20%.²² Chile, in 2011, spent US\$817 million, while Peru spent US\$794 million and Brazil, \$476 million.²³ Projections for 2014 anticipate an estimated US\$13.6 billion of expenditure in mining-related water infrastructure, almost doubling the 2011 global spend.²⁴

¹⁴ Ibid.

¹⁵ Ibid.

¹⁶ Szyplinska, "Thirsty world of mining: Harvesting new water solutions," (2012), op. cit.

¹⁷ "Water management in mining: a selection of case studies," International Council on Mining & Metals (ICMM) (2012), available at: <http://www.icmm.com/www.icmm.com/water-case-studies>

¹⁸ Rossana Brantes "Best practices and efficient use of water in the mining industry," Chilean Copper Commission (Cochilco), (2008), available at:

http://www.cochilco.cl/descargas/english/research/research/best_practices_and_the_efficient_use_of_water.pdf

¹⁹ "Water for Mining: Opportunities in scarcity and environmental regulation," *Global Water Intelligence (GWI)*, Media Analytics Ltd, Oxford, UK, 186pp (2011), available at:

http://www.globalwaterintel.com/client_media/uploaded/Water%20for%20Mining/GWI_Water_for_Mining_sample_pages-.pdf

²⁰ Includes public, private, by mining companies or third party spending.

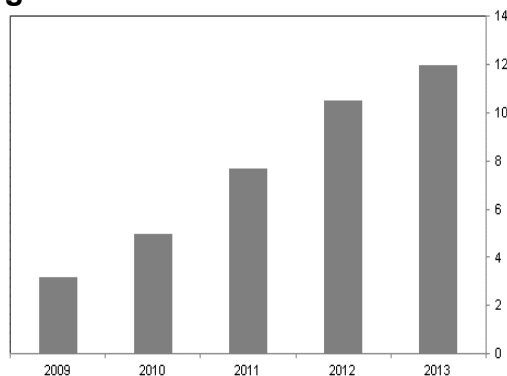
²¹ Thomas, "Water and mining: a love/hate relationship?," (2012), op. cit.

²² "Mining a rich seam for water companies," *Global Water Intelligence* (2011), op. cit.

²³ Thomas, "Water and mining: a love/hate relationship?," (2012), op. cit.

²⁴ Ibid.

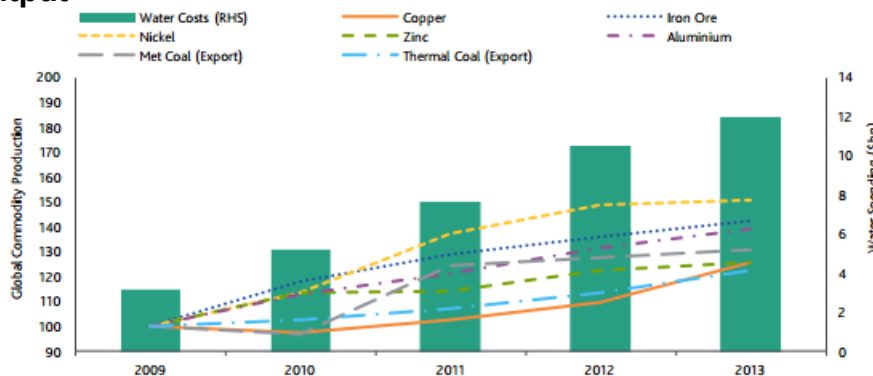
Figure 4: Increased water infrastructure spending (US\$ billion)



Source: Business Monitor International²⁵

In that context, water management costs surpass the gains in mining production output (see Figure 5). The UK-based Global Water Intelligence (GWI) has assessed that while mines spent 252% more on water infrastructure in 2013 than in 2009, their production increased by just 20-52% over the same period.²⁶

Figure 5: Increase in water management costs is outstripping gains in mining output



Source: Moody's estimates, company reports, GWI

Source: GWI²⁷

Governments, in this context, should ensure that mining companies' water management strategies are in line with the eco-system in which they operate. Efficient reduction of a mine's water footprint in terms of both quantity and quality from mining activities requires informed oversight and regulation by government institutions in setting and enforcing environmental standards and water rights regulations. *In turn, a strong regulatory framework can encourage investment in mining-related water infrastructure and technologies that enhance shared value by maximizing opportunities for shared use and minimizing the risk of disruption to mining operations.* Against that backdrop, shared use of water-related infrastructure means:

- **Diminishing the water footprint of mining companies (in quantity and/or quality)**
- **Increasing the water supplies to the community from alternative sources**

²⁵ "Water Scarcity the next big challenges for miners," *Business Monitor International* (2013), op. cit.

²⁶ Metcalf, "Water scarcity to raise capex and operating costs, heighten operation risks," (2013), op. cit.

²⁷ Ibid.

By reducing its footprint, a mining company would be better prepared for a scenario of water scarcity, stronger regulation, higher water rights prices and communities' opposition.

Minimizing a mine's water footprint and sharing the use of mining-related water infrastructure are also challenges relevant for water abundant areas where governments are less concerned by water scarcity issues. Water might be in plentiful supply, but without regulating water usage of mining operations, clean and safe water could become increasingly scarce due to contamination by mining discharges, surface runoff from overburden, or spillages from tailing dams. Water abundant areas should not be exempt from strong political will to diminish mines' water footprint.

Key barriers to achieving shared use

Desktop research of water supply to mining operations around the world highlights several common barriers that hinder the uptake of shared use models in practice:

1. Lack of knowledge from governments of their water resources;
2. Lack of water regulations that address and prioritize competing demands for water among the population, environment and industry;
3. Difficulty in regulating, enforcing and monitoring water use;
4. Lack of incentives and regulations encouraging mines to adopt the most efficient water management systems and support local water supply whenever possible.

Key recommendations to promote shared use

To promote effective shared use, each of the barriers described above must be mitigated to the extent possible.

This Policy Paper highlights the opportunities to lower these barriers drawing on lessons learned from case studies in Argentina, Australia, Brazil, Chile, China, Mongolia, Namibia, Papua New Guinea, Peru, Philippines, Saudi Arabia, Senegal, South Africa, and the United States (U.S.).

A main finding emerging from these case studies is that the modalities of the allocation of water rights, coupled with strong environmental regulations advocating zero mine waste water discharge, will determine the potential for shared use.

Water rights usually constitute the right to use, but not to own, water from a particular source.²⁸ The right allows a specific volume or percentage of water from a specific water source to be diverted for a specific use. Water rights are either attached to the mining/land concession or are treated as separate rights. The former is the most prevalent form, although the latter exists in, for instance, the U.S., Chile, South Africa, and in some states of Australia. In those jurisdictions, a water right market is in place.

²⁸ Hector Garduño, Stephen Foster, Charles Dumars, Karin Kemper, Albert Tuinhof, Marcella Nanni "Groundwater Abstraction Rights - From Theory to Practice" *GW-MATE Briefing Note Series 5* (2003)," available at: <http://water.worldbank.org/publications/groundwater-abstraction-rights-theory-practice>

Each regime of water rights has its own implications for competing demands on water supply and both can end up prioritizing the mining sector over the other sectors if no safeguards are put in place. The examples of the Philippines (Box 1) and of South Africa (Box 2) below illustrate both regimes and the negative consequences on the communities because of a lack of safeguards.

Box 1: Philippines - Lack of water access clauses in a Copper-Gold Mine Project²⁹

In Mindanao in the Philippines, the proposed Tampakan copper-gold mine developed by Sagittarius Mines Inc, is within the water catchment of six important rivers of the region: the Altayan, Dalal, Manit, Mal, Manteo and Taplan. According to the mining law of the country, the water rights are attached to the concession. Therefore, if the project is approved, all the nearby communities and the people living downstream of rivers originating inside the concession will lose their access to the water as the water rights become the property of the mine which can divert and control the water. Those rivers, nonetheless, provide water for agriculture, fishponds and drinking water to numerous villages.

Box 2: South Africa - Reallocating water rights from farmers to mining companies without proper compensation³⁰

At the beginning of 2001, because of the increasing demand for water from the mining industry in the Middle Olifants region in South Africa and the absence of remaining allocable water, the Department of Water Affairs and Forestry (DWA) suggested to temporarily re-allocate to mines some water rights held by farmers (13 of the 18 million m³/year). After negotiations between representatives of the mining sector, DWA and L-DAE (Limpopo provincial Department of Agriculture and Environment), the body representing the smallholders and communities, the parties came to the agreement that the mining sector would pay a compensation of 7 million Rands (approximately US\$700,000) for the water rights, that had been allocated to the partial rehabilitation of the irrigation infrastructure - which represented less than 0.1% of the overall mining development cost.

Sound management of water rights is also in the interest of mining companies. According to a recent study, 62% of the 13 largest publicly traded mining companies report being exposed to water-related litigation risks, and, often those risks are related to water rights.³¹ As reported by Ceres, Freeport-McMoRan, in their 2008 10K report, for example, noted that:

“we cannot predict the potential outcome of pending or future legal proceedings on our water rights, claims and uses. The loss of some or all water rights for any of our mines, in whole or in part, or shortages of water to which we have rights could require us to curtail or shut down mining production and could prevent us from pursuing expansion opportunities.”³²

²⁹ Working Group on Mining in the Philippines, “Draft Response to Xstrata/Indophil/SMI’s ESIA of the Tampakan Copper-Gold Mine Project in Mindanao, Philippines,” (2012), available at: <http://www.piplinks.org/system/files/ESIA+SMI+Xstrata+Tampakan+2011+CommentsRevised+03+July+2012.pdf>

³⁰ Stefano Farolfi and Sylvain R. Perret, “Inter-sectoral competition for water allocation in rural South Africa: Analysing a case study through a standard environmental economics approach,” University of Pretoria, Department of Agricultural Economics, Extension and Rural Development, Working Paper 2002-23 (2002), available at: <http://ageconsearch.umn.edu/bitstream/18026/1/wp020012.pdf>

³¹ Brooke Barton, “Murky waters? Corporate reporting on water risk,” Ceres, (2010), available at: <http://www.ceres.org/resources/reports/corporate-reporting-on-water-risk-2010>

³² Ibid.

The allocation of water rights is a strategic decision that will influence the water management policy of the mine. Drawing on lessons learned from countries' experiences around the world, we suggest a series of recommendations to implement a careful allocation of water rights with a view to incentivize shared use. The logic is as follows:

- 1) Understand the country's current and future water resources (in quantity and quality)
- 2) Assess the actual demand for water from the mines, taking into account that mines can implement water efficiency mechanisms and potentially use alternative water sources if the environmental regulatory framework entices them to do so
- 3) Once the actual water supply and demand has been estimated, allocate water rights to satisfy the unmet demand but devise a priority plan with review mechanisms
- 4) When mines build additional water infrastructure to serve their needs, adopt a sustainable operational model to ensure that communities benefit from the extra-capacity delivered by this infrastructure
- 5) Ensure an adequate institutional framework to regulate, monitor and enforce water rights

Recommendation One: Understand the country's current and future water resources (in quantity and quality)

The basis for building stringent regulations that incentivize water conservation and balances mining industry water usage with the water requirements of other industries (farming, for instance) lies in a good understanding of the water resources of the country in terms of location, seasonality, renewability, and variability.

The lack of hydrological information of a region's water resources could threaten available water resources by allowing overconsumption, but it could also lead to conservative limits. A new mine may not obtain water entitlements because none are available for release and the water allocation plan is not due to be reviewed for several years.³³ When water agencies are not in a financial position to run these assessments, the mines' expertise can be mobilized, as is the case in Peru (Box 3) and Brazil (Box 4), provided that safeguards preserving public interest are in place.

Box 3: Peru - Mining companies increase government's understanding of its water resources³⁴

In Tacna, Peru, mining companies coordinated with the local government to accelerate the process of determining water availability by commissioning studies and supplying the logistics for field inspections. An additional strategy adopted was to review the existing water allocations to identify unassigned resources. A mining company in Moquegua, for example, observed that the infiltration of water from a reservoir floor into the aquifer had been ignored and requested the right to this flow.

³³ Mark Hamstead and Steve Fermio, "Integrating the mining sector into water planning and entitlements regimes," *Waterlines Report Series 77* (2012), available at: http://archive.nwc.gov.au/__data/assets/pdf_file/0005/21857/Integrating-the-mining-sector.pdf

³⁴ Jessica Budds and Leonith Hinojosa, "Restructuring and rescaling water governance in mining contexts: The co-production of waterscapes in Peru," *Water Alternatives 5. No 1* (2012): 119-137, available at: http://www.sed.manchester.ac.uk/research/andes/publications/papers/Art5-1-8_Budds-Hinojosa_Published.pdf

In a situation such as that in Peru, important legal safeguards should be drafted and enforced such as the obligation to release all analysis to the government and unbundling the right to the water from the service provided. Although the mines have contributed to the water knowledge, they should be compensated by a scheme different from direct allocation of water rights (tax credit for instance), especially in a water scarce area such as the mining areas in Peru.

The availability of water sources needs to be understood, not only in terms of quantity, but also in terms of water quality. In the case of Brazil, mining expertise has been mobilized to assess water quality. In particular communities have been trained by the mine to complement the government's and company's monitoring efforts.

Box 4: Brazil - Knowledge-transfer to monitor water quality³⁵

In Brazil, Kinross has implemented a monitoring scheme of water quality processes across all its operations to protect water resources. For instance, the company shares with the public authorities its water quality readings taken near its mine in Paracatu, at downstream locations and tailings facilities. Moreover, Santa Rita, a community downstream from the operation received help from Kinross to undertake independent assessments of the water quality in that area. Those assessments now feed Kinross' monitoring program.

Another interesting experience is that of Barrick Gold in Nevada, U.S.. To better assess the implications of its water consumption and detect more precisely the subtle changes of the earth's surface resulting from drawing water from the subterranean aquifer, Barrick Gold adopted the Interferometric Synthetic Aperture Radar (InSAR) for its underground Goldstrike mine in Nevada. The results are then shared with other mining companies, local communities and government regulators.³⁶

After acquiring a good knowledge of the current state of water resources, it is fundamental to undertake a planning effort and try to anticipate the evolution of water resources. To that end, it is crucial for government regulations to address cumulative impacts. The availability and quality of water sources are often the result of cumulated impacts of mines within the same water system. The widespread reliance on project-specific Environment Impact Assessments (EIAs) has failed to provide an accurate picture of existing and future water sources in terms of quality and quantity whereas this is needed for a sound water allocation plan. More and more governments are observing the limits of mine-specific impact assessments and are increasingly adopting regulations that have a more holistic and informed approach. The examples of Australia (Box 5) and South Africa (Box 6) below are illustrative.

Box 5: Australia - Importance of assessing cumulative impacts

Nine major new coal mines are being proposed in the Galilee Basin in central Queensland. The mines will include 34 open cut pits and 11 underground mines to produce over 300 million tons of coal per annum. In order to do so, however, it is

³⁵ "Sharing utilities: Mines extend water and power to communities," World Gold Council (2012), available at: <http://www.goldfacts.org/en/society/utilities/>

³⁶ "Innovative satellite imagery takes water monitoring to the next level," Barrick Beyond Borders (July 3, 2008), available at: <http://barrickbeyondborders.com/2008/07/innovative-satellite-imagery-takes-water-monitoring-to-the-next-level/>

estimated that 1,354 billion liters could be lost as a consequence of water being pumped or drained, an equivalent of two and a half 'Sydney Harbors.'³⁷ The nine mines' activities combined also have the potential to structurally change the local geology by generating fracturing. The impact on surface water and shallow groundwater can be irreversible.³⁸

The Independent Expert Scientific Committee, appointed by the Australian Government in 2012, found that there has been an inadequate assessment of cumulative impacts and recommended building a "regional water balance model" of the cumulative impacts of these mining proposals with improved data on the connectivity between the aquifers and their key hydraulic properties. Despite these recommendations, projects have not been assessed in an integrated way and some of them have already received approval.³⁹

Similarly, in 2010, the Australian Government approved amendments to the Water Act 2000 that included a cumulative impact management regime to be overseen by the Queensland Water Commission. The amendments establish that where more than one petroleum tenure holder may cause an impact on underground water resources as a consequence of water rights, the area could be declared a 'cumulative management area.' In those regions, the Queensland Water Commission would then produce a single underground water impact report for the whole area and develop a regional groundwater flow model that is to be funded by the companies. The regulation also determines that petroleum tenure holders have additional obligations such as collecting data and making "good arrangements" among themselves so that activities are coordinated and impacts are minimized.⁴⁰

Box 6: South Africa - Cumulative impacts to control financial risks of closure

As part of a strategy to reduce environmental impacts on water, the South African Department of Minerals and Energy announced the Regional Mine Closure Strategy as part of the Sustainable Development through Mining (SDM) program in 2009. The program divided all of the country's gold mines into 17 regions on the basis of inter-mine connectivity and the geo-hydrological units.⁴¹

This approach represents an important departure from the previous approach whereby the Mineral and Petroleum Resources Development Act (MPRDA) of 2002 only addressed mine closure from the perspective of individual mines.⁴² The rationale is that a mine closure will affect the other mines within one geo-hydrological region and consequently, the last operating mine could be held accountable for the

³⁷ Boudicca Cerese "1,350 Billion Litres of Groundwater - 2 ½ Sydney Harbours – Could be Lost to QLD Mega Coal Mines," Lock the Gate Alliance (September 24, 2013), available at: http://www.lockthegate.org.au/new_report_1_350_billion_litres_of_groundwater_2_sydney_harbours_could_be_lost_to_qld_mega_coal_mines

³⁸ Matthew Currell "Coal's damage is cumulative: let's assess it that way," *Brisbane Times* (August 14, 2013), available at: <http://www.brisbanetimes.com.au/comment/coals-damage-is-cumulative-lets-assess-it-that-way-20130814-2rv8e.html#ixzz2igFqexsM>

³⁹ Ibid.

⁴⁰ Hamstead and Fermio, "Integrating the mining sector into water planning and entitlements regimes," (2012), op. cit.

⁴¹ Mark Oranje, "Discussion Document – A Strategic Framework for Implementing Sustainable Development in the South African Minerals Sector: Towards Developing Sustainable Development Policy and Meeting Reporting Commitments," The Department of Minerals and Energy (2007), available at: <http://www.info.gov.za/view/DownloadFileAction?id=78956>

⁴² David Jones, "Water in Mining Challenges for the Australian and the International Mining Industry," *International Mine Water Association Symposium – p.10 A – 10 I; Bunbury, Australia* (2012), available at: http://www.imwa.info/docs/imwa_2012/IMWA2012_Jones_10A.pdf

cumulated environmental impacts of all the mines that closed, which generates a financial risk for the mining investors. In this context, a regional and cumulative approach to mining development will help apportion liability to the contributing mines within a region in a manner that is legally defensible and hence enforceable.⁴³

The effects of water use in mining operations can be experienced in different jurisdictions that are distant from the mine location. Therefore, to be accurate, the cumulative impact assessment needs to adopt the right geographical scale and encompass the whole watershed; otherwise, distant affected communities will be either deprived of their water access and/or of compensation. For example, in Moquegua, Peru, villages claiming that their wetlands have reduced as a result of water supply to large mines but not located in the administrative districts close to the mine have received very little revenue from the mining tax.⁴⁴

Cross-boundary issues could further exacerbate the implications of the cumulative impact of the mining sector's water use and could lead to serious international and political implications. For instance, Bolivia and Chile have continuously disputed water rights to the small river Silala, in the Atacama Desert, the main region for Chile's copper mining industry. According to Chile (expected to need 45% more water for mining in 2020 as compared to 2009), it has the right to use the water because the Silala River is an international river. Bolivia argues that the river's course was artificially altered in the 19th century to fit Chilean companies' needs.⁴⁵

Recommendation Two: Assess the “actual demand” for water from the mines taking into account that mines can implement water efficiency mechanisms, and potentially use alternative water sources if the environmental regulatory framework entices them to do so

Experience shows that either as a result of more stringent environmental regulations related to water discharge (in some cases null discharge), or pressured by a water scarce environment, companies can reduce their water footprint through water efficiency processes and considerably reduce their demand on the water system (see Figure 6 for a spate of possible technologies) and consequently their demand for water rights to fresh water. The most frequent water efficient processes are presented below.

Recycle and reuse water

Because mines' water discharge is one of the most damaging ways mining operations can impact the quality of available water resources, governments have increasingly adopted strict environmental regulation to address possible impacts and incentivize water reuse as a sustainable alternative. For instance, the government of Victoria in Australia, in its environmental guidelines for extractive industries, indicates that mine water management proposals should be based on the principle of waste minimization. The companies should only consider disposal of the water used as a

⁴³ Oranje, “Discussion Document – A Strategic Framework for Implementing Sustainable Development in the South African Minerals Sector: Towards Developing Sustainable Development Policy and Meeting Reporting Commitments,” (2007), op. cit.

⁴⁴ Budds and Hinojosa, “Restructuring and rescaling water governance in mining contexts: The co-production of waterscapes in Peru,” (2012), op. cit.

⁴⁵ Diego Ore, “Bolivia and Chile wrangle over water in Atacama,” *Reuters* (September 22, 2012), available at: <http://www.reuters.com/article/2009/09/22/bolivia-chile-water-idUSN2220905120090922>

last resort and should promote waste water minimization through the waste hierarchy listed below:⁴⁶

1. Avoidance
2. Reduction
3. Reuse
4. Recycling
5. Recovery of Energy
6. Treatment
7. Containment
8. Disposal

If combined with proper water management procedures, water reuse enables the mining industry to save up to 40% of its daily freshwater intake, thereby reducing competition with the communities and the environment.⁴⁷ In Brazil, for example, a Vale mine is almost self-sufficient in water used for its operations.

Box 7: Brazil - Recycling more than 77% of water use

Vale, a Brazilian mining company with operations worldwide, increased its overall water reuse and recycling to 77% percent in 2012. Improved performance was a result of automating the water reuse system at the effluent treatment station.⁴⁸

At the Sossego Plant, in Pará, Brazil, performance is even more impressive. In 2012, the site was recycling 99.99% of the water used, avoiding pumping 900,000 m³ per year, equivalent to the water consumption of a 25,000-person town over 6 months.⁴⁹

In Western Australia, Rio Tinto has also managed to significantly improve water-recycling operations and reduce water consumption.

Box 8: Australia - Reducing water intake in 95%⁵⁰

Argyle Diamond Mine, a Rio Tinto operation, used more than 3,500 ML from Lake Argyle to run its diamond separation operation in 2005. The lake, however, is protected by the Ramsar Convention on Wetlands of International Importance, and as a result the company has set a target of reducing its use. After some feasibility studies, the company is now able to recycle about 40% of the water that would otherwise be discharged to the environment and also dewaterers from both the underground and surface operations into two dams. By introducing these changes since 2005, the mine has reduced 95% of the water taken from Lake Argyle.

In some other cases, mining companies can also help solve water management problems while simultaneously creating another source of income for the company. In China, for example, two companies partnered to benefit from treating and reusing water from mining operations.

⁴⁶ "Environmental Guidelines: Management of Water in Mines and Quarries," Department of State Development Business and Innovation – Energy and Earth Resources, Victoria State Government, Australia, available at: <http://www.dpi.vic.gov.au/earth-resources/minerals/environmental-guidelines/management-of-water-in-mines-and-quarries>

⁴⁷ Szyplinska, "Thirsty World of Mining: Harvesting New Water Solution," (2012), op. cit.

⁴⁸ Vale, "Sustainability Report 2012," available at: <http://www.vale.com/EN/aboutvale/sustainability/links/LinksDownloadsDocuments/2012-sustainability-report.pdf>

⁴⁹ Vale, "Sustainability Report 2012," op. cit.

⁵⁰ "Sustainable Development 2011, Water Factsheet," Rio Tinto (2011), available at: http://www.riotinto.com/sustainabledevelopment2011/pdf/water_factsheet.pdf

Box 9: China - Turning a wastewater treatment plant into a profitable operation⁵¹

Jiangxi Copper Company Limited, an important producer of sulphur, gold, and silver, partnered with Vancouver-based BioteQ Environmental Technologies to apply BioteQ's innovative industrial wastewater treatment processes to Jiangxi Copper's Dexing mine suffering from acid mine drainage resulting from rainfalls on the waste dumps and low grade stockpiles leading in turn to metal-contaminated waste water. By recovering dissolved copper from the mine wastewater, Dexing water treatment plant produces a saleable copper product whose revenues cover the cost of water treatment and treated water that is re-used at the mine site. The plant was commissioned in 2008 and within 6 months of operations, the plant already treated 3 billion liters of wastewater and recovered about 700,000 pounds of copper.

Another circumstance that could contribute to the discharge of polluted water is when the mine is underground and below a water table (known as 'wet' mine).⁵² To enable the extraction of ore in such wet mines, the water table has to be lowered by removing groundwater. Additionally, any rainfall or surface runoff that accumulates in the mine surface must also be removed. For instance, Resolution Cooper, a joint venture between Rio Tinto and BHP formed to develop and operate an underground mine in Arizona, U.S., had to remove almost 9 billion liters of water accumulated in the old mine to start exploring and begin the development of the mine 1.5 km below the surface. The company decided to build a US\$20 million water treatment facility (see Box 14).

Reduce evaporation

In arid regions, another common strategy is to reduce evaporation, which can significantly decrease the additional amount of fresh water needed for mine operations.

Box 10: Chile - Improving efficiency by reducing water loss⁵³

The Xstrata's Lomas Bayas mine in the water-scarce Atacama Desert in Chile took important steps to reduce evaporative losses from the mine's solution ponds and leach pads. Water evaporation was contributing to more than 40% of the total water lost on-site. This evaporation was found to be associated with a sprinkler system ("mildly acidic solution was sprayed over crushed ore to leach out the copper"). This system was replaced by a more advanced and water-efficient drip-feed system and impermeable plastic covers were also installed. By taking these steps, the mine managed to reduce the evaporation rate in the leaching process by approximately 54%.

The table below presents technologies for optimizing water resource consumption.

Figure 6: Technologies for optimizing water resource consumption

⁵¹ "Mining Environmental Protection Award: Jiangxi Copper," *Marketwire* (November, 13, 2008), available at: <http://www.chinamining.org/Specials/2008ChinaMining/2008-11-09/1226221443d18973.html>

⁵² The water table is the top zone of soil and rock in which all voids are saturated with groundwater.

⁵³ "Water management in mining: a selection of case studies," ICMM (2012), op. cit.

TECHNOLOGY	GENERAL DESCRIPTION
Automatic control of the thickening system	Optimize water recovery through an intelligent controller, increasing tailing density and thus reducing concentrator water consumption.
Permanent supervision of consumption	Control water consumption by operational area, also carrying out internal audits and charging fines for excess consumption.
Recirculation of waters from distant dams	Recirculate clear waters from tailing dams and dumps to the mine.
Bioremediation treatment of contaminated effluents	Use bio hydro-metallurgical treatments to precipitate contaminants found in effluents of hydro-metallurgical processes in stable salts, using filters and presses to recover water in these processes.
Leaching system drainage control	Use proper software and materials to plan leaching system drainage reducing solution losses by infiltration, leaks or the formation of saturated mineral pockets.
Filtering of tailings	Use band filters to dry the tailings, increasing concentration in weight up to 75% and then sending them to the deposit by conveyor belt or truck.
Optimization of mine consumables	Use technologies and procedures that permit minimizing water use at mining sites for loading ore, watering roads and drilling.
Extreme thickening	Use higher thickeners to produce hyper concentrated tailing discharges, recovering greater quantities of water and using the inclined dam method for deposit.
Dry grinding and pneumatic centrifuge	Grind the mineral until the optimal release size so they can be separated by dry classification before flotation.
Blown and extracted from the remaining aquifer in the tailing dam	Extract the water in the saturated zone of the tailing dams in operation or abandoned, through drainage and blow wells.
Use of drainage pipes	Use a system analogous to those used in water reservoirs and farmlands to capture water from the tailing dams.

Source: Cochilco⁵⁴

Desalination

Desalination, or processing seawater, is one of the most common treatments employed by mining companies where the shortage of fresh water is a limiting factor for their operations. In some cases, it is the only alternative. The EIA of the Langer Heinrich mine expansion project, one of the largest uranium reserves in Namibia, for example, concludes that:

*"The proposed abstraction of 250,000m³/annum from the Husab Berg compartment is not sustainable. The impact of this activity will be high since the sustainable abstraction rate is only 150,000m³/annum and the SEA gives a clear recommendation/guideline that future mining activities must source desalinated water only."*⁵⁵

However, this strategy can be very expensive (and very energy intensive). In Chile, desalination plants cost around US\$100 million for small mines and up to US\$3.5 billion for larger copper projects. Additionally, the plant may require a dedicated

⁵⁴ Brantes, "Best Practices and Efficient use of water in the Mining Industry," (2008), op. cit.

⁵⁵ "The Water Supply Improvement Project to the Langer Heinrich Mine." Draft Scoping/Environmental Impact Assessment Report – Draft 03 23/11/2010 for comments by stakeholders, Enviro Dynamics, (2010), available at: <http://www.the-eis.com/data/literature/Langer%20Heinrich%20Water%20Supply%20Draft%20EIA%20Nov%202010.pdf>

power source and long distance infrastructure to transport the water. As a result, desalinated water can be ten times more expensive than sourcing water locally.⁵⁶ Copper companies in Chile recently estimated that switching from freshwater to desalinated seawater could potentially add 20-30% to their costs.⁵⁷ Moreover, desalination adds issues in the mine planning. The construction of a new mine, for example, is fairly short compared to the time of designing and commissioning a desalination plant, especially if a pipeline is required. In Chile for instance, the permitting process can take up to four years, sometimes much longer than the timeline to start a mine.⁵⁸

Box 11: Chile - Desalination as an alternative for the loss of water rights

Candelaria mine, whose operation started in 2013, built a desalination plant and an 80 km pipeline to supply the mine water needs at a cost of approximately US\$315 million. Operation of the desalination plant, combined with the water from the Copiapo wastewater treatment facility, will eliminate the mine's need to withdraw water from the local aquifer.⁵⁹ Given the significant water supply provided by the desalination plant, this project has also made it possible to transfer water rights from the mine to the local water utility.⁶⁰

But while pumping seawater to some of the largest copper mines in the world is expensive, it is potentially an unavoidable alternative.⁶¹ The uncertain availability of groundwater and high cost of water rights in Chile, for example, suggest that because seawater is a more secure resource it could also be cost-effective (the potential of having insufficient/unreliable water supplies for the mine's operations would come at a greater cost). In some regions of the country, where water consumption is estimated to be six times greater than water renewal,⁶² the government has already prohibited mines from benefiting from the granted water right titles and already rejected new projects planning on using freshwater (see Figure 7).⁶³

⁵⁶ "Water Scarcity the next big challenges for miners," *Business Monitor International* (2013), op. cit.

⁵⁷ "International: Water rights," CSIRO (January 24, 2012), available at:

<http://www.csiro.au/Portals/Publications/Magazines/resourceful/Issue-3/Issue-1/1-Water-rights.aspx>

⁵⁸ Pierrick Blin and Antoine Dion-Ortega, "High and Dry," *CIM Magazine* (June/July 2013), available at:

<http://magazine.cim.org/en/2013/June-July-2013/feature/High-and-dry.aspx>

⁵⁹ "CDP 2013 CDP Water Disclosure 2013 Information Request," Freeport-McMoRan Copper & Gold Inc, available at: <http://www.fcx.com/sd/pdfs/ProgrammeResponseCDP%20Water%20Disclosure%202013.pdf>

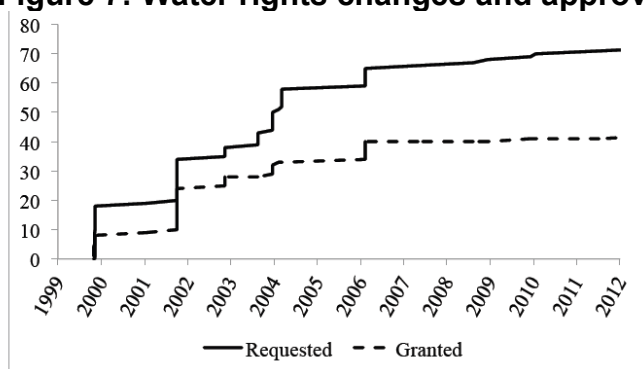
⁶⁰ Ibid.

⁶¹ This opportunity is mainly present in coastal countries but new technologies have been developed to enable desalination inland (for instance see: <http://www.ecomagination.com/landlocked-no-more-desalination-goes-inland>).

⁶² Water flows out of the region or evaporates faster than it is replaced by rainfall or runoff.

⁶³ Eric C. Edwards, Oscar Cristi, and Gary D. Libecap, "Groundwater Conservation via Desalination: Regulator Behavior and Welfare Implications," Working Draft (September 6, 2013), available at: http://www2.bren.ucsb.edu/~eredwards/WP_Desalination_as_GW_Conservation.pdf

Figure 7: Water rights changes and approvals in Antofagasta since 2000



Source: Edwards et al⁶⁴

In Peru, host to some of the world's largest and most water intensive copper and gold mines, water scarcity has also emerged as a major risk affecting both existing mining operations and new projects, and mining companies are being forced to use seawater and desalination plants. In April 2012, for example, following months of violent protests, the Peruvian government halted the US\$1 billion Tia Maria project of Southern Copper Corporation on the grounds that the new mining project could harm local water supplies. The decision led the company to delay the project significantly, conduct a new EIA and consider building a desalination plant to avoid using local fresh water.⁶⁵

South Australia presents a similar case (Box 12).

Box 12: Australia - Building a desalination plant to avoid competing with local communities

In South Australia, the majority of known water resources are attached to a license including provisions that the water use should not impact other consumers by changes in the quantity or quality of water supply.⁶⁶

As a consequence, BHP Billiton is proposing to build a desalination plant to supply water for its Olympic Dam expansion project in case the project goes further. The Olympic Dam project is the fourth largest copper deposit and the largest deposit of uranium in the world.⁶⁷ Currently, the Olympic Dam and the town of Roxby Downs use water from two wells in the Great Artesian Basin (GAB). To support its expansion plan, the company will need significant additional water supplies, which in order to comply with water license provisions and avoid competing with the local community for fresh water, the company must obtain from another source rather than the GAB.⁶⁸

As anticipated in its EIA Draft, the company proposed a desalination plant located 320 km from the site with capacity of 280 ML/d (MegaLiter/day), out of which 80ML/d would be supplied to towns in the Upper Spencer Gulf and Eyre Peninsula regions out of charge. Currently, those cities draw water from the River Murray. The project, however, got blocked when the South Australian Government decided it did not need

⁶⁴ Ibid.

⁶⁵ "Water Scarcity the next big challenges for miners," *Business Monitor International* (2013), op. cit.

⁶⁶ "Capitalizing on Sustainable Development in Mining," KPMG (2012), available at: <http://www.kpmg.com/Global/en/IssuesAndInsights/ArticlesPublications/Documents/sustainable-development-mining.pdf>

⁶⁷ "BHP advances on Olympic Dam project," *The Australian* (March 31, 2011), available at: <http://www.theaustralian.com.au/business/bhp-advances-on-olympic-dam-project/story-e6frg8zx-1226031002936>

⁶⁸ "Olympic Dam Expansion - Draft Supplementary EIS Information Sheet: Water Supply," BHP Billiton, available at: <http://www.bhpbilliton.com/home/aboutus/regulatory/Documents/Olympic%20Dam%20Supplementary%20EIS/Information%20Sheets/Olympic%20Dam%20EIS%20Water%20Supply.pdf>

the 80 ML/d offered. In addition, the Olympic Dam expansion project has been postponed due to strong public opposition fueled by anti-nuclear concerns.⁶⁹

These examples reveal that mines have the capacity to reduce their water footprint and technological solutions are already available to diminish mines' water consumption. In that context, the "actual" mining demand for water should be carefully assessed before any water right is allocated.

Recommendation Three: Once the actual water supply and demand have been estimated, allocate water rights to satisfy the unmet demand but devise a priority plan with review mechanisms

Once water rights are allocated to mines, it is desirable to implement programs prioritizing residential use over commercial use in case of an emergency and excessive water shortage as in New South Wales, Australia (Box 13). Those programs should be reviewed on a regular basis.

Box 13: Australia - Planning and prioritizing water rights allocation

In New South Wales, Australia, there are currently two pieces of water legislation in place. The first is the Water Act 1912 while the second is the Water Management Act 2000.

The Water Act 1912 grants licenses that are generally tied to the land as they cover the right to take a specific volume of water. Under this water allocation/ rights system, water resources had been over-allocated causing environmental degradation and reduced supply reliability. Recognizing the need to protect the ecosystem while also providing more secure access to water and greater opportunities to trade water, the government then introduced the Water Management Act 2000 and the associated Water Sharing Plans.

A Water Sharing Plan determines the total volume of water available for water extraction. The total amount is then divided among the license holders who are entitled to extract a share of the total available water. In most areas the government makes a Water Sharing Plan every year for each water source, especially for areas affected by drought. Therefore, even though the share of the water rights may remain fixed, the amount of water related may significantly vary over time. It also established rules and priorities between different types of water users such as towns, the environment, irrigation, stock, and domestic needs and industry. In dry periods, for example, water for domestic purposes is given priority over commercial uses.⁷⁰

Both Acts are currently in effect. By the end of 2010, about 90% of the water extracted was covered by the Water Management Act 2000. The original Water Act 1912, nonetheless, continues to apply in areas that are not yet covered by the new Act.⁷¹

⁶⁹ "Global Desalination Report: Australia," *GWJ* 46 (1) (January 4, 2010), available at: <http://www.desalination.com/wdr/46/1/australia>

⁷⁰ "How water sharing plans work?," Office of Water, Department of Primary Industries, NSW Government, Australia, available at: <http://www.water.nsw.gov.au/Water-management/Water-sharing-plans/how-water-sharing-plans-work/default.aspx>

⁷¹ "Water Sharing Plans," Office of Water, Department of Primary Industries, NSW Government, Australia, available at: <http://www.water.nsw.gov.au/Water-management/Water-sharing/default.aspx>

As the water sharing plans, the allocation of water rights should be reviewed periodically. Governments should consider statutorily limiting the length of water licenses to short-term licenses, or introduce a periodic review mechanism to allow authorities to re-assess water allocations over time. Of course, mining companies favor long fixed-period water concessions to be able to plan for the lifespan of their mining operations but it is at the expense of the government's ability to adjust the water resource allocations to the evolving reality of supply and demand of water.⁷²

Recommendation Four: When mines build additional water infrastructure to serve their needs, adopt a sustainable operational model to ensure that communities benefit from extra-capacity delivered by such infrastructure

The opportunity for shared use of water infrastructure can arise from different situations.

The case of wet mines is often the one presenting the biggest scope for synergies and mutually beneficial outcomes: indeed, in this case, mines often have to remove and treat more water than what they need and when a zero-discharge policy is in place, the mine is often eager to partner to find an outlet for the extra-water whose marginal cost is null. Boxes 14-15 present cases in point, from the U.S. and Australia. Water agencies in water-scarce countries should always have a clear knowledge and understanding of the existence of wet mines in order to identify the synergies.

Box 14: United States - Partnering to use water resources from wet mines⁷³

Resolution Cooper, a joint venture between Rio Tinto and BHP formed to develop and operate a copper underground mine in Arizona, U.S., realized that to start exploring and begin the development of the mine 1.5 km below the surface, almost 9 billion liters of water accumulated in the old mine (closed in 1996) had to be removed. In 2009, the company decided to build a US\$20 million water treatment facility to discharge the water once it is pumped to the surface but did not know where to direct it once it was treated so as to ensure that the water is fully used (beyond the mines' needs) and the environment not negatively impacted.

The solution found was to work with the New Magma Irrigation and Drainage District (NMIDD) to use the extracted treated water to irrigate cotton, alfalfa and Bermuda rye grass and avoid depleting groundwater for agricultural, municipal and industrial uses. The project includes a 44 km pipeline to transport water from the treatment facility to the agriculture fields. The mine is also working with NMIDD and the Hohokam Irrigation and Drainage District to store water for the mine operation in the future and minimize its impact.

⁷² Nicolas Maennling, Alpa Shah, Sophie Thomashausen "A Framework to Approach the Issue of Shared Use of Mining-Related Infrastructure: Case Study: Mozambique," Vale Columbia Center on Sustainable International Investment, Columbia University, New York (2014).

⁷³ Michael Matichich, Marek Mierzejewski, Bill Byers, Dan Pitzler, Sartaz Ahmed, and CH2M HILL, "The Changing Value of Water to the US Economy: Implications from Five Industrial Sectors," CH2M Hill (September 17, 2012), available at: http://www.indecon.com/iecwweb/documents/CH2MHILL_ChangingValueofWater_MatichichMierzejewskiByersPtizlerAhmed_FINAL_9-12-12_2.pdf

Box 15: Australia - Using excess mine water for irrigation

Xstrata Coal's Ulan coal mine in New South Wales is a "water surplus" mine site, which means that more water is generated from removing water from the underground mine than is used in its operations. The mine produces 9-11ML/day of water, but only 5-6ML/day is used on-site. In order to dispose of the additional water generated and comply with the Pollution Reduction Programme attached to Ulan's EPA license requiring a zero discharge of mine water, the company implemented in 2003 the Bobadeen Irrigation Scheme at a project cost of US\$ 4.5 million.⁷⁴ The mine water is pumped 6 km from Ulan Mine to a 502 ML storage dam and is then pumped from there to five points to irrigate 242 hectares of pastures where beef cattle are grazed.⁷⁵

Whereas the information on the commercial arrangement between the mines and the water authorities is generally insufficient, it is quite detailed in the case of South Africa (Box 16). This information evidences that water treatment infrastructure developed by mines provides the opportunity to develop infrastructure whose access is inexpensive. In fact, since mines are not in the business of developing infrastructure other than for their own use, they are interested in keeping costs low and charge access at cost. Mines also have access to project finance at lower interest rates than typical water infrastructure companies since they can guarantee the infrastructure use by their own demand. Sometimes non-mining related water infrastructure is not even bankable given the risk for tariffs set at below cost-recovery level and uncertain demand data.

Box 16: South Africa - A mutually beneficial arrangement between the mines and the municipalities

The Witbank coalfields, located around the city of eMalahleni, contain many mines and some of which are closed and contain significant volumes of groundwater, which could lead to contamination of groundwater and surface water. In the same time, the city of eMalahleni, struggles to meet the water demand of its expanding population and removes almost 50% more from the local Witbank Dam than it is licensed to do.

To tackle two environmental water-related challenges, water pollution due to acid-mine drainage and growing water-stress, AngloAmerican's AngloCoal division partnered with BHP Billiton and the eMalahleni Local Municipality to build the eMalahleni Water Reclamation Project (EWRP) in 2007. The plant will be owned and operated by AngloAmerican while treating BHP's water on a right-of use basis. The project involved the construction of three pipelines to convey water from participating mines, Klienkopje, Greenside Colliery and South Witbank Colliery, to a central water storage facility, a water treatment plant and two reservoirs.

The water-treatment plants cost about US\$100 million and are partly financed by selling potable water produced from these plants to local municipalities at the operating costs. The water-reclamation plant currently supplies around 12% of the

⁷⁴ "Strategic Framework for Water Management in the Minerals Industry," Government of South Australia, available at: http://www.ret.gov.au/resources/Documents/mcmpr/Strategic_Framework_for_Water_Management_in_the_Mine_rals_Industry.pdf

⁷⁵ Justine Winn, "Bobadeen Irrigation Scheme Officially Opened," Xstrata (November 5, 2003), available at: <http://www.glencorexstrata.com/assets/Uploads/200311050701.en.pdf>

city's water, decreasing the percentage of people without drinking water from 14% to 2%.⁷⁶

In addition, the partnership has also made a number of the nearby coal mines and collieries self-sufficient and created sufficient conditions for new industries to start up (for example, Anglo Zimele created the White River Beverage Company, utilizing some of the plant's water for the retail bottling industry).⁷⁷

In the case of desalination, there is a business case to invest in big infrastructure for water storage and, to a lesser extent, waste treatment, to accommodate the extra capacity because of the economies of scale.⁷⁸ For instance, in Moquegua in Peru, the infrastructure required was not economically viable for the mine alone so the company sought to partner with the government to co-finance the proposed dam and reservoir on the basis that it would also provide water to other sectors and that it would last longer than the mining project.⁷⁹

Examples are many and show that partnering around water infrastructure can be mutually beneficial. What is essential is to find the right partnership and commercial framework. There are generally 2 possibilities: joint ventures and off-take agreements. When the mine does not require a financing arrangement with the utility, at least there should be a breakdown of responsibilities between the bulk infrastructure and the distribution network, and between the construction and financing on the one hand and the operations and maintenance on the other hand.

Joint venture

In Saudi Arabia, the mining company Ma'aden is building a desalination plant with the State-owned Saline Water Conversion Company (SWCC) to serve both the aluminum smelter and the surrounding cities.

Box 17: Saudi Arabia - Public Private Partnership and scale economies

In Saudi Arabia, less than half of households are adequately connected to the water and sewage system. According to market estimates, desalination capacity needs to double over the next 20 years to cover drinking water alone.⁸⁰

In that context, the SWCC and Saudi Electricity Company (SEC), both government agencies, signed a contract with Ma'aden, the largest mining company in Saudi Arabia (50% state-owned) to jointly build a desalination plant in 2009.⁸¹ Of the water "produced," the aluminum complex will use only 25,000 m³/day of water out of 1.025 million m³. The rest of the water will be pumped to the cities of Riyadh, Hafr Al-Batin and Nuayriyah.⁸²

⁷⁶ AngloAmerican website, Section on Sustainable Development, available at:

http://www.angloamerican.com/development/case-studies/environment/water_for_adaption.aspx

⁷⁷ "Water management in mining: a selection of case studies," ICMM (2012), op. cit.; "BHP Billiton- Partnership for Water Efficiency," ICMM, available at: <http://www.icmm.com/page/55479/bhp-billiton-partnership-for-water-efficiency>

⁷⁸ Michael W. Hanemann, "The economic conception of water," *Water Crisis: myth or reality* (2006): 61-91, available at: <http://are.berkeley.edu/~gh082644/The%20economic%20concpetion%20of%20water.pdf>

⁷⁹ Mining Company (anonymized representative), source: Budds and Hinojosa, "Restructuring and rescaling water governance in mining contexts: The co-production of waterscapes in Peru," (2012), op. cit.

⁸⁰ Raj Sinha and Nasser Moumen, "Saudi infrastructure – Mining: the third pillar of the economy," HSBC – Global Research - Industrials, Mining/Equities (July 2010), available at:

<http://www.research.hsbc.com/midas/Res/RDV?p=pdf&key=ytfpc3nbuw&n=271876.PDF>

⁸¹ Ma'aden website, available at: <http://www.maaden.com.sa/en/business/aluminium>

⁸² Ibid.

In South Australia, companies and government co-invest in water treatment facilities.

Box 18: Australia - Partnering to improve water quality for human consumption⁸³

In 2006, the mining company Iluka built a Mineral Separation Plant (MSP) near Hamilton in Victoria, Australia, to process rutile and zircon products. The MSP is located near Wannon Water's waste water treatment facility from which it will use the secondary treated waste water for its mineral separation process. Thanks to a partnership arrangement between Iluka, Wannon Water and the Victorian Government, all water used on the site will be retreated to allow for human consumption. There is potential to save up to 500 ML of potable water from Hamilton's water supply.

Off-take agreement of excess water

When the public utility cannot share in the capital expenditure, it is also possible to secure the extra-capacity with an off-take agreement, as is the case with Areva's uranium mine in Namibia.

Box 19: Namibia - Taking advantage of the desalination plant's extra-capacity

Areva, a French mining and energy corporation, is committed to reducing its water usage globally by 35% from 2008 levels. In order to achieve this goal, when planning its Trekkopje uranium mine in Namibia, the company included a desalination plant.⁸⁴ The plant supplies all the water consumed at the Trekkopje mine, plus an additional 8-10 million m³ for domestic use and other mines. Areva is the sole owner of the Erongo desalination plant, and it has been operated and maintained by AvengWater for the past three years.

Currently the state-owned NamWater (national water supplier) extracts about 9Mm³ of potable water each year from the Omdel aquifer and 6Mm³ from the Kuiseb river to efficiently supply the water needs of Henties Bay, Swakopmund and Walvis Bay and mining entities in the Erongo region. With an off-take agreement with Areva and a connection between the plant's pipeline and NamWater's pipelines, NamWater will be able to reduce its water intake and on sell in particular to the mines.⁸⁵ Also, the expected operational life of the desalination plant is longer than the anticipated life of the mine; therefore, it has been agreed between the parties that NamWater will take over the plant as part of the mine closure plan.⁸⁶

If the water infrastructure is a greenfield investment, mines and utility can come together to leverage the anchor demand of the mines with take-or-pay agreements and benefit from scale economies as is the case in South Africa.

⁸³ "Strategic Framework for Water Management in the Minerals Industry," Government of South Australia, op. cit.

⁸⁴ Al Bredenberg, "Sustainable Mining Today Engages Local Communities," *Thomas Net News* (August 13, 2012), available at: http://news.thomasnet.com/green_clean/2012/08/13/sustainable-mining-today-engages-local-communities/

⁸⁵ "Areva Namibia and NamWater reach water supply agreement," *Namib Times*, (August 6, 2013), available at: <http://www.namibtimes.net/forum/topics/areva-namibia-and-namwater-reach-water-supply-agreement>

⁸⁶ "Water management in mining: a selection of case studies," ICM (2012), op. cit.

Box 20: South Africa - Bankability of a government project thanks to take-or-pay agreements with mines

In 2008, the Department of Water Affairs & Forestry (DWAF) of South Africa and 23 mining companies signed a Memorandum of Agreement (MoA) to jointly invest R7.4-billion in the Olifants River water project to increase water availability in the Limpopo province.⁸⁷ The MoA made the project bankable by providing guaranteed revenue streams: mining companies committed to take-or-pay agreements whereby each mine will cover the costs associated with the allocated capacity, regardless of water use.

The project involved the construction of the De Hoop Dam on the Steelpoort River to supply water and the related infrastructure to the expanding mining sector and 800,000 people.⁸⁸ The De Hoop Dam will only serve the platinum group metals mines in the area after bringing bulk supply to residential and commercial users as well as rural communities.⁸⁹

Allocation of investment and management responsibilities

Even if mines can invest in water infrastructure to serve beyond their own needs, they certainly cannot enter the business of distribution, which should be shouldered by the national/local government or public utility. The same goes with the management, operation and maintenance of the infrastructure. It is therefore fundamental for responsibilities and roles to be properly allocated to parties to ensure the sustainability of the system. The details of the partnership worked out during the life of the mine will impact the sustainability of the system post-closure as well (see Boxes 23 and 24).

In Tanzania, AngloGold Ashanti built and financed the bulk infrastructure while the government is in charge of building and managing the distribution.

Box 21: Tanzania - Breaking down the responsibilities

In 2012, AngloGold Ashanti's Geita gold mine partnered with the Tanzanian government to finance the Geita Town Water Project. The project costs approximately US\$4.9 million and involves the construction of a water supply system that includes a treatment plant adjacent to Nyankanga dam, a reservoir tank at Katoma Hill and a pipeline to transport water from the Lake Victoria. In addition to providing water for the mine operations, the system will also provide clean water supply to more than 150,000 residents located around Geita.⁹⁰

Although the mine is constructing the water project, the government will be in charge of the distribution network. The mine, however, has also committed to operate the system for 12 months after closure during which local council operators will be trained to run the system.⁹¹

⁸⁷ "Limpopo gets R7.4bn water project," *South Africa Info* (May 28, 2008), available at:

<http://www.southafrica.info/business/economy/infrastructure/olifants-280508.htm#.UnQ16vkju2#ixzz2jRGShTa9>

⁸⁸ "Water key to wealth building in Limpopo," *The Water Wheel* (July/August 2008), available at:

http://www.wrc.org.za/Knowledge%20Hub%20Documents/Water%20Wheel/Articles/2008/04/WaterWheel_2008_04_10%20De%20Hoop%20p%2028-29.pdf

⁸⁹ "Limpopo gets R7.4bn water project," *South Africa info* (28 May 2008), available at:

<http://www.southafrica.info/business/economy/infrastructure/olifants-280508.htm#.UxSaKHmP4pG>

⁹⁰ "Geita Gold Mine builds water supply system for new Geita municipality," *The Guardian* (June 21, 2012),

available at: <http://www.ippmedia.com/frontend/?l=42836>

⁹¹ AngloGold Ashanti – Tanzania Fact Sheet, available at: <http://www.anglogold.com/NR/rdonlyres/B40A0B49-FFF9-43B6-820B-C196B1AF41C1/0/Tanzania.pdf>

Given that the mine is not in the water business, it is often suggested to have a third party managing the water infrastructure even though the mine provides guaranteed demand, financing and expertise. An example comes from the Cerro Verde mine in Peru.

Box 22: Peru - Third-party management of the water treatment facility

Freeport McMoran's Cerro Verde mine is an open-pit copper and molybdenum mining complex located near the city of Arequipa in southern Peru. The mine is a zero-discharge facility that recycles approximately 85% of the water used in the process. The company, however, plans to expand and triple its production; in order to do so, the project will require an 85% increase in its water requirements.⁹² At the same time, access to clean water in the region is a major challenge. The main source of water supply, Rio Chili, has become contaminated because of untreated sewage discharge, and there is insufficient wastewater treatment capacity in the region.⁹³

In 2011, the mining company thus proposed to supply the additional water requirement through a new wastewater treatment plant with excess capacity reserved for the communities. By avoiding polluting discharge to Rio Chili's water quality, the project would also improve agriculture productivity in the area and reduce water-related diseases.⁹⁴ It will also be a long-term source of treated water for mining operations. The Regional Government of Arequipa, the National Government and SEDAPAR (Servicio de Agua Potable y Alcantarillado de Arequipa S.A) agreed with Freeport McMoran that the mine will finance the engineering and construction of the wastewater treatment plant and that the plant will be operated by SEDAPAR. Construction started in 2013.⁹⁵

Anticipating mine closure

Lack of planning regarding the sustainability of water infrastructure after the mine ceases operations is likely to have a detrimental impact on the local communities. In Mashonaland in the West Province of Zimbabwe, for example, the community suffered a 96% shortfall of their daily water supply after the Mhangura copper mine was closed. Prior to the closure, water supply to both the mine and the local community was made through a 33 km pipe from a dam, but when the company left, the lack of investments and increasing leaks lead to a significant decrease in supply to the Township. In that situation, the government faced difficulties applying taxes to the population to pay for the required maintenance as they previously had water for free.⁹⁶

⁹² "Cerro Verde Facts- Cerro Verde Expansion," Freeport-McMoran Copper and Gold, available at: http://www.fcx.com/sd/pdf/fast_facts/2011/cerro_verde_expansion_july11.pdf

⁹³ "Clean Water for Arequipa, Peru," Freeport-McMoran Copper & Gold, available at: http://www.fcx.com/sd/news/2011/clean_water_peru.pdf

⁹⁴ Ibid.

⁹⁵ "Cerro Verde Facts- Cerro Verde Expansion," Freeport-McMoran Copper and Gold, available at: http://www.fcx.com/sd/pdf/fast_facts/2011/cerro_verde_expansion_july11.pdf

⁹⁶ Itai Offat Manyanhaire, Joseph Matewa, and Ezekia Sivotwa, "Water shortage related problems following the closure of Mhangura copper mine in Mashonaland West Province of Zimbabwe," *Journal of Sustainable Development in Africa*, 11(4) (2009), 239-252, available at: http://jsd-africa.com/Jsda/V12NO2_Winter2009_B/Pdf/Water%20Shortages%20Mhangura.pdf

This situation could have been avoided if the public utility would have been strengthened, equipped and trained to collect fees⁹⁷ on the water distributed as in Senegal (Box 23) and if the clear responsibility of operations and management would have been transferred to the local government as in the case in Tanzania (Boxes 21 and 24) and Peru (Box 22).

Box 23: Senegal - Teaching locals managerial skills to increase water supply in the long term⁹⁸

In 2011, in partnership with the regional hydraulic department, Teranga, a Canadian-based gold company has provided financial and project management support to the upgrade of the Sabodala village potable water supply, as well institutional support to the water management committee (ASUFOR).

Water used to be available from two community water fountains, and household connections were non-existent. The partnership helped increase the storage capacity and water distribution to seven community water fountains and more than 60 household connections. As a result, the project led to a significant improvement of public access to potable water and a reduction of the time required for women to collect water. All water fountains are now metered, which allows ASUFOR to collect payments for water consumption that in turn serve as a source of revenue that now supports the ongoing operation and maintenance of the water system.

Box 24: Tanzania - Local communities involved in Operations and Management

African Barrick's Bulyanhulu mine is an underground gold mine, 55 km from Lake Victoria in Tanzania, that started operating in 2001. In order to provide water for the mine's operations, an intake and pumping station has been constructed at Smith Sound, as well as a pipeline to Bugarama ward where the mine is located with 15 off-take points along the route.⁹⁹ The pipeline, which provides about 40% of its capacity for the needs of the community, helps reduce the community time to collect water and provide 30,000 people with access to water.¹⁰⁰

Although the mining company contributes with project management and financial resources for construction of the infrastructure and community education to effectively manage the provided infrastructure (e.g. management skills and implementation of revenue earning systems), the government is in charge of the design of the water system, and local communities take long-term responsibility for the operations and management of the system.¹⁰¹

⁹⁷ Collecting fees is important to ensure the sustainability of the water project even if those fees ought to be set at a very low level to ensure social equity.

⁹⁸ Teranga Gold Corporation, Community relations, available at: http://www.terangagold.com/files/doc_downloads/2011%20RR.pdf

⁹⁹ "Miner to fund 3.2bn/- water project to benefit three districts," *The Guardian* (July 14, 2011), available at: <http://www.ippmedia.com/frontend/?l=31179>

¹⁰⁰ Emmanuel M. Nyankweli, "Foreign direct investment and poverty alleviation: the case of Bulyanhulu and Geita gold mines, Tanzania," (2012) 154, available at: <https://openaccess.leidenuniv.nl/bitstream/handle/1887/20160/asc-075287668-3256-01.pdf?sequence=2>

¹⁰¹ Michael Warner and Dom Verschoyle, "Partnerships for Managing Social Issues in the Extractive Industries: Learning from Project Partnering in the Constructive Industry," *Business Partners for Development Natural Resources Cluster, Working Papers* 12 (2001), available at: http://www.commddev.org/files/1519_file_G21.pdf

Recommendation Five: Ensure an adequate institutional framework to regulate, monitor and enforce water rights

A good understanding of the water resources of the country combined with good and sound regulations are crucial but not sufficient to ensure good water management. It is equally important to have proper institutional capacity and autonomy to enforce and supervise the water rights. Since environmental and water rights regulations will determine the scope for shared use, institutional capacity should be strong enough to overcome economic pressure by important market players that advocate for a more relaxed approach to water conservation.

In Mongolia, for example, the government decided to declare a seasonal lake a protected area, but faced with demands from the mining industry, it finally authorized the mines to pump the underground water of the lake. Furthermore, due to mining companies' pressure, an important law seeking to strengthen environmental protection of water sources is also about to be softened (see Box 25).

Box 25: Mongolia - "Law on Prohibition of Mineral Exploration and Mining Activities in areas in the Headwaters of Rivers, Protected Water Reservoir Zones and Forested Areas"¹⁰²

In 2009, due to growing environmental concern in the country caused by the increasing level of mining activities, the Mongolian Parliament adopted the Law on Prohibition of Mineral Exploration and Mining Activities in areas in the Headwaters of Rivers, Protected Water Reservoir Zones and Forested Areas (actually known as the "Law with the Long Name"). The law aims to provide environmental protection of water sources and stipulates that mining is prohibited at the headwaters of rivers, water protection zones along rivers and lakes and forested areas with the boundaries of prohibited areas to be set by the government. The law also states that existing mining licenses currently operating in riverbeds and forested areas are revoked within five months of the day the law was enacted (but out of 1783 licenses only 117 placer-gold mining licenses were canceled).

The mining companies argued that they had already invested a large amount of money before the law went into effect and that although mining companies were to be compensated if their licenses were revoked, the law would still have had a significant adverse impact on the mining sector and consequently on the country's economy.

In 2013, when the total of foreign investments decreased in the first nine months by 30.6%, the Mining Minister stressed that the government was supporting the sector and announced that a draft amendment to the law was being discussed in order to attract more investments.

It is equally important to have a clear definition and understanding of the role of each agency, Ministry, or other water authority involved. As exemplified by both Brazil (Box 26) and South Africa (Box 27), in order to build a strong institutional framework, one of the most important requirements but also one of the biggest challenges is the coordination of different specialized agencies with different but overlapping purposes. A regulatory framework that enhances coordination mechanisms could

¹⁰² "Gold and Dynamite: Mongolian Law with the Long Name – Acute Conflict in Media Excerpts," Rivers Without Boundaries (September 30, 2013), available at: <http://www.transrivers.org/2013/990/>

have the advantage of improving the operational efficiency of the water laws as well as ensuring a clear regulatory framework for the mining industry.

Box 26: Brazil - Difficulties of coordinating tasks between different agencies¹⁰³

In Brazil, the implementation of a mining project requires both environmental licenses and authorizations referring to water resources. In Minas Gerais, one of the most relevant States for the mining sector, the roles of the State Water Agency and the Environmental Agency are not easily distinguished in terms of evaluation of the water use rights. For small projects (loosely defined by the regulations), the demand for water rights is integrated in the environmental licensing approval process whereas for the large projects, the two agencies are involved separately. It generates regulatory confusion in particular when the water impact assessment is carried out at a different time from the environmental assessment or when the water use rights are applied for at a different time from the environmental licensing process.

Box 27: South Africa - Difficult enforcement and monitoring of water license

The government of South Africa requires all water users, including mines, to acquire a water license from the Department of Water Affairs (DWA) of the Ministry for Water and Environmental Affairs before they start operations. The granting of mineral rights does not include water rights: mineral rights are regulated by the Mineral and Petroleum Resources Development Act 28 of 2002 (MPRD), and it is the National Water Act (NWA) 36 of 1998 that regulates the use of water resources.

Due to DWA's processing delays induced by a lack of capacity and coordination between the agencies, there are currently several mines using water without a license.¹⁰⁴

Monitoring has strengthened, though, and in March 2012, there were only 53 mines operating without water licenses, down from 125 mines in June 2010 and 69 at the end of 2011.¹⁰⁵ By May 2012, the Department had shut down 4 additional mines for operating without water-user licenses.¹⁰⁶

Strong institutions are also fundamental when countries implement a water rights market. Some governments are implementing water rights markets to ensure efficient use and conservation of water resources. However this market approach can have far-reaching implications undermining the restricted approach to water rights that we have advocated so far in this Policy Paper with a view to encouraging shared use of mining-related water infrastructure.

¹⁰³ Leonardo M. A. Castro, José R. C. Cordeiro, Ana K. P. de Souza, and Gilcimar P. C. Oliveira, "Legal aspects of water resources management relating to mine water in Brazil," in Rüde, R.T., Freund, & Wolkersdorfer, eds., *Mine Water – Managing the Challenges* (Aachen, Germany : IMWA, 2011), pp.655 – 659, available at: http://imwa.info/docs/imwa_2011//IMWA2011_Castro_303.pdf

¹⁰⁴ Claire Tucker and Twaambo Muleza, "Penalty for failing to obtain water-use license can be severe," *Polity* (April 12, 2010), available at: <http://www.polity.org.za/article/penalty-for-failing-to-obtain-water-use-licence-can-be-severe-2010-04-12>

¹⁰⁵ "46 local mines continue operating without water licenses," *Infrastructure NE* (September 4, 2012), available at: <http://www.infrastructurene.ws/2012/09/04/46-local-mines-continue-operating-without-water-licenses/>

¹⁰⁶ "South Africa shuts down four mines for violating water-use regulations," *Oosaka News* (May 2012), available at: http://www.ooskanews.com/international-water-weekly/south-africa-shuts-down-four-mines-violating-water-use-regulations_22527

In a water rights market, the seller holds a water use right that is surplus to its water demand while the buyer faces a water deficit and is willing to pay to meet his water demand. In such a water rights market, water rights can be bought to meet particular needs, such as seasonal requirements, or as supplement water in case of drought. By setting a competitive price for the resource, water market mechanisms have proved to incentivize water conservation and efficient water use. According to the Goulburn Broken Catchment Management Authority in Australia, for example, the increase in the re-use of water caused by price signals of the water market has been more effective in promoting water conservation than the re-use mandated by the government: they observed that 80% of farms in their region have re-used their water.¹⁰⁷

By valuing water rights, water market mechanisms have also been successful in transferring resources from less to more water efficient economic activities. According to the Australian Bureau of Statistics (ABS) estimates, in 2004-2005 the average value added¹⁰⁸ per ML of water used was around AUS\$86,000/ML for coal mining, AUS\$50,000/ML for metal mining and AUS\$25,000/ML for other mining. Those numbers are far higher than for other economic sectors (for instance AUS\$162/ML for rice production and AUS\$3,870/ML for vegetable production). This significant difference between the average value added per unit of water used among sectors, suggests that economic benefits will be gained if water is traded more freely between users.¹⁰⁹

Re-allocation between sectors caused by the implementation of a free market certainly has positive consequences in terms of strict economic efficiency and water productivity, but it may challenge important objectives of the government that include equity, sustainable rural development and environmental protection.

In the South African example previously mentioned (see Box 2), the value added of water used in the local mining industry would allow those companies to offer 10-20 times more for water rights than the smallholders. If an unregulated water rights market were to be fully implemented, the imbalance would result in the complete transfer of water rights allocated to the irrigation sector for smallholder farming towards the mining sector.¹¹⁰ A similar process occurred in Chile over the last 20 years after the implementation of water legislation that established a free water-rights market in 1981. Smallholders eventually sold their rights to other users, resulting in decreasing agricultural production and deepening rural poverty.¹¹¹

The implementation of a water rights market should therefore provide the necessary arrangements to ensure that industries, including mining, have access to water supply in a market that reflects both demand and the opportunity cost of supply, but regulatory policy tools are also necessary to ensure a sustainable allocation of water rights addressing equity issues.

¹⁰⁷ Alan Moran, "Property Rights to Water: Effects on Agricultural Productivity and the Environment," IPA background, *Vol 15, Issue 3*, Institute of Public Affairs (June 2003), available at: <http://www.ipa.org.au/library/IPABackgrounder15-3.pdf>

¹⁰⁸ Gross value added is measured by taking the difference between the value of output and the value of intermediate input used in the process of production.

¹⁰⁹ ACIL Tasman, "Water reform and industry: implications of recent water initiatives for the minerals, petroleum, energy, pulp and paper industries," National Water Commission (2007), available at: http://archive.nwc.gov.au/_data/assets/pdf_file/0011/11513/Water_Reform_and_Industry.pdf

¹¹⁰ Farolfi and Perret, "Inter-sectoral competition for water allocation in rural South Africa: Analysing a case study through a standard environmental economics approach," (2002), op. cit.

¹¹¹ Ibid.

To mitigate some of the negative effects of the water rights market, two important safeguards can be put in place:

- a restricted allocation of water rights at the outset as in Antofagasta in Chile (see Figure 7)

- a penalty for unused water rights to discourage speculation and encourage reallocation where it is needed: for instance, in Chile, when the government reformed the Water Code in 2005, it imposed new restrictions on water use.¹¹² Applicants need now to justify how they intend to use the rights and water rights holders need to pay a fee for “lack of use” if the Water Agency determines that the water rights are not being used. If the fee is not paid, then the Treasury initiates a judicial process to revoke the water rights from the holder and auction it.¹¹³ In Argentina, similarly, it is crucial to provide evidence of the use of water, and the water codes provide for the termination of the water concession in case of non-compliance with water right-related obligations.¹¹⁴ In the U.S., Freeport-McMoRan leases unused water rights to municipalities, other industries and the local communities to shield its water rights from forfeiture or abandonment claims. Several operations in both Arizona and New Mexico lease water rights to local farmers when water is not required for current mine operations.¹¹⁵

Further Research

This Policy Paper has set out preliminary findings on appropriate commercial, financial, technical and regulatory models to leverage the mining industry’s water demand either to improve the availability and reliability of the water supply or to expand access to communities. Those findings have led to a refined framework to approach the issue of shared use available on the VCC website:

Toledano P., Thomashausen S., Maennling N., Shah A., (2014), A Framework to Approach Shared Use of Mining-Related Infrastructure, Chapter 3, Vale Columbia Center on Sustainable International Investment, Columbia University, New York.

Further research will examine more closely the scope for cost savings for the country and the company of the different arrangements, emphasizing a quantitative analysis of the different situations.

¹¹² “A step in the right direction,” *GWJ* Vol 11, Issue 10 (2010), available at:

<http://www.globalwaterintel.com/archive/11/10/market-insight/step-right-direction.html>

¹¹³ Jerónimo Carcelén, “Chile,” Interview, *Latin Lawyer* (10 June 2013), available at:

<http://www.latinlawyer.com/reference/topics/46/jurisdictions/3/chile/>

¹¹⁴ Florentina Heredia and Maria Paula Terrel, “Argentina,” Interview, *Latin Lawyer* (2011), available at:

<http://www.law.du.edu/documents/enrgp/Mining-2011-Argentina.pdf>

¹¹⁵ “CDP 2013 CDP Water Disclosure 2013 Information Request,” Freeport-McMoRan Copper & Gold Inc, available at: <http://www.fcx.com/sd/pdfs/ProgrammeResponseCDP%20Water%20Disclosure%202013.pdf>

The Columbia Center on Sustainable Investment (CCSI), a joint center of Columbia Law School and the Earth Institute at Columbia University, is a leading research center and forum dedicated exclusively to the study, practice and discussion of sustainable international investment (SII) worldwide. Through research, advisory projects, multi-stakeholder dialogue and educational programs, CCSI constructs and implements an investment framework that promotes sustainable development, builds trusting relationships for long-term investments, and is easily adopted by governments, companies and civil society.