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Water Risk and Its Impact on the Financial Markets and Society

New Developments in Risk Assessment and Management

Edited by
Thomas Walker · Dieter Gramlich ·
Kalima Vico · Adele Dumont-Bergeron

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Introducing Water Risk: A Framework for (Integrated) Water Risk Assessment and Management

Adele Dumont-Bergeron and Dieter Gramlich

1 The Water Challenge

It is well known that water is necessary to life. Without water, organisms cannot grow and thrive, yet alone survive. Despite this knowledge, water is largely taken for granted, at the national and international levels. Water is a finite resource; it is not something that can be grown or scientifically engineered. The current amount of water on the planet represents what we must work with. Since 97% of the total water is salt water, only 2.5–3% of water is freshwater that can be used for consumption, a number that decreases as the quality of freshwater worsens (National Oceanic and Atmospheric Administration, 2020). Glaciers, lakes, reservoirs, ponds, rivers, streams, wetlands, and groundwater all make up

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freshwater. This amount of freshwater is globally shared among 7.7 billion people, ecosystems, and industries (Boretti & Rosa, 2019). Many sectors are not only water-dependent, but also voracious when it comes to freshwater consumption. These sectors include agriculture, beverage, textile, mining, energy, and transport, with agriculture accounting for about 70% of human water use because of such practices as crop irrigation and livestock rearing (WWF, 2011; WWF Germany, 2019). Boretti and Rosa (2019) report that, over the last century, the global water demand has seen an increase of 600%, a number which will continue to rise as population is expected to grow between 9.4 and 10.2 billion by 2050. More people on earth necessarily means more pressure on the limited quantity of water in order to grow food and feed everybody (Boretti & Rosa, 2019).

While the quantity of water is a global problem, it is by no means a fairly distributed one. Indeed, already in 2020, some regions suffer more from water scarcity than others, among them are Central-South America, the Middle East region, Eastern Europe, sub-Saharan Africa, and areas of Central-South Asia, including China (WWF, 2011). Therefore, while it is a global problem, it is simultaneously a local problem that requires local solutions. Naturally, droughts in the United States (US) and droughts in India affect differently their respective population because of the countries' socioeconomic situation as well as geographic location. Consequently, the remedial actions—and the available solutions—will differ.

The limited amount of freshwater is part of the conversation on **water scarcity**, which is defined as "the volumetric abundance, or lack thereof, of freshwater resources" (PRI & WWF, 2018). Water scarcity, at its most simplistic, refers to quantity. It thus relates to the physicality of water and its material risk, which could highly affect the gross domestic product (GDP) of some regions, costing them up to 6% of their GDP (UNESCO, 2020).

This unequal division of water resources has notably led to the adoption of the Sustainable Development Goal (SDG) number 6 by the United Nations (UN) in 2015: To "ensure availability and sustainable management of water and sanitation for all by 2030" (UN, 2020). In 2017, 2.2 billion lacked access to safely managed drinking water while 4.2 billion had the same problem with sanitation. During the COVID-19 pandemic of 2020, a lack of access to safe water and sanitation signified that three billion could not prevent the spread of the disease through basic handwashing (UN, 2020). These numbers shared by the UN illustrate the significant role of water in preventing and curing diseases, which can be forgotten when discussing water scarcity.

Globally, it is estimated that four billion people already suffer from severe drought at least one month per year (UNESCO, 2020). Droughts generate consequences that reach far beyond the direct impacts (water scarcity, crop losses, local food shortages, and forest fires), such as migration, unemployment, and social unrest (WWF, 2019a). Although droughts tend to recur seasonally, their frequency as well as magnitude is further exacerbated by climate change. Not only are droughts extreme weather events to monitor, but so are floods, extreme precipitation, hurricanes, heatwaves, and so on, which all have an impact on water resources, whether in terms of overflow or dryness (IPCC, 2008, 2018). For instance, heavy precipitation leads to soil erosion, adds pressure on infrastructure, and affects the quality of groundwater (UNECE, 2009).

Due to climate change, these events are happening at a faster rate, occasioning short-term and long-term damages to ecosystems, as well as the economy (UNESCO, 2020; WWF & ABInBev, 2019). For example, droughts between 1991 and 2013 in sub-Saharan Africa have incurred agricultural production losses amounting to US$31 billion. While cases from developing countries are perhaps too historically familiar, droughts affect various regions of developed countries, increasingly so. The US is one of them. Between 2011 and 2013, three drought and heatwave events led to a US$60 billion loss because of their impacts on various sectors, such as agriculture and energy (Alizadeh et al., 2020).

In addition, quality is part of the water problem too. The pollution of water bodies represents a human challenge, as it is associated with human actions driven by population and economic growth among other factors (Boretti & Rosa, 2019). Indeed, industries have their fair share of blame as they annually release 300–400 megatons of waste in the water (Boretti & Rosa, 2019). In terms of sanitation, untreated sewage spills into water in 90% of developing countries. This percentage signifies that "730 million tons of sewage and other effluents are discharged into the water" every year (Boretti & Rosa, 2019, p. 2), thus greatly affecting the availability of clean freshwater. When water quality is affected, the effects are multifold: Biodiversity is threatened, consumption is impossible for both personal and economical gains, diseases proliferate, and nutrient and chemical overloads become dangerous and pathogenic (Boretti & Rosa, 2019; UNESCO, 2020). By 2050, about 3.9 billion (around 40%) of the world population will suffer from water scarcity and will live under severe water stress (UNESCO, 2020). Therefore, quality of freshwater, which is part of water stress, is just as worrying as water scarcity.

In short, **water stress** is defined as "the ability, or lack thereof, to meet human and ecological demand for freshwater" (PRI & WWF, 2018). A broader category than water scarcity, factors of water stress include quality, accessibility, and availability. Factors that strain the quantity and quality of freshwater are usually part of the conversation on water stress. Population growth, for example, represents a driver of water stress, as it affects the quality, the availability, and sometimes the accessibility of freshwater.

Water, therefore, should be of personal concerns for individuals and industries, as the problems its absence would create are phenomenal. At the economic level, such consequences would be in the billions of dollars. To be more precise, "$415 billion in revenue may be at risk from lack of water availability for irrigation or animal consumption" (Ceres, 2019, p. 2). If the agriculture sector takes a hit of US$415 billion in revenue, we can only imagine how the other sectors would be impacted. Yet, it is important to note that this number encompasses the negative effects that water scarcity would have on the supply chain; it is a cost that farmers, transporters, and retailers (i.e., the supply chain) would absorb, thus having widespread socioeconomic impacts at the national and international level. A report by Water Aid et al. (2017) reveals that one in five individuals is estimated to work in a globalized supply chain. Such a loss also implies that production has been disrupted, either in the short term or the long term, resulting in a decrease of goods. For the agriculture sector, it represents less food for consumers, thus contributing to inequalities. At its core, water is a basic human right on which prosperity and well-being rely.

2 Defining Water Risk and Discussing Opportunities

PRI and WWF (2018, p. 7) provides a helpful definition in thinking about **water risk**: "The possibility of an entity experiencing a water-related challenge (e.g., water scarcity, water stress, flooding, infrastructure decay, drought)." First, as this definition mentions, water scarcity and water stress represent water-related challenges. They are therefore part of the broader category of water risk, which also include climate change events. Secondly, by definition the word "risk" implies the possibility (or probability) of a threat to occur, hence relating uncertainty to risk. Part of the goals of academics and organizations alike is not necessarily to predict the materiality of these risks (i.e., when risks become events), but rather to find adequate ways to prevent and mitigate the consequences of these risks. In other words, the aim is to understand the potential scenarios in order to act as best as possible under uncertainty (Garnier et al., 2015; United Nations Global Compact et al., 2020).

Water risk presents a challenge; it is not yet a lost cause. Challenges should be stimulating because they offer problems that society must solve. In that sense, they motivate the collective minds, which lead to an important aspect: opportunities. While water risk represents national and international challenges, it also represents opportunities to create multidisciplinary knowledge, improve or generate tools, innovate technology and infrastructures, teach about water, risks, and water efficiency, and most importantly for this book, help investors and companies toward sustainable decision-making. Some of these opportunities relate to what has been deemed "unconventional" water resources (UNESCO, 2020). These resources include:

- Wastewater reuse (also known as reclaimed water), including gray water reuse (from sinks, showers, washing machines);
- Water recycling;
- Rainwater or stormwater harvesting;
- Desalination of salt water.

In the cases of water reuse and water recycling, most times these processes require water treatment. In some cases, depending on the treatments, water reuse can become potable water, while a lesser treatment might be enough for irrigational or industrial purposes (Nicholson & Vespa, 2010). Similarly, rainwater catchment also requires the necessary installations: A roof or a drain is necessary, as well as some storage equipment, to capture non-potable water (Garnier et al., 2015). Likewise, treatment of harvested water can be done to improve its quality. Another low-cost derivative of water harvesting is the catchment of atmospheric moisture (fog) in highly foggy regions (UNESCO, 2020). Finally, the desalination of water also necessitates a specific technology, and one that warrants a massive input of energy. Some regions, such as the Gulf Cooperation Council countries (GCC), already rely on desalination to meet their water requirements (Darwish & Zubari, 2020; UNESCO, 2020). Since these unconventional methods are emerging, there are opportunities to invest in these technologies, as well as to do further research.

Furthermore, companies face a wide array of challenges that are deemed material. Out of these challenges emerge direct impacts for businesses, including water price and availability, as well as the disruption of production, or even losses, such as with crop irrigation. Additionally, these risks engender indirect impacts that may include surges "in electricity prices, macroeconomic decreases in consumer spending, stranding of corporate infrastructure, or loss of access to markets or growth opportunities as a result of water shortages" (Vivid Economics, 2020, p. 9), only to name a few.

The term water risk hence refers to a comprehensive, multifaceted context. Water risk expresses the possible affectedness of individuals and institutions from water-related challenges and their potentially negative or positive impact. It materializes in different forms whereby the types of water risks differ in the way they affect people and organizations. Many of them emerge in relation to the following risks:

- Physical water risks;
- Regulatory water risks (transition water risks);
- Reputational water risks.

Physical water risks relate to materiality issues because of water-related events. They result from problems in water quantity and quality. For example, water scarcity can disrupt business operations, as water may be used to produce goods, irrigate, process, cool, and clean (Barton, 2010), and consequently represents a **physical water risk** for companies (CDP, 2015; WWF, 2019b). Without water, many parts of the supply chain are threatened, often unbeknownst to corporations. Other types of physical risks include polluted water and flooding (WWF, 2011). Naturally, sectors use different quantities according to their needs, but an insufficiency of water at some point in a water-intensive supply chain can cause important damages in revenue to companies. For example, droughts and heatwaves can significantly impact the energy sector, especially when installations rely on hydropower, or use cooling water with coal or nuclear energy. Before 2013, California produced 18% of its electricity using hydropower. When droughts started in 2013 and continued through 2016, the percentage decreased to 10.5%, even dropping to 7% in 2015. As a result, California turned to less sustainable and more expensive sources of power, which increased electricity costs at US$2.45 billion and generated pollution (WWF, 2019a). Experts have forecast, under a moderate climate change scenario, that California could lose 10–20% of its total hydropower, amounting to an annual US$440–880 million loss (Barton, 2010). Moreover, in 2016, El Niño led to a water-level drop of 13% in Zambia. For a country where 95% of its power comes from hydropower, such a decrease put the country's electricity security in jeopardy (WWF & ABInBev, 2019). A low-level river due to droughts, such as the Rhine river in Germany in 2018, can also prevent boats and cargos from reaching their destination. In the case of the Rhine, they had to lighten their loads to pass (WWF Germany, 2019).

Regulatory risk, also referred to as "transition risk," appears in the form of laws, policies, and regulations imposed by the government as means to control freshwater use and wastewater discharge (WWF, 2011; WWF Germany, 2019). Licenses and sanctions, as well as water and wastewater pricing, materialize as additional costs for a company. Conversely, a lack of stringent regulatory rules can have an adverse effect on the company due to other companies' use and may lead to physical and reputational risks (WWF Germany, 2019). Unanticipated, these changes in regulation can be quite costly. Yet, they often spark from physical (e.g., scarcity risk) and reputational (e.g., worried citizens) concerns that lead to additional pressure to the governments to make changes (Barton, 2010). Similarly, responses from governments such as the implementation of "net zero transition policies" also represent risks because of the changes in the business-as-usual design. Nonetheless, these objectives to attain net zero emissions strive to encourage actions and opportunities toward innovation, rather than being detrimental to entities (Vivid Economics, 2020).

When a company and/or its supply chain perpetrates actions that negatively affect the environment, it may suffer from reputational damage. More precisely, **reputational water risk** occurs when a company poorly manages water resources, thus affecting communities and ecosystems (PRI & WWF, 2018). Consequently, a company's reputation might be harmed as the result of tensions between the company's actions and local communities regarding local resources. In developing countries where water is perceived as a scarce resource, the population tends to raise public awareness and boycott the product as a way to oppose the industrial use of water (Barton, 2010). These kinds of campaign can hurt the reputation of the company and its brand, usually costing sales, and sometimes even costing its license to operate (Barton, 2010). In 2017, PepsiCo was the subject of such action as it kept producing soft drinks in Tamil Nadu, India, despite the ongoing drought. As a result, boycotts from retailers and consumers led to a decrease in purchase of the product (WWF Germany, 2019). These damages can emerge quickly and spread from the local community to the global scandal, thus blackening a company's good name (WWF, 2011).

What is important to note here is that physical, regulatory, and reputational risks are intertwined: One may lead to another as drivers or emerge as consequences. In a way, these risks are branches of water risks, constantly interacting with one another (see Fig. 1). Regardless of how these risks materialize, they offer opportunities for a company to improve their risk management as well as for governments to establish more stringent measures and frameworks. In that sense, these risks create behavioral opportunities toward a collective accountability, where each party attempts to do what is best for the common good.

The goal in discussing these consequences is to illustrate that the effects of the current drivers of water risk, such as population and economic growth, can be addressed, and potentially mitigated through actions that aim to diminish the physical, regulatory, and reputational risk of a company. Yet, the projected mid- to long-term consequences must be addressed *now*. While it is important that corporations have focused in the last decades on decreasing their greenhouse gas (GHG) emissions, air pollution, and more recently the global COVID-19 pandemic, they are not the only threats for risk managers to focus on (Ceres, 2015).

As demonstrated in the previous sections, water risk presents a great challenge, with far-reaching impacts in various sectors. Even though investors and companies are becoming increasingly aware of the ramifications of water risk on their business operations, awareness and actions are still lagging, in part because frameworks to assess, record, and report are neither globally adopted and widespread, nor locally suited (Ceres, 2015; Christ & Burritt, 2017). In addition, these frameworks need qualitative and quantitative information about the direct and indirect relationships