

# Life-cycle based water footprinting methodology in the production of metal commodities

Stephen Northey<sup>1,2</sup>, Nawshad Haque<sup>2</sup>, Gavin Mudd<sup>1</sup>

<sup>1</sup> Monash University

<sup>2</sup> CSIRO Mineral Resources

Email: [stephen.northey@monash.edu](mailto:stephen.northey@monash.edu)

## ABSTRACT

The production of metal commodities is often dependent upon access to water resources, particularly during the initial mining and mineral processing stages of production where the majority of water is typically used. Given that different metals are sourced from mines operating in different regions, the relative water supply risk facing individual metals will differ.

Recent advances in water footprinting methodology have resulted in a variety of spatial indicators for water scarcity and stress being available. Different indicators assess these issues from different perspectives, such as assessing the level of competition for water resources in a given area or relating the impact of water consumption to the long-term availability of water in a given area. Mapping the location of metal ore mining and processing against these various indicators provides some insight into which metal commodities are potentially at risk from water supply related issues.

**Keywords: water footprint, mining, metals, water scarcity**

## 1. INTRODUCTION

The concept of a water footprint has been developed, partially independent of developments in the assessment of water use within life cycle assessment. The recent international standard for water footprinting, ISO 14046:2014 [1], advocates taking a life cycle approach when conducting a water footprinting. This provides a framework for communicating estimates of the consumptive and degradative water use impact associated with products and processes, in a way that is complementary to life cycle assessment studies that consider a broader range of environmental impacts.

Several of the major environmental impacts associated with metal production are the impacts to water resources, particularly at the initial mining and mineral processing stage of production. In the particular regions where mines operate they can be large local consumers of water and are often also perceived as being major contributors to water quality risks. Due to this the development of any new mines is often predicated upon the availability of water resources.

The interactions of mining operations with water resources is very site specific, depending heavily on: local climate, processing configurations, and site water management strategies. Assessments of mine site water withdrawals have highlighted significant variability existing between sites when expressed on a product basis (e.g. m<sup>3</sup> / t metal) [2-3]. However this type of data by itself is not particularly informative and would lead to perverse outcomes if used as the basis of decision making for sourcing of mined materials. This is because the unit water consumption associated with mined products is often lower in regions experiencing water scarcity, due to increased optimisation to reduce the water requirements of processing. Benchmarking the water consumption associated with mined products produced from different regions therefore requires methods to account for these regional differences in water scarcity.

## 2. CONSUMPTIVE WATER USE IMPACT CHARACTERISATION METHODS

The impacts associated with water use vary heavily due to differences in the local availability, quality and demand for water in different regions. A variety of spatially explicit impact characterisation factors have been developed to assess the consumption of water that occurs in different regions. Examples of mid-point characterisation factors include the water stress index [4], which provides a measure of competition for water resources in a region, and the water depletion index [5], which indicates the potential for water consumption in an area to lead to long-term decreases in water availability. A range of other characterisation methods also exist at the mid-point and end-point level, with each providing a different perspective on the nature of impacts associated with water use [6]. The main differences between the methods include the conceptual basis for estimating relative water scarcity of regions, how to account for water quality, and the nature of how water deprivation impacts various end-users.

### 3. QUANTIFYING THE EXPOSURE OF THE MINING INDUSTRY TO WATER STRESS

Characterisation factors, such as the water stress index, can also be used to begin to quantify the overall exposure of an industry to water stress related issues. In highly water stressed regions, companies may face increased difficulty in gaining access to water rights and entitlements due to greater competition for water resources. Additionally more scrutiny may be placed on water discharges due to the proximity of other water users that could potentially be adversely affected.

The water stress index has been evaluated against national production data for mining, mineral processing and metal production on a global scale [7]. Metals such as chromium, platinum and copper are found to be mined and processed in countries with relatively high water stress. Whereas other metals such as lead, molybdenum, titanium, tin, nickel and cobalt are produced from countries that experience relatively less water stress. There is also differences in the exposure of individual stages of a metals supply chain to water stress. For instance, copper smelting and refining is occurring in countries with lower water stress than the countries where copper ores are being mined and concentrated.

Limitations exist when using national scale production and water stress data to make these types of assessments. Countries such as Australia are hydrologically diverse and display an uneven distribution of water use. Therefore the water stress index of individual watersheds in a country can be substantially different to the national average. As an example, Fig. 1 shows the water stress index associated with global copper production. The production weighted average water stress using country scale data is 0.55, compared to 0.50 when using individual watershed and mine data. The watershed scale data is also more binary in determining whether a production facility is located in a water stressed area. Based upon this, sub-national information pertaining to the location of mine sites and other industrial production facilities should ideally be included in LCI databases to enable accurate estimation of water related impacts.

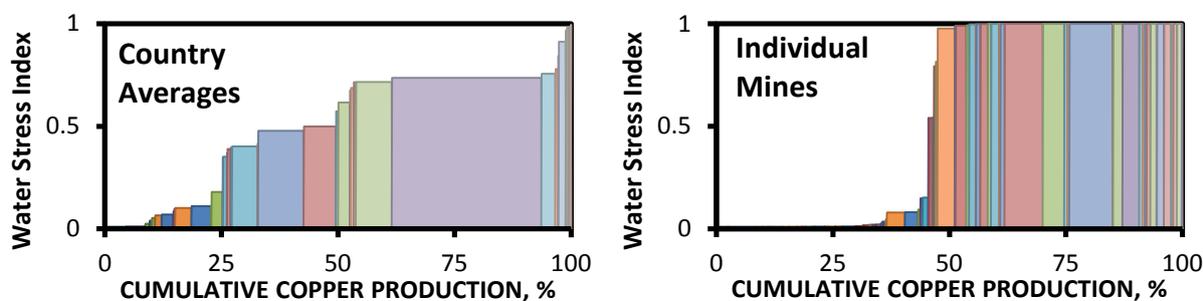


Fig 1. Water stress index associated with global mine copper production in 2012, based upon country scale data (left) and individual mine/watershed data (right).

### 4. ACKNOWLEDGEMENTS

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