WATER FOOTPRINTING AND WATER SECURITY IN THE MINERALS INDUSTRY

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Abstract

Water is a fundamental component of extractive industry operations. It is both a key input of the production process as well as a key component within certain products, such as cement. Through the Environmental Impact Assessment (EIA) water has also long been a central aspect of predicting and monitoring any consequences of quarrying that might occur beyond the site boundary, whether such impacts are environmental or relate to social impact or regulatory compliance. Historically the minerals industry has therefore been well acquainted with water and has developed solutions to enable a successful outcome to quarrying or mining at a particular location.

More recently the quarrying industry's perspective on water issues has evolved beyond the more traditional environmental impact and compliance focus to the wider perspective that incorporates an understanding of the risk to business and long-term water security of its operations. According to the Carbon Disclosure Project (CDP, 2014) almost half of the materials sector respondent's experienced detrimental impacts related to water in the last reporting year, this being the second highest percentage compared to other market sectors. Access to water and energy also entered the Ernst Young top 10 mining business risks for the first time in 2014.

Now the challenges facing the industry require a more holistic approach to consider possible constraints on business growth and impacts on revenue and cost. Individual businesses have begun to assess risk by reviewing water usage data in this wider context and through the development of a water footprint. This is enabling companies to understand risk and then develop countermeasures to manage it. Often this includes a close linkage with a quarry's operational energy footprint to also understand possible trade-offs between the two when planning new efficiency improvements.

This paper looks at water resources and usage within the concepts of water security, water risk management and the water footprint. Awareness within the industry is reviewed from water footprint data disclosed by some of the main extractive industry companies and consideration is given as to how this more holistic approach might create useful insights into strategic planning and have an influence within operational water management. Having sufficient quantified data is a recognised key requisite and water footprints and water risk management will continue to improve as data acquisition improves.

White, C.C. 2015. Water footprinting and water security in the minerals industry.
Pp. 217-226 in Hunger, E. and Brown, T.J. (Eds.)
Proceedings of the 18th Extractive Industry Geology Conference 2014 and technical meeting 2015,
EIG Conferences Ltd, 250pp.
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Introduction

According to a recent United Nations (UN) water development report (2030 Water Resources Group, 2009) the demand for water is anticipated to be 40% higher in 2030 than it is today. The mining sector is a significant water user and producer of wastewater. Water security is in fact moving fast up the business agenda across all market sectors, but at different rates depending upon the level of reliance on water to be able to operate and by what value it places on it. Often its low cost commodity value has kept any consideration of reliance on water either below the radar or at a low priority given a generally small return on investment compared to other competing factors. It is only when the prospect of significant impact to business continuity as a result of water scarcity (quantity & quality) occurs, that water surfaces as a serious issue.

This pushes the boundary of any water risk assessment beyond the site itself, to identify other water users within a river basin catchment and a need to understand the cumulative impact of all abstractors on the long-term availability of water resources. The problem then arises that often there is insufficient data to correctly assess the situation. This may require a stronger communication with external stakeholders, thereby incorporating site water management as part of a wider water stewardship approach related to a business's licence and freedom to operate.

Even within the minerals sector, the Carbon Disclosure Project (CDP) reports that less than a third of the respondents to its 2014 publication have undertaken a comprehensive and robust water risk assessment that incorporates both direct operations and supply chain. On a positive note the report does state that some 86% of respondents had committed to both goals and targets for the coming year. However if such water targets are considered in isolation and purely related to reducing a sites operational water footprint, this then misses the importance of considering the link between water risk and business growth; how water risk is particularly tied to energy; and how water challenges may constrain a business over the long term.

Given that many of the UK extractive industry businesses are part of companies that have global mining operations, then company performance will also be judged on the impact of water risks from overseas operations. Collectively they all contribute to a company's profitability, its values and its business wide sustainability approach. Indeed much can be gained from how water risk is managed overseas when considering risk response options; and application of best practice to water scarcity issues in the UK.

Identification Of Water Risks

A starting point is to consider three main categories of water-related risk for mining companies; physical (quantity & quality); regulatory (possible restrictions on water availability and tightening of wastewater discharge quality); and reputational (adverse impact on community, ecology, international expectations). These are illustrated in Figure 1. All risks can result in direct financial impact to operations and possibly a negative impact on share price.

The World Resources Institute (WRI) has looked at water issues as a key factor that could significantly affect the growth and profitability of companies working in the mining sector. Its target audience in its 2010 review (Miranda and Sauer, 2010) was the financial community investing in such operations. The WRI concluded that:

- water quality data is not sufficiently reported,
- water consumption data lacks context in terms of local water availability and competing demands,
- water reporting is inconsistent, and,
- a true evaluation of water risks facing the industry is difficult.

The WRI report summarises the range of water related issues that can occur during the exploration, extraction, processing, transportation and mine closure/post operation stages; and then presents a preliminary risk framework to steer any water risk assessment. The framework categorises risks as Low, Medium or High and considers how such risks are influenced by;

- the surrounding environment,
- type of commodity extracted,
- type of operation,
- corporate policy approach,
- engagement with stakeholders/disclosure, and,
- the regulatory environment.

Water risks can be described as 'acute' or 'chronic' (Acclimatise, 2010). This differentiates risk management activities that take account of extreme events (e.g. drought, flood) compared to incremental and longer-term impacts as a result of climate change. Chronic as well as acute risks are relevant to the mining industry because of the long-term lead-in times for new developments, the significant amount of capital invested and the long term commitment following site restoration.

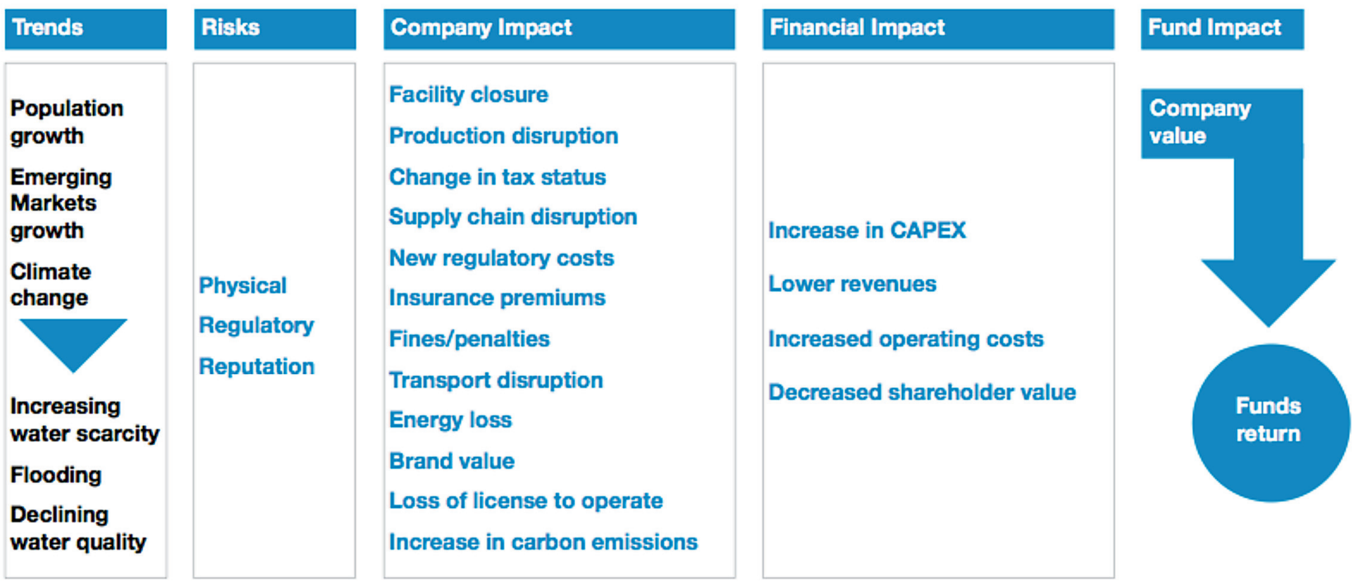

Figure 1. *Risks and Impacts related to water as defined by CDP (2014) reproduced under the CDP general licencing terms.*

Developing A Strategic Approach To Water Risk Management

The minerals industry recognised early on that water scarcity could lead to a number of business and social challenges, because of the diversity of environmental settings in which many companies operate. Recognising such risks has often been the first step to then set out a road map to identify what type of risk could be significant and then proceed with how such risks could be minimised.

To take one example, CEMEX published its own road map (CEMEX, 2013) setting out a 3 year+ plan (from 2010) by benchmarking what was already known, identifying data gaps and then proceeding to survey its sites in order to begin to understand potential risks and incorporate such findings into a workable plan. Within its 2013 sustainability report, CEMEX announced that it had rolled out a new corporate water management methodology. Its evolution has similarities of approach with many businesses (also common across other market sectors). These include:

- teaming up with an academic institution to gain a steer in developing an appropriate methodology, in their case the International Union for Conservation of Nature (IUCN),
- revisiting the type and accuracy of data previously collected and whether such data was consistent across all operations to be able to make useful comparisons and gain insights,
- progressing to develop Key Performance Indicators (KPIs) more aligned to tackling water risk,
- maintaining consistency of approach within the minerals sector itself, for example, through having KPI's and their definitions matching those being currently agreed upon in the Cement Sustainability Initiative (CSI),
- gaining external verification, and,
- understanding the real issues, before target setting to reduce water usage and risk.

CEMEX, in recognising the importance of water management, also implies that whilst cement operations in the UK and Europe may be at less risk due to a temperate climate, understanding the way water is used throughout all its business operations becomes important when evaluating risks, opportunities and response measures afforded by differing climates and institutional contexts (IUCN, 2011).

CEMEXs 2013 water policy (CEMEX, 2013) conveys many of the attributes associated with water conservation and environmental protection typically seen within the industry from previous decades, but it also reflects newer factors that the extractive industry faces, namely:

- a greater emphasis on ecosystem protection (following the introduction of drivers such as the EU Water Framework Directive),
- recognising the increasing need for communication and working together with other stakeholders to share water challenges and develop joint solutions,
- realising the benefits to partner with Non-Governmental Organisations (NGOs), other organisations, trade associations etc. to advance and share knowledge, and,
- coming to terms with the complex relationship that water has with other pertinent sustainability or business orientated factors, such as energy usage.

For many companies, particularly those from other market sectors that have not needed to undertake EIAs; analysing a company's impact beyond the factory gate has been difficult to grasp. Other barriers have included linking with other stakeholders being seen as a process too difficult to even know where to start, or perhaps being viewed with suspicion that it may lead to a negative impact by disclosing information. In this respect the minerals sector has been far more engaged generally. For example, Anglo American has disclosed that it has identified four principal categories within its water management strategy: water efficiency, water security, water risk & liability and stakeholder engagement (ICMM, 2012).

Water Risks And The UK

The UK is an important producer of a range of minerals that are consumed in many sectors of the economy. According to the British Geological Survey (BGS), some 198 million tonnes of minerals were extracted from the UK landmass for sale in 2012, of which 80% were construction minerals, 11% industrial minerals and 9% coal (BGS, 2012).

Risk is dependent upon where quarrying or other mineral activities are located; hence geography remains a key factor within an individual country as well as on a global scale. This is exemplified in Figure 2, where the location of limestone quarries and principal limestone outcrops (BGS, 2012) is compared with the status of Catchment Abstraction Management Strategies (CAMS) within England and Wales, as mapped by the Environment Agency (EA, 2013). The latter forms the basis to control the amount of surface water or groundwater resource that can be abstracted by users whilst also ensuring that there is sufficient water to support a healthy catchment ecosystem.

A comparison of both maps shows that parts of the UK limestone outcrops (and hence a number of limestone quarries) are coincident with areas where groundwater is deemed to be 'not available for licencing'. In such areas, further abstraction of groundwater for consumptive use may not be permitted by the EA and, although abstractions for quarry dewatering are currently exempt from the licensing process, there are uncertainties over how this will operate in future. Hence the risk of insufficient water or greater regulatory control may vary across the country based upon this factor alone. Similar comparisons could be made for sand & gravel or other mineral extraction, where local circumstances will dictate the Key Risk Indicators (KRIs) to any given operation, which in turn may influence operational KPI's and type of mitigation measures required to minimise such risks.

Other UK water related risks may be identified from longer term climate change factors (Acclimatise, 2010) for example:

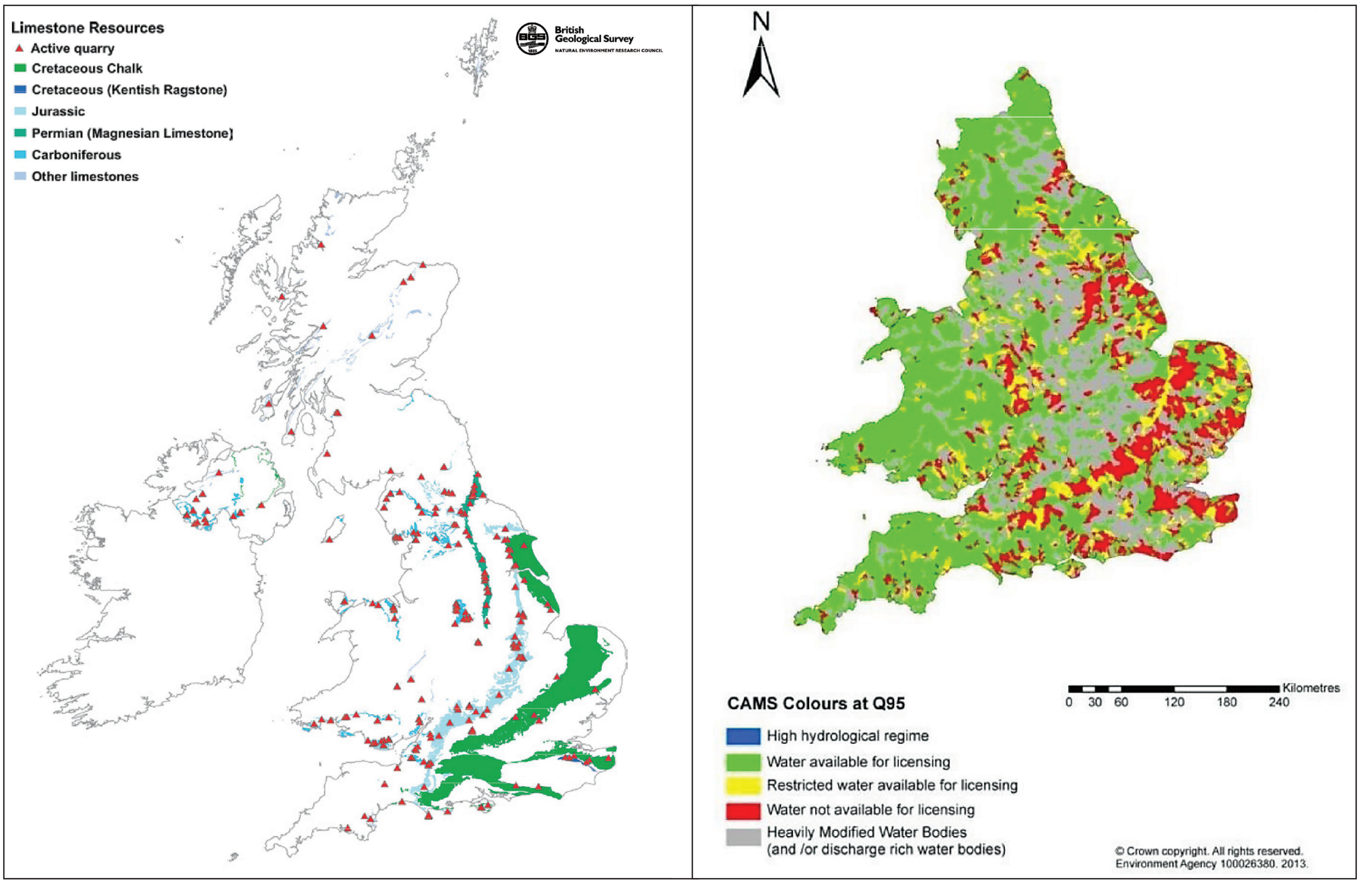

Figure 2. *Left: Limestone quarry locations and principal limestone outcrops in England & Wales in 2014 (Cameron et al, 2014. No scale given on the original figure). Reproduced with the permission of the British Geological Survey ©NERC. Right: Status of Catchment Abstraction Management Strategies (CAMS) in England & Wales, 2013, at Q95 (low flow conditions) (EA, 2013). All rights Reserved. Contains Environment Agency information © Environment Agency and database right.*

- rising groundwater levels creating new source-pathway-receptor relationships,
- increasing flood levels resulting in a possible enhanced risk to decommissioned sites requiring higher levels of flood protection, and,
- environmental site protection and reinstatement plans agreed during licensing may not be appropriate. Hence decommissioning costs may therefore need to be reassessed.

Defining a Water Footprint

A water footprint is a measure of the amount of water resource used (either directly or indirectly within a supply chain) and the impacts of wastewater. It is an effective means of raising awareness of water challenges and has also proved to be useful for the assessment of strategic corporate risks relating to water scarcity and pollution (White, 2012). A full definition and details of developing a water footprint approach is provided by the Water Footprint Network (Hoekstra et al, 2011).

Water footprints can be expressed in a number of ways, such as water consumed per company, per site, per unit mass of product, per unit of energy etc. Developing this type of metric benchmarks a site for where the most intensive uses of water occurs within a product, compared to water availability. The consequences (hence material impact) in terms of the likelihood and severity of a risk event occurring (such as business interruption, financial impact etc.) can be determined from an understanding of water availability, business usage and cumulative river catchment demand. At a business level this enables a strategy and targets to be set in keeping with local circumstances.

Examples of published water footprints from within the minerals industry are available. Lafarge (now LafargeHolcim) disclosed its global water footprint for all its global extractive activities, within its 2011 Corporate Social Responsibility (CSR) report (Lafarge, 2011) subdividing water usage data within its cement, aggregates and concrete operations. It also separated out water sources into surface water, groundwater, rainwater harvested and municipal water supplies.

Their global water footprint provides a number of statistics that quantifies and provides context on water usage. From a review of the data presented (Tables 1 and 2) a number of insights can be gained.

The water footprint gives a perspective and means of comparison in terms of how much water a global minerals company uses; and its publication also conveys to anyone that water is sufficiently on the business agenda to be measured and quantified in this way. Lafarge has also analysed its data on a geographical basis and has disclosed that some 25% of its cement production takes place in areas where there is high water stress; and hence where its main water risks may lie.

Armed with such data, a company can then compare the significance of water risk to other business risks and the extent that this might vary across its global operations.

The data also tells us that most water used is surface water; that cement is its biggest water footprint, closely followed by aggregates; and that Lafarge has introduced water management measures (at various locations) including recycling and rainwater harvesting as a substitution for surface water and groundwater where possible. Such measures are not just confined to the more obvious countries suffering from water stress, but include the more temperate regions. Five of Lafarge's cement plants in the UK now use rainwater as the sole source of water supply (Lafarge, 2011). This is further exemplified in its disclosure about its UK Cauldon cement plant where an artificial lake has been created with a closed loop water recycling system (Lafarge, 2011).

Quantifying water supplied by a municipality is interesting from the perspective of recognising a quantity of water supply where the origins of such water may not be immediately obvious. Hence understanding water supply on a regional water resource scale can give information on how sustainable water supplied by the municipality actually is and how much competition for water resource might exist from other stakeholders at a particular locality.

From the total quantity of water withdrawn (Table 1), the data shows that some 57% is returned; hence the quantity consumed is much less. Given that water impacts are local in nature, whether for environmental, social or ecological reasons, a metric that recognises that the water is returned to the same catchment is important from a supply point of view. There is however no mention of the quality of this returned water in the CSR report (although it is noted that the quality of water discharged from quarries is regulated through environmental permits).

Additional data is disclosed through a comparison of water usage between two years, 2010 and 2011 as shown in Table 3. Such comparisons can be used to compare performance year on year against any disclosed targets and be assessed in terms of improvement in a company's sustainability goals. This works to a point but cannot always be taken at face value. For example, comparisons year on year assume that a company's operational portfolio has stayed the same. Acquisitions and divestitures can skew a water footprint, but can also give a useful insight to why such changes have resulted.

Lafarge has supplemented the data with additional insights to enable a more accurate interpretation. For example the 2011 water footprint assessment revealed that previous water withdrawal data had been over estimated. This sort of acknowledgement is not uncommon as companies continually challenge their own data, identify new metrics to measure and increase quantification of its operations. So the water footprint evolves over time. Lafarge does not appear to give any reason for the apparent reduction in rainwater harvesting in 2011.

Lafarge has extended its water footprint assessment to provide a metric on the amount of freshwater water used to make a tonne (t) of cement and how this can vary between operational plants. It has then analysed this metric across its operations to understand how impact varies depending upon the amount of annual renewable water supply available on a per person basis. Hence it is able to compare its industrial water usage with the amount of water available to the local population. Databases exist for a variety of metrics on a country-by-country basis to enable such comparisons. In this case a useful comparison of m^3 of freshwater available/person/year, with the quantity of freshwater consumption/ year/tonne cement, yields a key insight between the company's operations and population. For example, a value of 379 l/year/tonne cement is presented in regions of high water availability per person, such as the UK. Elsewhere this figure can vary from 61-342 l/year/tonne of cement.

Water footprint information is also available from other companies, but may not be fully comparable. CEMEX, for example, has published data within its 2013 sustainability report (CEMEX, 2013) and provides water consumption data as 376 l/t cement; 194 l/m^3 ready mix and 317 l/t aggregates. It is assumed that these figures are global averages, but again the underlying factor is that there has been an attempt to understand and quantify water use as part of its strategic approach discussed earlier.

Water use	Quantity
Total water withdrawn	282.5 million m^3
Water returned to same catchment	161.7 million m^3
Net withdrawal	120.8 million m^3

Table 1. *Total water used by Lafarge in global operations (Lafarge, 2011).*

Water use as % of net withdrawal	
Cement	49%
Aggregates	43%
Concrete	8%

Total water withdrawn as a % of water source	
Surface water	75%
Groundwater	15%
Rainwater harvested	5% (13% of net water withdrawal after taking account of total water returned to the same catchment)
Municipal supply	5%

Table 2. *Percentage breakdown of total water usage by Lafarge in global operations (Lafarge, 2011).*

	2010 million m^3	2011 million m^3	% difference
Total water withdrawn	316.2	282.5	Down 11%
Water returned to same catchment	142.3	161.7	Up 14%
Net withdrawal	174.0	120.8	Down 31%
Rainwater harvested	23.4	15.7	Down 33%

Table 3. *Comparison of water global usage between years 2010 and 2011 (Lafarge, 2011).*

Other companies within the minerals sector have also developed their own tools for specific analysis within their direct operations. BHP Billiton developed a water use index that measures the ratio of water recycled and reused to high quality water consumed (defined as having less than 5,000 mg/l of dissolved solids) (Miranda and Sauer, 2010). Anglo American has also devised its own water efficiency tool (Bradford and Salmon, 2008) which also assesses the financial value of water. Hence a number of companies have on an individual basis developed tools to provide a means to gain consistency of approach and accuracy of an operation's water footprint.

Water footprints are also being produced to understand how much water is used to make a particular product. In 2012, the UK brick industry produced some 1.5 billion bricks using more than 4.5 million tonnes of materials from 60 brickworks in the UK (The Green Construction Board, 2013). As part of its resource efficiency action plan (REAP) the sector has identified a number of intended actions, including estimating its water footprint. Together with the Brick Development Association, the industry has recognised that data gaps on water usage (measurement and reporting KPIs) currently exist. The industry has also recognised that the promotion of using a greater proportion of non-mains water through case study development would create a more resilient business.

The water footprint of Wienerberger Ltd (brick manufacture) was produced by Ceram Research Ltd in 2011 (CERAM, 2011). This was confined to the water use within the manufacturing operation only, largely because of the difficulty of accessing external data. A more comprehensive water footprint would also usually cover water use within the supply chain (e.g. water required in mineral extraction) through to water usage by the customer (cementing bricks together).

The water footprint was developed for the Wienerberger's UK Sandown plant, where some 147,640 tonnes of bricks were manufactured in 2010, using some 187,321 tonnes of raw materials. A selection of key points are summarised as:

- direct water: mains water used (13,413m³), additional quarry water is also used to a limited extent,
- indirect water: 17,588m³ used, estimated as *c.*10% moisture content of materials delivered to site,
- water output: evaporation from the brick drier,
- water footprint: 217 litres per tonne of product (0.5 l per individual 2.32kg brick) as best estimate using available data - it was noted that this estimate varies from month to month, presumably in response to material moisture content and temperature,
- a financial cost was also incorporated as an indication to a financially positive impact if some of the mains water was replaced with quarry water,
- improvements could be made to the water footprint with more quantified data from its supply chain.

Water Risk Management Tools

A number of water risk evaluation tools have been developed to support companies (across all market sectors) to assess what can be a complex risk to understand and to grasp the long term implications. Some of these are listed in Table 4.

Tool	Lead developer	Aims to provide a:
WBCSD Global Water Tool ***www.wbcsd.org/web/watertool.htm***	World Business Council for Sustainable Development (WBCSD)	Global portfolio scoping study of which sites are in water stress areas
Watershed Risk Assessment ***www.water.nature.org***	The Nature Conservancy	Methodology to assess impacts within a river basin
WWF/ DEG Water Risk Filter ***http://waterriskfilter.panda.org***	World Wildlife Fund and DEG -- Deutsche Investitions-und Entwicklungsgesellschaft mbH	Method to quantify risks at site level
Aqueduct ***www.wri.org/aqueduct***	World Resources Institute (WRI)	On-line global database of water risk at sub river basin level
GEMI Water Sustainability Planner Tool ***http://www.gemi.org***	Global Environmental Management Initiative	Provides an inventory of a site's water use and discharge; sensitivity analysis
CDP Water Disclosure ***www.cdp.org***	Carbon Disclosure Project	Method to quantify water usage and assess risk at a river basin level
Water Footprint Assessment Methodology ***www.waterfootprint.org***	Water Footprint Network	Method to quantify water usage through value / supply chain, e.g. all water embedded in a product

Table 4. *Water risk management tools.*

Water footprints reported at an aggregate corporate/global level provide a high level assessment of water usage which can be applied to determine an overall understanding of water risk and begin to set future targets. However as water risk has to be defined at a local level, this requires a much more detailed set of water metrics specific to the local operating environment. Headline statistics of water usage per tonne etc. also only tell half the story, as water quality and other impacts are not accounted for. Many of these tools are designed to provide an insight into both.

CEMEX (2013) reported that it had used the World Business Council for Sustainable Development (WBCSD) tool to scope out how many of its sites were located in officially designated water stressed zones. This tool indicated that this related to some 9% of its sites.

A customised version of the WBCSD Global Water Tool for the cement sector was launched in 2013. Other tools such as the Water Risk Filter and Aqueduct provide a more detailed approach and offer a number of databases containing country information (including those used by WBCSD).

The Water Footprint Assessment itself (Hoekstra et al, 2011) provides a detailed methodology and approach, which includes four phases;

1. setting goal and scope,
2. water footprint accounting,
3. water footprint sustainability assessment, and,
4. response formulation.

Water Risks And Response Strategy

Water risks might be categorised as high, medium or low, with appropriate countermeasures being suggested to reduce risk to a more acceptable level in each case. Responding to water risk has been approached in a number of ways depending on the specific local circumstances encountered. This has included developing engineering options such as using alternative source of lower quality water to freshwater where possible, including untreated seawater. Other options have included rainwater harvesting and maximising water efficiency through water recycling etc. Other responses have involved working with other stakeholders within a river basin to find solutions such that mining and communities can co-exist because sustainable practices and awareness of other stakeholder rights to fresh water have been included.

Responses have also included identifying solutions that address the interrelationships between water and carbon footprints. This has enabled companies to better understand their dependence upon water and energy resources (White et al, 2014). Examples include;

- assessing trade-offs of high energy costs required by desalination plants to supply water,
- minimising freshwater use, but involving higher energy costs to recirculate water; and awareness of win-win situations such as,
- minimising water contamination minimises energy costs to treat water to a required standard.

In a recent publication of The Official Journal of the World Coal Industry (Hightower, 2014) it was commented that the water footprint, even more so than the carbon footprint, could become a critical factor in defining a secure, resilient and sustainable energy future.

The various response strategies available (White et al, 2014) are captured in the categories shown in Table 5. These include some examples from the mining sector that are applicable to the UK.

Water Accounting & Risk Management Standards In The Minerals Sector

An international standard providing a consistent methodology for defining a water footprint is still work-in-progress. If one is eventually published, the extent to which it will be used may depend on a company's preference to perhaps use a modified approach that best fits its business or has a consistency of approach already agreed with its market sector peers.

There has already been a number of initiatives within the minerals industry, of which a few are mentioned below by way of illustration:

- There has been a number of initiatives from Australia, including that from the International Council for Mining and Metals (ICMM), which has produced a Good Practice website that includes water management guidance and best practices from around the world (SMI & MCA, 2012). The purpose of this framework is to provide consistency of approach in determining what to measure; how to quantify and what to report.
- Initiative for Responsible Mining Assurance (IRMA) produced a draft standard for responsible mining (environmental and social) in July 2014 (IRMA, 2014). It is intended to be applicable to all kinds of industrial mining, listing requirements and means of verification. The subject of water is covered in two chapters, water quality and water quantity and covers sampling & monitoring, trigger levels, hydrogeology, water rights and more.
- The WBCSD's Cement Sustainability Institute (CSI) is supported by some 22 major cement producers around the world and was established to share best practice to minimise the impacts of cement production. It has developed a common methodology in relation to understanding its carbon footprint and has also set up a task group to define a set of indicators to measure a company's performance in water management and develop a protocol for measurement and reporting (WBCSD, 2014).
- The UK Mineral Products Association (MPA) promotes sustainable construction and recognises that the importance of water management also requires visibility alongside carbon and biodiversity. The MPA summarised the water challenge by suggesting that the first tasks are to monitor water use; understand the water footprint of individual products; and share best practice (MPA, 2013).
- A similar theme is set out in a roadmap (2014 -2016) proposed by the UK Brick Development Association, which includes the development of a water strategy

Category	Response strategy	Company	Country	Source
Technology (new investment)	Installation of new pumps and pipes ($82M)	Anglo American	UK	CDP Metals & Mining 2013 (CDP, 2013)
	Large scale desalination plants	Various	Global	Moody's, 2013
	Use of rainwater as sole source of supply	Lafarge	UK	Lafarge, 2011
Efficiency (cost reduction)	Creation of artificial lake and closed loop recycling system	Lafarge	UK	Lafarge, 2011
	Objective is to reach zero net water consumption by 2030	Anglo American	Global	The Guardian, 2014
Strategy & due diligence	Assessment of the sustainability of water resources	various		
	Investigating the impact of climate change on its business			
Stakeholder engagement (governance, reputation, incentivisation)	Reservoir construction ($200M) to get back licence to operate	Newmont Mining	Peru	CDP Water Disclosure 2013 (CDP, 2014)
	Mine water treated to drinking water quality for use by local municipality	Anglo American	South Africa	Bradford & Salmon, 2008
Knowledge sharing & education (single sector or cross sector collaborations)	Untreated seawater used for mineral processing	Minera Esperanza	Chile	ICMM, 2012

Table 5. *Examples of response strategies to water risk.*

and guidance notes to improve data collection and develop case studies to encourage the sharing of best practice.

These initiatives are at various stages and this is a typical situation across all market sectors. Individual companies are also at various stages of developing a consistent approach towards a pragmatic water risk management methodology. One of the earlier water footprints identified through a desk study review was from Anglo American in 2008 (Bradford and Salmon, 2008). Rio Tinto published some of its thoughts on developing a water strategy in 2005 (Rio Tinto, 2013). Hence there is documented evidence that water risk management has been on the radar within the minerals sector for at least 10 years. Over this period there has been a steady build-up of case histories which, in turn, should provide some guidance towards building a consistent approach for the industry.

Long Term Water Security

Unlike other market sectors that could relocate business to less water stressed areas, mining and quarrying operations can only take place where the minerals naturally occur. Some 80% of the worlds mining is reportedly located within water stressed areas. According to an evaluation on the outlook of the mining industry by Moody's in 2013 water scarcity is thought likely to emerge as a key risk for mining companies over the coming years (Moody's, 2013). That report observed that, if rated companies do not proactively manage these risks, their ratings could be adversely affected as a result. The risks were summarised as follows:

- Water scarcity and broader environmental risks will continue to push up development and operating costs in the global mining industry as these trends become more pronounced.
- Water scarcity is already changing the mining landscape.
- Projects will take longer to complete, be costlier and riskier, with credit-negative implications for the entire industry.
- In general, smaller, less-diversified mining companies –particularly those with single- mine operations – in water-scarce regions, such as South America, are the most vulnerable.
- The large, globally diversified mining companies, such as Rio Tinto plc (Moody's rating; A3 stable), Anglo American plc (Baa1 stable) and BHP Billiton Limited (A1 stable), will continue to be adversely affected given their global footprints and willingness to operate in the most remote and arid regions.
- Anglo American's head of sustainable development and energy (Sam Hoe-Richardson) was recently interviewed by The Guardian (2014) about how it is tackling this challenge. Some of the key points made, which are relevant to this paper were:
- Anglo American has developed a 10 year water strategy; clearly recognising the long-term nature of such a challenge to begin adapting to climate change;
- It had rolled out a water efficiency tool across the company to improve water efficiency (and presumably consistency of data collection);
- It is partnering with other stakeholders, hence tackling water risk beyond its mine boundary to be aware of cumulative impact and secure water for its own needs without compromising water resources for others;
- They have set ambitious targets, rethinking the way they look at water, including setting a target for new mines being water neutral by 2030. Technology (research and solutions) will form part of the investment to realise such goals.
- There is also the awareness of the complexity of reducing freshwater consumption at, for example, the expense of increased energy consumption; but recognise that such challenges need to be tackled.

Rio Tinto's water strategy (McKinsey and Company, 2010) also encourages similar long term thinking about water use while promoting better performance. This is likely to be a reoccurring theme for all companies within the minerals industry, whether such information is disclosed or not.

Conclusions

Water security within the extractives industry is now considered to require a more holistic approach than just the traditional focus on environmental impact and compliance. This wider approach recognises that water risk management is also needed to develop mitigation measures to potential long term constraints on business growth related to climate change and associated impacts from any physical, regulatory and reputational issues that may develop.

This has been recognised within the extractives industry and a number of companies have responded by developing an understanding of their water footprints, from a global to an individual site operational level. These perspectives are enabling the long-term resilience of a business to have some quantified approach to identifying what type and where key water associated risks may exist and then considering to what extent and how such risks should be best mitigated.

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