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Water disruption: investment risk from multiple angles

FRANKLIN TEMPLETON THINKS™ | WATER DISRUPTION

FRANKLIN TEMPLETON

In this issue

Acknowledgement

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Before the well runs dry: the time for investors to understand water risk is now

> **"When the well is dry, we know the worth of water."**
> Benjamin Franklin, 1746

There is a lot of talk about how regulatory reforms connected to climate change will impact financial markets. However, we firmly believe the leading issue, at the end of the day, is that we have been entrusted to look after our clients' assets and are responsible for returning those assets in better condition than when we received them. Therefore, we have a duty to understand the full spectrum of business relevant risks that can reshape a company's or sector's competitive positioning in the marketplace and impact its operational resiliency.

Riffing on Benjamin Franklin's observation in the context of the current landscape of understanding the importance of water to financial markets: if we don't know how much water there is in the well, we won't know until the well goes dry. Meaning: unknown and undisclosed risks are likely to be mispriced and put assets at risk. Therefore, companies and sectors lacking understanding of their water sources and footprints, lagging in disclosure of water risk, and/or postponing adjustments to the regulatory reforms touched upon later in this piece all present long-term risks to investors.

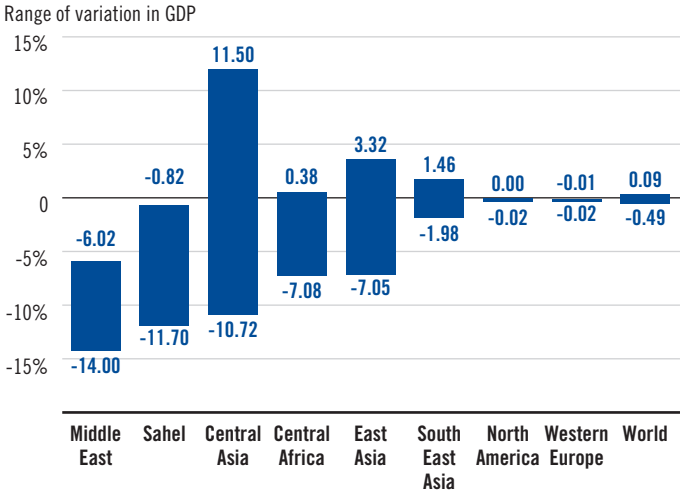
With all the charts, examples and best practices we outline in this piece, ultimately, we are trying to help end investors understand that water itself isn't just an economic policy issue and risk arising from population growth and climate change. Water is impacting the day-to-day operations of investee companies and how they are thinking through their own business models and business risk.

The macro view: our water future

By 2030, the global population will reach nine billion and the world will require 40% more water than it does today.[1] However, the global supply of accessible fresh water accounts for less than 1% of water supplies and will not grow with population. This limited supply is threatened by overuse, contamination, and over-demand. The World Economic Forum (WEF) has identified "Water Crisis" as one of the top five global risks in terms of impact in nine out of its last 10 Global Risks Reports, including 2020.[2] The WEF classifies water crisis as a "Societal" risk; it's easily argued that a water crisis would envelop the totality of the WEF's risk categories: economic, environmental, geopolitical and technological. Critical investments in purification, reuse, efficiency and delivery infrastructure are required on a global scale—including in first world countries such as the United States.

WATER SCARCITY WILL IMPACT GDP

Exhibit 1: Economic impacts of climate change-induced water scarcity by world region, 2050
As of 2016



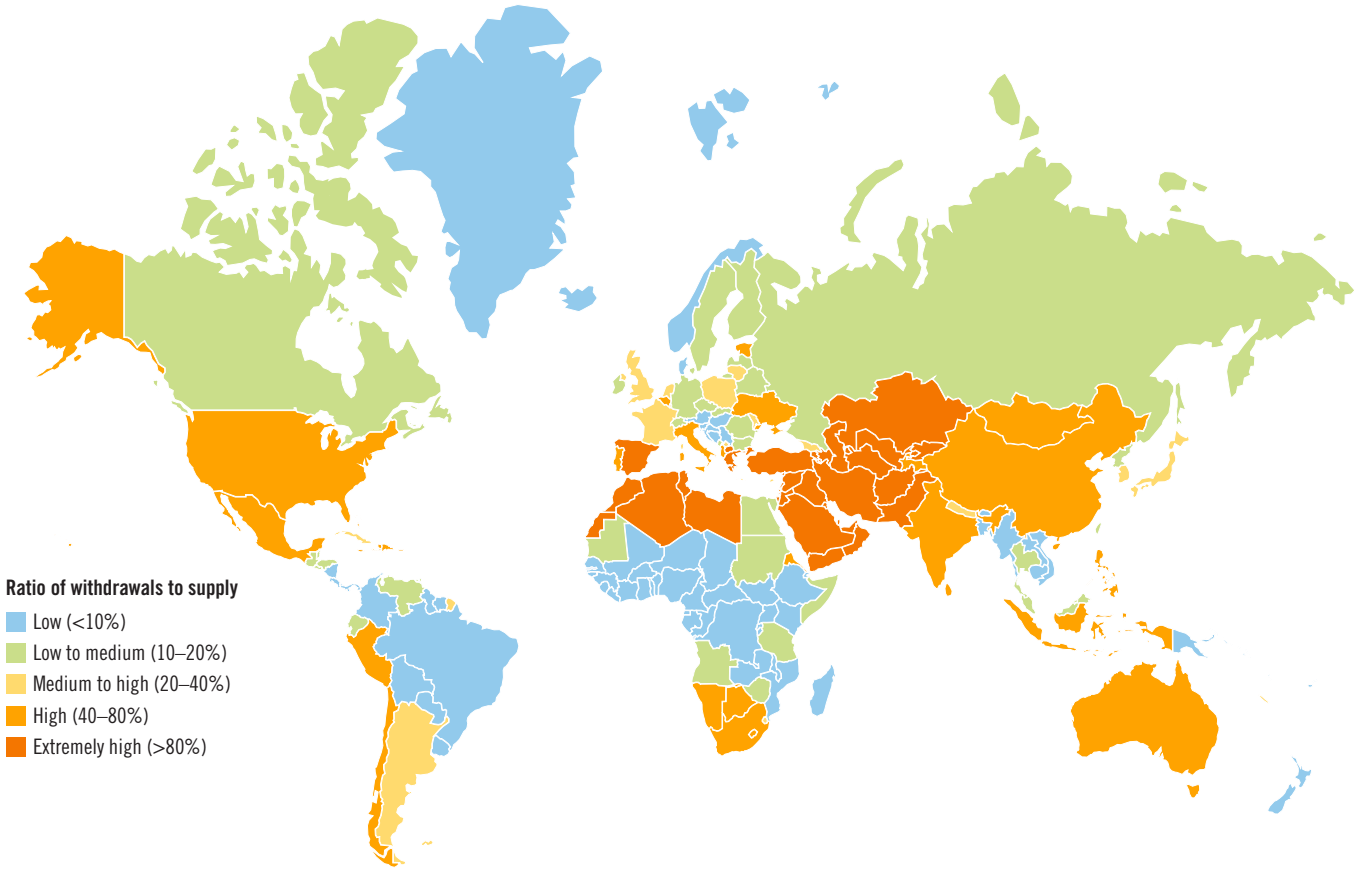
Source: World Bank. "High and Dry: Climate Change, Water, and the Economy," World Bank, Washington, DC. 2016. Note: The range of impacts, as determined by the type of policies implemented to cope with water scarcity, is from a business-as-usual policy (–14%) to a policy seeking to reallocate water to the most productive uses (–6%). There is no assurance that any estimate, forecast or projection will be realized.

Then, there's climate change. Projections of 2°C increases in global temperature from climate change, expected by 2050, will accelerate water scarcity in many regions of the world. As seen in Exhibit 1, the World Bank estimated that water scarcity exacerbated by climate change will cost some regions 6% in gross domestic product (GDP)—without policy change, declines may reach 14%.[3] These declines are not limited to frontier and emerging markets; they impact every continent and economy, as seen in Exhibit 2. The San Francisco Bay Area—home of Franklin Templeton's headquarters—is in one of these water stressed regions.

This may seem counterintuitive to some. California is perceived to be a land of abundance; home to two of the world's most fertile and water intensive valleys—the "Central" and "Silicon"—one growing almonds and the other cooling data servers. In reality, it's in one of the most drought-prone and high water risk regions in the world. And, without early 20th century water wars (have you seen the movie *Chinatown*?), multi-billion-dollar infrastructure investments, and a system of the most complex and litigated intrastate and

WATER STRESS IMPACTS ALL MARKETS

Exhibit 2: Country-level water stress in 2040 under business-as-usual scenario



Source: World Resources Institute, August 2015. Note: Projections are based on a business-as-usual scenario where global socioeconomic and emission trends continue on their current trajectories.

binational water agreements on the planet, the world's fifth largest economy would have run out of water decades ago. Think about that in the context of risk to an investor.

Finally, California is often cited as a microcosm for an impending global water crisis driven by population growth and climate change.[4] Referring to the highly complex nature of water in California combined with climate change, Dr. Peter Gleick—a MacArthur Genius Fellow who many refer to as the foremost expert on world water—points to California as a "laboratory for all of peak water's concerns."[5] Peak water is an idea he coined akin to peak oil. Meaning, all the water (or oil) on the planet is already here. As we use it, and pollute it in the case of water, it will never be replaced. Again, take a minute to think about that in the context of risk to an investor. Yet very few asset managers are talking about water risk as an investment concern. Why is that?

Why we're thinking about water…

The projected declines in water availability, and corresponding dips in GDP, present across-the-board risk for investors. And these risks extend to all asset classes and encompass a broad range of sectors—from those with logical connections, like agriculture and utilities, to those that may not be so apparent, like packaging and semiconductors. In already water-stressed emerging and growth markets, like China and India, climate change models project that stress to grow.

This significantly impacts sectors where many investors are now seeing growth opportunities, such as: apparel, textiles, metals, mining and materials. These sectors are essentially "building blocks" for other sectors. Therefore, the water risk in these sectors does not stop once they are grown or extracted; they carry forward to the complex web of sectors that transform the building blocks into products—think of everything from lithium-ion batteries in your smartphone, to the shirt you're wearing.

As stewards of our clients' assets, we believe water risk must be accounted for in portfolios today, not in 2030 or 2050. But how can this be done? Water is not only a misunderstood commodity but also a basic human right recognized by the United Nations (UN) in 2010. As sustainability-informed investors using environmental, social and governance (ESG) metrics as key performance indicators (KPIs), how do we address the dual-bottom line of adding value to clients' portfolios while also contributing to positive outcomes? How do we translate macro-scale risks into a focused investment lens? And, finally, what is our role as investors and what more can we do to move the dial?

WATER ACCOUNTING 101

As you will see throughout this piece, water accounting is highly complex and often misunderstood. Again, it is where mispricing happens. Much of this has to do with how water is measured and where it is in the system—whether it is groundwater or surface water, in a river or a lake.

How much water am I looking at here?

One of the biggest challenges in understanding water data is how it is measured. Gallons? Liters? Acre-feet? Liters per minute? Hectares? cfs/acre? If you're storing it, it is one thing; if it is moving, it is another. If it is falling out of the sky, it is another thing altogether. If you are irrigating with it, it is something different. And if you are generating power from it, then it gets more complicated. And then these calculations must be converted if you are moving across an international border where one country uses imperial measurement and the other uses metric (e.g., China-Myanmar; US-México).

Use it, use it again, use it one more time…try using it again…use the last drop

Water can be used multiple times. One liter of water may be in a river and be used to generate hydropower as it moves through a dam. Downstream, it can be pumped out by a community for municipal use, used, then treated again and discharged back into the river. Further downstream, it can be diverted for irrigation of crops. It is important to understand, typically, the more water is used it depletes the quality of that water. For example, in the United States, every drop of water in the Colorado River is said to be used 17 times.[6] By the time it reaches its end, the water must be desalinated before it can be used yet again.

Is it surface water or groundwater? Yes…?

Groundwater, once pumped and discharged, becomes surface water and surface water that does not evaporate can seep into the ground. And over time, surface water becomes groundwater again. In many countries, both are regulated differently.

These are all important questions. And we admit we don't have all the answers. But we are thinking about these questions on a daily basis and aspire to grow our knowledge base and capabilities. It is our duty as active managers and stewards of our clients' assets to find solutions that address information gaps and benefit clients' portfolios. It is within these information gaps that mispricing happens. Where mispricing happens, an active manager can find opportunity.

In the case of water, we see three main areas contributing to information gaps: pricing, risk and markets. The subsequent chapters of this piece explore each of these ideas through the lens of equity, fixed income and alternative investments.

The signals

Before we dive in, it is important to quickly discuss the underpinnings of our strategy related to water. First, we believe ESG factors can have a material impact on the long-term performance of the investments we make. And, as ESG-informed investors, we analyze ESG factors alongside traditional financial and economic measures, to promote a more comprehensive view of the value, risk and return potential of an investment. The analysis includes looking at current and upcoming "signals" that are going to shift the landscape for all investors. We don't want to go into great detail about these regulatory issues but feel it is important to touch on them briefly.

Current signals include the UN Sustainable Development Goals (SDGs) and the corresponding targets set for 2030. These will drive companies' bottom lines, consumer and investor behavior, and the long-term viability of some industries. Looking forward, we are confident major regulatory reforms focused on directing investor capital toward carbon neutrality, such as the implementation of the 2019 Sustainable Finance Disclosure Regulation (SFDR) and the 2021 European Union (EU) framework for a common classification for sustainable activities (aka, the "Taxonomy Regulation"), are going to drive assets toward companies implementing best practices for sustainability and disclosure. As we highlight throughout this piece, disclosure is key to understanding risk and is lacking in many industries. In our view, companies and sectors currently leading on disclosure of water risk and its impacts on operating costs will have a leg up on competitors who are trailing or resistant.

Bottom line: water risk imperils clients' assets

Our fundamental position is guided by three main principles. First and foremost, our stewardship and fiduciary responsibility to our clients. We must make better-informed decisions because we have a duty to our clients.

Second, the time to identify water risk is now, not the future. Water risk is a material risk. We must recognize that broader environmental risks are beginning to pose business-relevant vulnerabilities today. These vulnerabilities translate into asset value destruction through asset impairment via valuation. We are always trying to connect the dots on how these broad issues translate into asset impairment by identifying the channels of financial impact that macro-factors could have on a company and how our analysts price in this impact—whether pricing through a readjustment to a financial model or through an adjustment to a company's financial forecast. For example, if a company operating in a water-stressed region does not have good governance and/or broad oversight of its water supply, these problems will trickle down to the bottom line through higher operating costs or a lack of supply chain optimization.

Third, as active managers, ultimately, our goals are to be better informed managers generating sustainable risk-adjusted returns for our clients. We must be able to identify companies and sectors, through their management of these issues, that differentiate themselves as better run businesses. We must identify companies where latent risks become much more business relevant, and in quicker time frames than anticipated. We are also seeking to identify companies providing solutions to deal with water scarcity, water sanitation and water efficiency.

We anticipate these issues are going to take on much more prominence in the asset management industry and the client landscape. Issues related to climate change—water scarcity, sea level rise, more severe storms and wildfires—can no longer be ignored or be considered latent risks just because many believe they are priced too far out or they will not impact portfolios until a point in the distant future. As a fiduciary for our clients' assets, we must be positioning our portfolios for climate change today, not in 2030 or 2050.

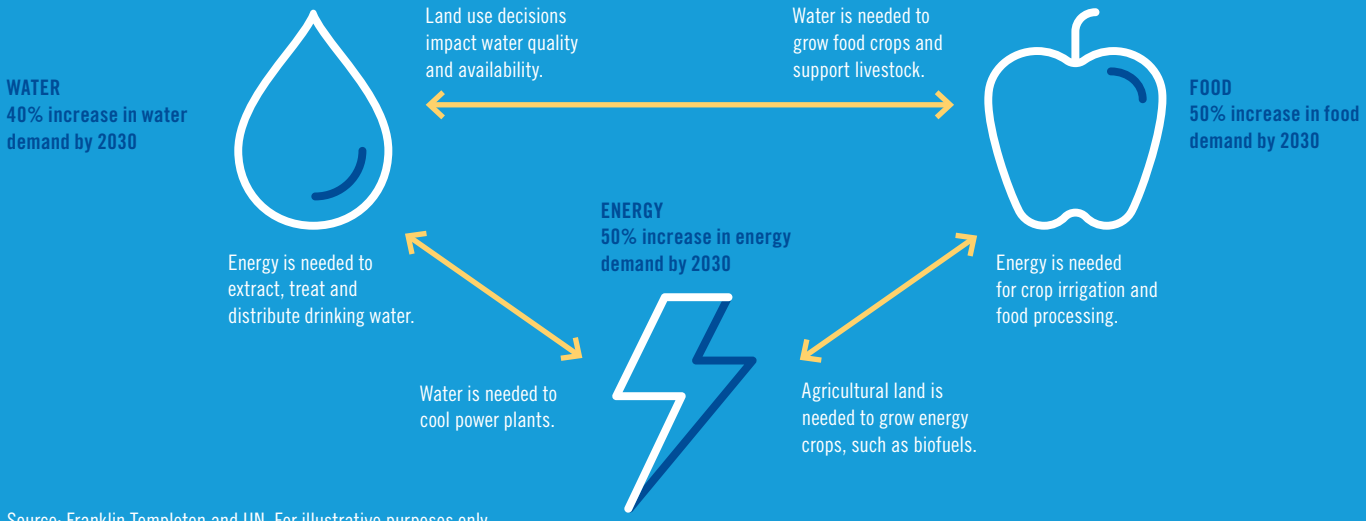
Water-food-energy nexus

As alluded to previously, water is an essential component of most sectors of the economy. It is the intersection of water, food and energy—commonly referred to as the "nexus"—where the interdependencies and complexities peak. These interactions rank among the most complex global challenges today and will only grow over the coming decades. Food and energy production cannot happen without water. As investors, our goal is to seek to understand the effect of these complex interactions on companies and industries.

Agriculture accounts for 70% of global freshwater use. Due to urbanization, population growth, climate change, and increased adoption in developing markets of high caloric diets now common in developed markets, the World Bank estimates global agricultural production will need to expand 70% by 2050 in order to meet demand.[7] Northeast China, northwest India, and the southwestern US are the global agriculture regions facing the greatest water risk in the coming decades. Without action to address this risk, these three hotspots will suffer shocks that will impact global financial markets, trade and food security.[8]

Energy production accounts for 75% of global industrial water use. And power plant cooling is responsible for over 40% of freshwater withdrawal in Europe and nearly 50% of that in the United States.[9] Global withdrawals are expected to increase 20% by 2040, and countries like China and India may see even higher demand as they build more power generation capacity to meet growing urban demands.[10] You are likely looking at these figures and questioning the math based on what you read in the previous paragraph regarding agriculture usage.

CAN'T HAVE ONE WITHOUT THE OTHERS
Exhibit 3: Water-food-energy nexus



Source: Franklin Templeton and UN. For illustrative purposes only.

In this piece, we will focus on water, but our next two Big Ideas pieces on environmental disruption will delve into food and energy. It is this trifecta where we see the most potential for risk, price disruption and overall market impacts as we move into the next years and decades. And, as we've already pointed out, these issues will be substantially impacted by climate change and be key drivers of shocks to markets.

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Water-related risks in equities: pricing in risk

Water risk impacts investors' equity holdings in two simple, yet key, ways: decreased revenues and increased costs. These risks manifest operationally, potentially impacting or preventing a company's day-to-day operations, and through the company's understanding and management of risk via its water and wastewater management plans. Risk in these plans surfaces through supply and demand needs, proper treatment and storage of wastewater, and the company's interactions with local stakeholders and communities. If not properly managed, these risks can lead to regulatory and reputational issues in addition to a negative impact on water sources required for operations. And, if not properly understood and priced, these risks can negatively impact clients' assets.

A closer look at mining and minerals

To illustrate these issues, we'd like to focus on the mining and minerals industry, where water risks feature prominently and can significantly impact business valuations. While many mining firms report water-related metrics and various service providers attempt to aggregate and standardize the data, available information remains incomplete and often inconsistent. We believe active investors practicing in-depth fundamental analysis will have a competitive advantage in an environment where such material information is not easily attainable.

Mining and processing raw materials requires large amounts of water and results in a considerable amount of wastewater that must be properly treated and stored to avoid harmful releases of toxic waste into the surrounding environment. Therefore, the two main water-related risks impacting the mining industry are:

1. **Equitable water access**—What are the community, environmental and capital considerations related to water access and are they being addressed in ways that are both responsible and sustainable?
2. **Responsible wastewater management**—The bulk of water used for mineral processing is retained in tailings disposal facilities, where the non-valuable parts of ore are stored after separating the valuable fraction. The safety of these facilities for the environment and surrounding communities is of paramount importance and represents a material risk that requires close scrutiny.

We'll explore both through case studies and how our research process is designed to understand a company's true water footprint rather than relying on single points of data.

Equitable water access

Water access in the metals and mining industry varies significantly by location. Water access can be a relatively small portion of costs in some areas, but much more significant in areas experiencing water scarcity due to droughts, climate change or resource competition. This can lead to not only higher prices, but also to production disruptions or—in the worst case—a full decommissioning of the mine and material

asset write-downs. HSBC estimated that if mining companies had to pay water prices more in line with societal demands and needs in locations with higher population densities and that are exposed to water stress, operating profits would decline by 9% on average, ranging from 2% to 26%, and net debt to operating profits would increase by 40% on average, ranging from 2% to 102%.[11]

In water-stressed regions, mines viewed as excessive water consumers may face conflict or discontent, and many mining companies find it necessary to go beyond regulatory compliance, particularly when government capacity is limited.[12] To avoid competing with other users, mines may invest in infrastructure to source water or increase efficiency. Mines often build desalination and water treatment plants to supply operations and local communities with clean drinking water, which may be a requirement for the approval to operate a mine. Operators are sometimes able to use unconventional and lower quality water—such as seawater, high saline groundwater and wastewater—for various processes.

The water needs of a mining operation can be significant. For example, to produce 1 metric ton of copper concentrate ready to be refined into metal, a typical copper mine would need to mine 154 metric tons of rock and use 65 metric tons of water, resulting in 114 metric tons of slurry tailings (some of which can be recycled).[13] To assess a company's overall water access risk, we want to know how much fresh water is withdrawn and consumed, what portion comes from water-stressed regions and alternative water sources, the percent recycled/reused, corporate efficiency targets, and any record of past breaches of permits, standards, and regulations.

> ...to produce 1 metric ton of copper concentrate ready to be refined into metal, a typical copper mine would need to mine 154 metric tons of rock and use 65 metric tons of water, resulting in 114 metric tons of slurry tailings.

We also seek information on disruptions due to water shortages, disputes with local communities, increasing water costs, and related capital expenditures, as well as information on asset write-downs or penalties and compliance costs. We hope to see a high level of transparency along with a strong management strategy and effective oversight.

Though disclosures have been improving, gathering relevant information can be a challenging manual task. We attempt to leverage water-related information from external data providers, but we find large gaps and inconsistent data even for the most basic statistics. For example, as of June 2020, MSCI ESG Manager had water consumption data for only 14% of our global equity holdings, and CDP (formerly known as the Carbon Disclosure Project) had it for only 19% of our holdings, reflecting the percentage of holdings that respond to CDP's annual water questionnaire. For the metals and mining industry, MSCI data feeds did not have consumption data for any companies, while CDP had it for only 25%. However, when reviewing company reports, we found all of our industry holdings reported this data, albeit not always in a consistent and comparable manner.

Challenges in obtaining comparable data for risk assessment underscore the need for more robust reporting standards, such as the Water Accounting Framework (WAF) used by the International Council on Mining and Metals (ICMM). The ICMM requires members to report to at least one of the main disclosures systems, for example: CDP Water, CEO Water Mandate or Global Reporting Initiative. While these are considered good systems, the ICMM has developed more comprehensive guidelines to help investors understand the industry's material water practices, nuances and risks.[14]

Water access at Anglo American

London-based miner Anglo American plc has high water access risk, with 75% of sites located in water-stressed areas, according to the World Resources Institute's Aqueduct tool. In 2019, restricted water availability due to drought conditions decreased copper production by 5%, and the firm's reputation as an industry leader on ESG issues was impacted by a lawsuit relating to water shortages at a Colombian coal mine in which it owns a minority stake.[15] Determined to maintain leadership in resource stewardship, the company's ambitious water strategy includes a goal to achieve a 50% net reduction in freshwater extraction from 2020 to 2030. It set a target for a 75% recycling rate for 2020, and water withdrawals were down 8% in 2019 compared to 2018.[16] Some of its water reduction efforts include technological innovation to

significantly reduce the amount of mineral ore having to be processed, dry tailings disposal, dry separation, and waterless processing. A key part of its water strategy is switching to lower quality water to reduce costs and make more water available to communities in which it operates. All of this does not come cheap—costs for water risk mitigation represented over 70% of its capital expenditure in 2018.[17]

THE NUANCE IS IN THE NUMBERS

Exhibit 4: Comparing Anglo American and Sumitomo Metal Mining (SMM) water footprints

	Anglo American	SMM
Water consumption (m3)	141,075,000	11,419,000
Water consumption intensity (m3 / US$1 million sales)	4,723	1,423
CDP water score & stewardship level	A– (Leadership)	B (Management)
Water reduction target	50% by 2030 (6.7% per annum)	N/A

Source: MSCI, CDP. As of September 2020.

Water access at Sumitomo metal mining

In contrast, Japanese miner and refiner Sumitomo Metal Mining (SMM) has relatively low water access risk and less ambitious management targets. The company uses seawater for 82% of its water withdrawal needs, and 94% of water withdrawals are returned to the environment. However, its smelting business uses a large amount of fresh water and includes facilities in the Philippines, where there are water shortages in the dry season. To address this, the firm recycles water from its tailings storage facility when shortages occur. Given water scarcity in the area, SMM has been providing local residents with high-quality drinking water since the beginning of the plant construction and is working with the local government to evaluate the possibility of installing water facilities that draw drinking water from nearby rivers.

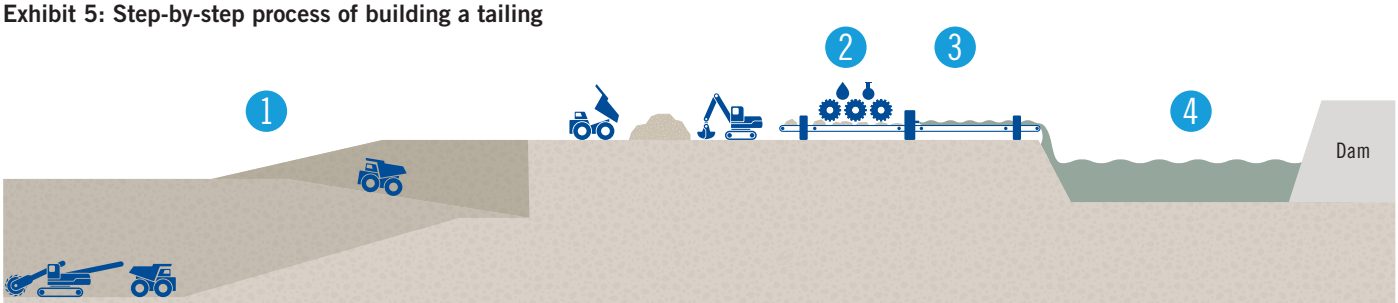
Responsible wastewater management

Water used in extraction and processing usually contains toxic metals and pollutants, which—if not managed properly—can contaminate the environment, potentially resulting in large fines, cleanup costs and loss of water access rights or license to operate. While some of this wastewater can be purified, the process is often prohibitively expensive, and much of the unwanted byproduct ends up in a purpose-built tailings reservoir.[18]

Tailings are a slurry-like byproduct of extracting minerals and metals from mined ore. There are different ways to store tailings that are suitable for different topographies and climates. The waste in tailings ponds is contained by a dam that must be able to withstand flood risk and seismic activity, with monitoring and regular maintenance to ensure it remains stable. Operations with poor waste treatment practices and storage facilities could experience catastrophic failures, resulting in huge cleanup costs, legal damages and the potential loss of license to operate. Of the 48% of mining companies reporting to CDP, water-related financial losses totaled US$11.8 billion over the last five years, in large part caused by flooding and severe weather events resulting in production disruptions, fines and asset write-downs.[19]

ANATOMY OF TAILINGS

Exhibit 5: Step-by-step process of building a tailing



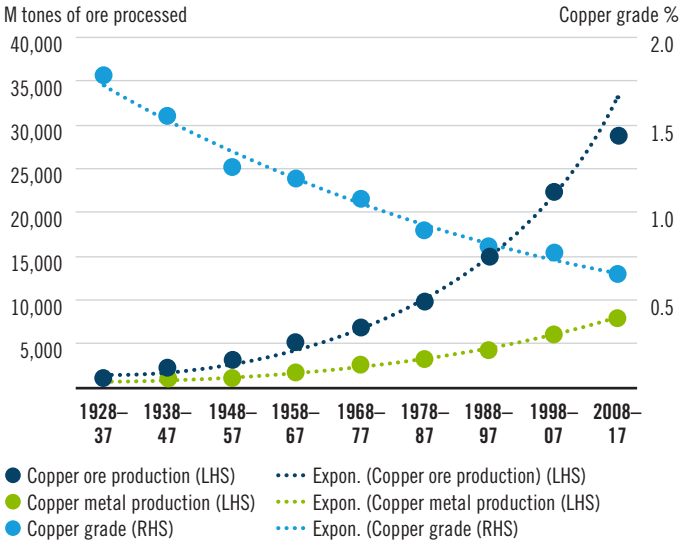
1. Rock containing minerals and metals are mined from the earth and processed to separate the minerals and metals.
2. The mined rock is finely ground and mixed with water and sometimes chemicals to separate minerals and metals.
3. Once the desired minerals or metals are extracted from the finely ground rock, fines*, the waste that remains is in the form of a slurry, known as tailings.
4. This slurry can be processed to a sand-like material and transported to a dry stack, or pumped in its wet state into a reservoir with a dam.

Source: Franklin Templeton. For Illustrative Purposes Only. *Fines are solid particles with diameters less than 44 microns and are comprised mostly of clay and silt material.

While tailings dam collapses remain rare, the impact of a failure can be catastrophic, as was the case with a tailings storage facility at Vale's Córrego do Feijão mine in Brumadinho, Brazil, in January 2019. The dam collapsed, releasing 11.7 million cubic meters—roughly a 10-meter high wave—of mining waste on the town and surrounding countryside, resulting in over 10 kilometers of destruction, the contamination of the Paraopeba River, 259 people confirmed dead and 11 missing (as of January 2020).[20] Vale's stock price fell 24% in response to the disaster, a loss of US$19 billion in market capitalization. Its debt was downgraded, there were direct costs of over US$5 billion and the former chief executive officer faces murder charges.[21]

LOWER-GRADE ORE INCREASES WASTE

Exhibit 6: Copper grade, copper metal production and ore production by decade
1928–2017

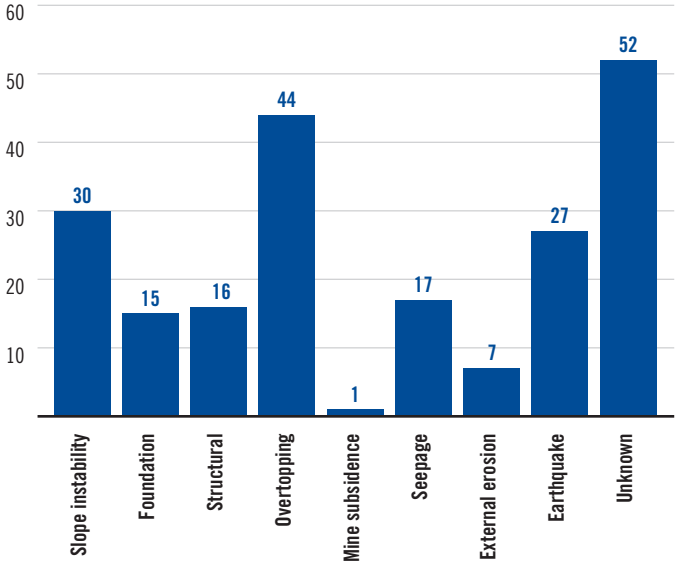


Source: World Mine Tailings Failures Organization, as of March 2019.

The risk of dam failures may be increasing. This is partly due to higher water and waste ratios resulting from the increased use of lower-grade ore as high-grade ore is used up, as illustrated in Exhibit 6. Climate change is also increasing the risk of dam collapse through more frequent flooding and extreme weather events. In our view, tailings dam failures can be avoided with strong independent oversight and strict regulatory enforcement. State-owned companies or mines operating in countries plagued by corruption or limited government capacity may be exposed to greater risk, requiring reliable third-party auditors and extreme vigilance on the part of investors.

MANY TAILINGS DAM FAILURES ARE PREVENTABLE

Exhibit 7: Causes of tailings dam failures
2015–2016



Source: UNEP and GRID-Arendal 2017, ICOLD 2001, Chambers 2017.

Slope instability—static failure / 30
A constant load that causes deformation, to the point at which a dam partially or completely fails. Often caused by partial saturation of areas of the dam that are designed to remain dry.

Foundation—structural and foundation conditions, foundations with insufficient investigations / 15
Failure related to building the dam on a surface that does not support for the weight of the dam. An example is a layer of clay under a dam.

Structural—structural inadequacies, inadequate or failed decants / 16
Design errors or failure of a designed component to function as designed. Failed decants (which drain water from the impoundments) are a common cause.

Overtopping / 44
Water flowing over the top of a dam. Tailings dams are made of erodible material, and overtopping will cause erosion.

Mine subsidence / 1
If the dam or impoundment is built above an underground mine, collapse of the underground mine workings can lead to release of the impoundment tailings.

Seepage and internal erosion / 17
Erosion of dam material due to water passing through areas of the dam that are designed to remain dry.

External erosion / 7
Simple erosion of a dam face, typically due to precipitation run-off that is not repaired.

Earthquake—Seismic instability / 27
Dams are designed to withstand earthquakes, but if the earthquake is larger than that which was anticipated, the structure can be destroyed by the shaking.

Unknown / 52
Many of the older dam failures that were not sufficiently documented may fall into this category.

Following the Brumadinho disaster, a group of institutional investors led by the Church of England and Swedish National Pension Funds (now representing more than US$13 trillion assets under management) have written to 726 extractive companies seeking information on the management of tailings storage facilities ("TSF"), as part of the Investor Mining & Tailings Safety Initiative.[22] Most of the largest mining companies responded with disclosures on tailings dams/facilities, details of which have been organized in the Global Tailings Portal, launched in January 2020.[23] This free database has information on mine tailings dams around the world, and the next phase of the project will test satellite monitoring and aim to increase the number of dams monitored in its database. The Investor Mining & Tailings Safety Initiative, along with the ICMM, the United Nations Environment Programme (UNEP) and the Principles for Responsible Investment (PRI) also conducted a global tailings review to create a Global Industry Standard on Tailings Management in order to establish robust requirements for the safer management of both existing and new tailings facilities globally.

Comparing Vale and SMM tailings storage facilities

We've already begun to use the new Global Tailings Portal to understand tailings dam failures and their potential risks to equity investors. Turning back to SMM for a comparison, we find that the company has relatively low risk of tailings dam failures compared to Vale and other companies in more flood-prone regions with weaker regulatory controls. SMM's main tailings risk is from earthquakes.

The company has no active tailings facilities in Japan, but given its hundreds of years of history, it has many inactive sites with large volumes of tailings that require responsible oversight and maintenance. All inactive facilities have been closed for at least 45 years. Following the Great East Japan Earthquake in 2011, the government significantly tightened regulations for tailings storage facilities, and SMM identified 11 that needed reinforcement against a large-scale earthquake. Improvements were completed in 2018.

By comparison, Vale reports 91% of facilities are categorized as high to extreme risk of failure, and 24 facilities have reported past stability concerns. Many of the facilities are also very high volume, suggesting greater environmental impact from any failure. Brazilian authorities have ordered Vale to close several operations, affecting approximately 10% of production. The cause of the recent dam failure was likely due to deteriorating quality and poor oversight. Given the prior incidents with remaining uncertainty around total costs, investors would be prudent to factor in ongoing environmental damages into their forecasts for Vale. SMM, on the other hand, appears to have relatively low risk of catastrophic failures or damages.

NEW TOOLS TO UNDERSTAND RISK

Exhibit 8: Global tailings portal data comparing Vale and SMM tailings facilities side by side
As of September 2020

	Vale	SMM
# Tailings storage facilities	86	45
# With approved design	82	45
# With extreme weather assessment	86	45
# With past stability concern	24	2
Total active TSF	41	2
Tailings volume (m3)	1,826,600,000	73,100,000
Maximum height (meters)	163	89
Tailings intensity (m3 / US$ million sales)	48,476	338,000
% Tailings with extreme, very high, high risk	91%	0%*

Source: Global Tailings Portal. *Note: TSFs not categorized based on consequence of failure.

In-depth analysis required

Water issues impacting corporations are first and foremost a matter of community equity and environmental stewardship. The examples explored here are some of the clearest to explain, but every industry has its nuances when it comes to water. Companies and governments that do not recognize them as such, or cut corners or ignore regulations, bear significantly higher risk of value-destructive consequences over a long-term horizon. Companies must prioritize water access and disposal issues when assessing and managing projects in order to conduct accurate cost analyses and manage associated risks. Water disclosures at the corporate level are improving, but are still inadequate, in our assessment, and have not yet been standardized in a widely accepted scoring methodology. We believe in-depth fundamental investors are well-positioned to gauge the true risks stemming from water issues on a case-by-case basis, and to accurately reflect those risks in their company models and investment theses. This ability to uncover and assess difficult-to-interpret information can be a meaningful source of alpha for active managers.

Gail Counihan
ESG Analyst
Franklin Templeton
Fixed Income

Directly engaging to understand water risk

We'll now focus on risk and use fixed income investing as our lens. Firms with water intensive business operations and those operating in areas of water stress—where water withdrawals are high relative to supply—face the risk of having to pay higher water prices or losing access to water supply. These risks are likely to rise in the future: water scarcity is rising due to population growth, over-use, and ecosystem degradation, plus more frequent and severe droughts. Where water scarcity has been severe enough to have an operational impact, several bond issuers have had their credit ratings downgraded in the past, as illustrated in Exhibit 9.

Water risk is most severe at the intersection of two variables—lack of investment in resilient infrastructure and occurrence of severe drought. Since droughts are outside our control, we engage with companies to collect information that will allow us to understand how the companies we invest in are positioned to deal with these risks. In practice, this means that we try to understand any mitigation attempts by companies, investment into preparing for these risks, best practice within the sector and the realities faced by certain geographies or sectors.

Our first port of call is existing data—disclosures that have been made that will assist us, metrics that are universally comparable, or processes and frameworks that exist to manage risk. We then use MSCI data for further company specific information, and our final port of call in gathering data is a short questionnaire that is sent to each company we engage with. Our first objective is to learn more about how these risks are managed, and once we have established a good benchmark, we will continue engagement in cases where we think this risk management can be improved.

WATER SCARCITY'S OPERATIONAL IMPACTS

Exhibit 9: Examples of recent water-related impacts on company bond ratings
As of October 2020

Year	Company	Event	Impact
2013	Barrick Gold	One of its mines was ordered to close to ensure the physical and chemical stability of the water sources affected by the project.	S&P cut rating to BBB from BBB+
2017	K&S	Lower-than-expected water levels on German rivers disrupted K&S's operations, leading to higher-than-expected logistics costs.	S&P cut rating to BB from BB+
2018	Multiple	Of the 9,000 corporate research updates published between July 2015 and August 2017, 717 involved environmental and climate factors. Of these, water factors were an important consideration in 197 cases.*	Update to corporate research
2019	EDF	Forced to cut output from multiple plants due to historically low levels of the Rhine, Rhone and Garonne rivers in 2019 (water required for reactor cooling).	Output cuts

Source: Franklin Templeton based on our research of water-related downgrades. *S&P Global Ratings, *COP24 Special Edition: Shining A Light on Climate Finance.* December 2018.

Our engagement process

We follow an internal process to identify companies that are at higher risk of being impacted by water scarcity, as measured by MSCI. Using water risk as an example, some of the factors that we consider in identifying these companies include:

- Water intensity relative to peers
- The portion of company assets in lines of business that are typically water intensive
- The portion of company assets in geographies that typically experience moderate to high levels of water stress
- Presence and nature of water-related controversies

We then review these companies in more detail, and where we require more information, we will engage the company to provide us with some extra detail around the following areas:

- Further information around the firm's approach to estimating water scarcity
- Water efficiency targets over the next five to 10 years
- Any initiatives to work with the company's supply chain on water scarcity strategy
- Investment into water efficiency
- Targets and investment around recycling levels and returning wastewater to the environment safely
- Accountability for management and delivery of water management strategy and KPIs

To better illustrate our process, we'll focus on some key findings from recent engagements in Europe with energy utilities and cement manufactures—two sectors we believe highlight how water stress is key to valuing and understanding risk in corporate bonds.

Energy utilities

A typical power company is a large user of water—most are cooled by river water—but a negligible consumer, as much of the water is returned to the source after it is used and treated. Most of the loss, or consumption, occurs through steam. Water is critical to thermal and nuclear power generators—which currently account for around 60% of power generated in Europe and over 40% of freshwater withdrawal.[24] Global withdrawals are expected to increase 20% by 2040.[25] Given the high withdrawal rates, if the source is a static body or a river, there is a risk that the company will be denied access in times of drought.

Water is critical to thermal and nuclear power generators—which currently account for around 60% of power generated in Europe and over 40% of freshwater withdrawal.

We recently engaged seven energy utilities operating in the EU. Here are some of our key findings based on our survey:

- When it comes to expectations regarding increases or decreases in water efficiency, an almost unanimous forecast is that the organization is expected to become up to 25% more water efficient. The key driver of this improvement is an industry-wide movement away from a high-water intensity energy (high thermal capacity) toward less water-intensive renewables. The spending to achieve improved efficiency is cited as being a defined percentage budgeted in annual or forecasted research and development (R&D) budgets—almost half of companies chose this—or "ad hoc" spending.
- With respect to accountability and organization governance, there was consistency among responses. All the companies have an executive committee member responsible for management and delivery of water management strategy and oversight of water KPIs. In terms of the KPIs that are tracked, there was divergence in responses—ranging from baseline KPIs such as those that are obtained from a water supplier, to more granular metrics such as recycling rate, consumption and discharge by source, water use in megaliters per gigawatt hour (ML/GWh), and water use/overall sales—the latter providing investors with the most easily comparable metrics from one company to the next. We will continue engagement where required in order to source these comparable metrics.

- Water recycling is not cited consistently as a target, and where it is pursued, we observed only marginal savings in thermal processes. For example, the installation of a system for the recovery and use of rainwater at a thermal power plant may be expected to save 2% in annual withdrawals or treating wastewater from power plants and might result in a 1% saving. It is useful to compare these marginal improvements to the fundamentally lower water intensity that is associated with renewable power generation.

Overall, we were encouraged by the granularity and oversight of water risk in our respondents. We will continue engagement with some issuers where we think disclosure and internal processes can be improved.

EU ETS—boosting climate resilience of energy infrastructure

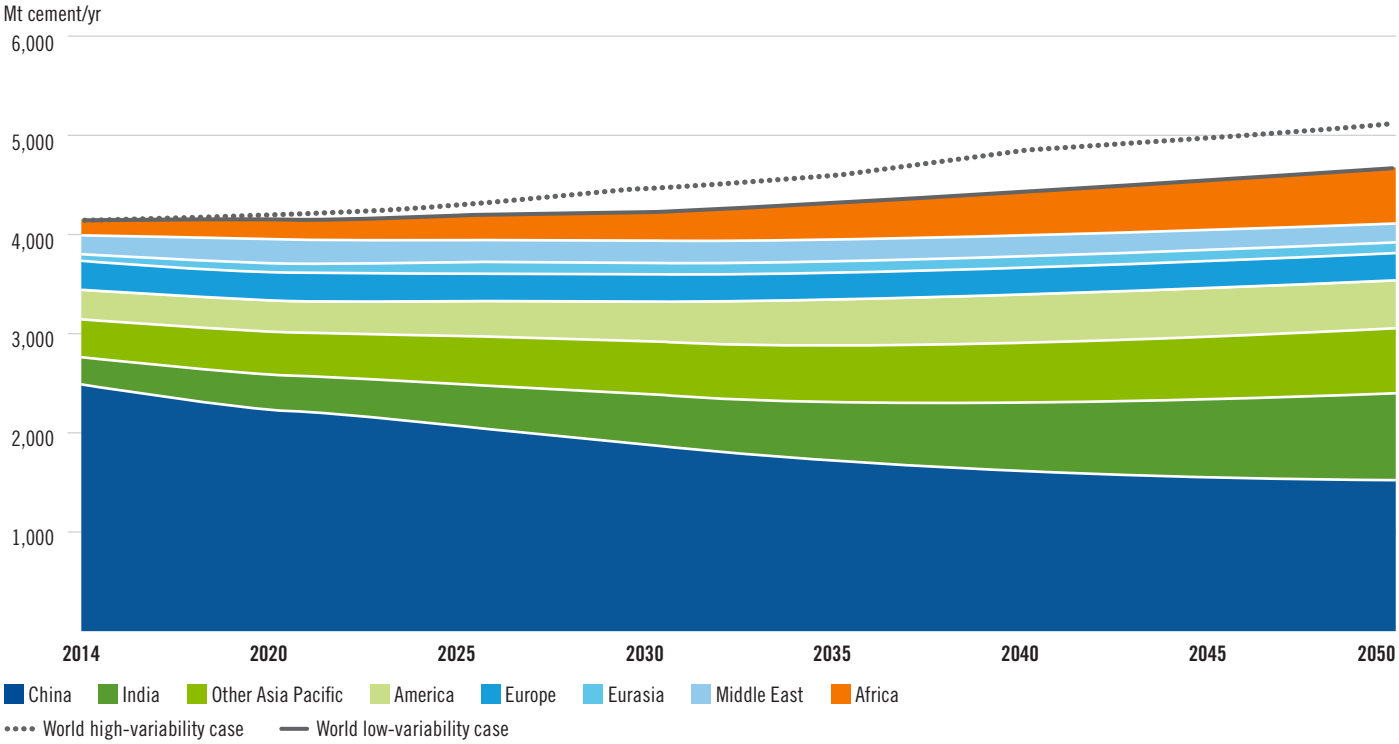
Across Europe, the frequency of extreme weather has been on the rise—ranging from falling river levels to an increased number of droughts or heat waves. Warmer temperatures are fueling peak demand loads on the continent's energy grid, and the requirement for cooling water in thermo-electric power plants is an important climate risk that is growing for electricity producers. A mitigating action here is conversion to a mostly renewable generation base, and in this light we can view decreasing water risk as an unintended consequence of the European Emissions Trading System (EU ETS)—the scheme provides economic incentive for utilities to move toward less water-intensive power generation, thus decreasing their water risk.

Cement

Next we'll focus on cement production—also an activity covered by the EU ETS. Not only because it is the most used construction material in the world—you'll find it on every continent and in every market from frontier to developed—but also with global growth, concrete production is increasing substantially and is projected to grow more. The industry has made strides to measure energy consumption and CO_2 emissions but has lagged on understanding and reporting on its water footprint. As seen in Exhibit 10, a 2018 report from the International Energy Agency (IEA) and the World Business Council for Sustainable Development (WBCSD) Cement Sustainability Initiative (CSI) projects cement production to increase 12%–23% globally. Of that growth, 75% is projected to occur in water-stressed regions.[26]

PROJECTING CEMENT THROUGH 2050

Exhibit 10: Cement production by region projected through 2050, with world high- and low-variable projections (in megatons/year)
As of 2018



Source: IEA, WBCSD, CSI, 2018. Base year cement production data 2014 Minerals Yearbook: Cement, United States Geological Survey data release, 2016. There is no assurance that any estimate, forecast or projection will be realized.

Having a clearly articulated water management strategy in place, having a view of the extent to which operations will become more efficient over the short to medium term, and working directly with suppliers to understand their water strategy together form the baseline of good operational management.

As we did with energy utilities, we created a direct engagement process and survey with three of the larger European cement manufacturers. The feedback received has helped us to start building a picture of what good forecasting and operational management looks like.

- When it came to understanding water sources, responses that were common included leveraging more than one source of water availability assessment tools—such as the GEMI Local Water Tool, Aqueduct or the Water Risk Atlas. Having a clearly articulated water management strategy in place, having a view of the extent to which operations will become more efficient over the short to medium term, and working directly with suppliers to understand their water strategy together form the baseline of good operational management.
- Regarding investment, there is no clear trend with regard to spending to achieve greater efficiency. Approaches ranged from ad hoc spending to the investment being a defined percentage of the R&D budget—the latter would ordinarily be associated with a dedicated strategy to target water efficiency and would represent the best practice among responses.
- With respect to KPIs for recycling and returned wastewater, we couldn't obtain a clear picture of best practice. Metrics were either reported as absolute numbers or percentages—rendering both as non-comparable. This will be an area that we continue to engage on. An internal price for water is something that is being used by most of our respondents—an indicator of good water governance.
- There was consistency across the board with respect to accountability for water management and efficiency programs—this is something that has become standard practice rather than indicative of strong governance. While we think the level of risk management and oversight in our respondents varied widely, we also think the baseline level of oversight was stronger than global peers, due to regulation in the European region.

Active engagement helps us gather information that improves our understanding of how companies are managing these evolving risks. With varying disclosure requirements globally, it is still challenging to compare companies across regions, and some of our next steps in our cement engagement will include establishing a real-world baseline and sourcing comparable and up-to-date data.

Complexity necessitates engagement

These engagement examples are just scratching the surface, and we immediately saw the need for further engagement. Additionally, analysis of results from multiple data sources combined with company responses is quite complex. The lack of standardization not only within sectors, but also across sectors, enhances the complexity. It is important for us to understand these complexities and continue to engage companies to move toward standardization and a better baseline. The time to do this is now—complexity will only grow with the growing demand and competition for water.

Greg Danielian
Research Analyst
Franklin Templeton
Fixed Income

The future is here: municipal bond risk and a shrinking river

Climate change is often discussed as something occurring in a distant future—an event we have time to prepare for and perhaps even prevent if we course correct. The future is already here in western North America. Over the last two decades, climate change and a megadrought have wrought havoc on the region's most vital water supply, the Colorado River. As municipal bond ("muni bond") investors in utilities, we are watching these events unfold while we continue to monitor municipal bond opportunities in the region. We believe muni bond investors play an important role in providing capital to these utilities in funding their capital needs to promote a reliable water supply in the face of mounting water supply stress.

Often referred to as the "World's Hardest Working River"—each drop of water is used 17 times in its journey from the headwaters to the terminus—the Colorado River in the United States provides municipal water to over 40 million people, irrigates over 5.5 million acres of agricultural land, and generates over US$1.4 trillion in annual GDP and 16 million jobs.[27] The total economic impact of the river is higher, but not as well documented, when you include México's 1.5 million acre feet (MAF)[28] allocation irrigating over US$2.9 billion of crops in the Mexicali Valley and supporting the Mexicali region's globally linked US$2.4 billion manufacturing economy.[29]

Since the megadrought began in the late 1990s, available water supply in the river has declined over 15%, and due to climate change the river is projected to experience between 20%–30% less flow by 2050 and 35%–55% less by 2100.[30] Based on 2014 dollars and economic activity, those reductions would cut economic production and labor income in the region by over US$576 billion and US$1.1 trillion respectively, as seen in Exhibit 11. Just over half of the economic loss will occur in California, the fifth largest economy in the world.

EVERY DROP COUNTS

Exhibit 11: Extrapolated estimates of total economic impacts of different amounts of Colorado River water loss for the entire basin region

Percent decline in availability of Colorado River water	Gross state product $Billions 2014	Employment Millions job in years	Labor income $Billions 2014
10%	143.4	1.6	87.1
15%	215.1	2.4	130.7
25%	358.5	4.0	217.9
50%	717.1	8.0	435.7

Source: James, et al., The Economic Importance of the Colorado River to the Basin Region. Tempe: Arizona State University, December 18, 2014. There is no assurance that any estimate, forecast or projection will be realized.

The Lower Colorado River Basin, which is made up of US states Arizona, California and Nevada, along with the country of México, is experiencing the full brunt of shrinking water supplies. The region is the lab for dealing with the impacts of climate change in real time—so much so that the Lower Basin has a doomsday clock, of sorts. However, the "clock" does not measure time, but rather the level of Lake Mead, the largest storage reservoir in the Lower Basin. And, instead of striking midnight, the magical number is 1,075 feet. This spot marks the water level of Lake Mead at which there will be an automatic shortage declaration. You're probably wondering, what is a shortage declaration and who is impacted? How close could it be? And, what are the chances of it occurring? Finally, you may be wondering what this all has to do with muni bonds and what are we doing as muni bond investors to understand the implications. We'll quickly explain them one by one.

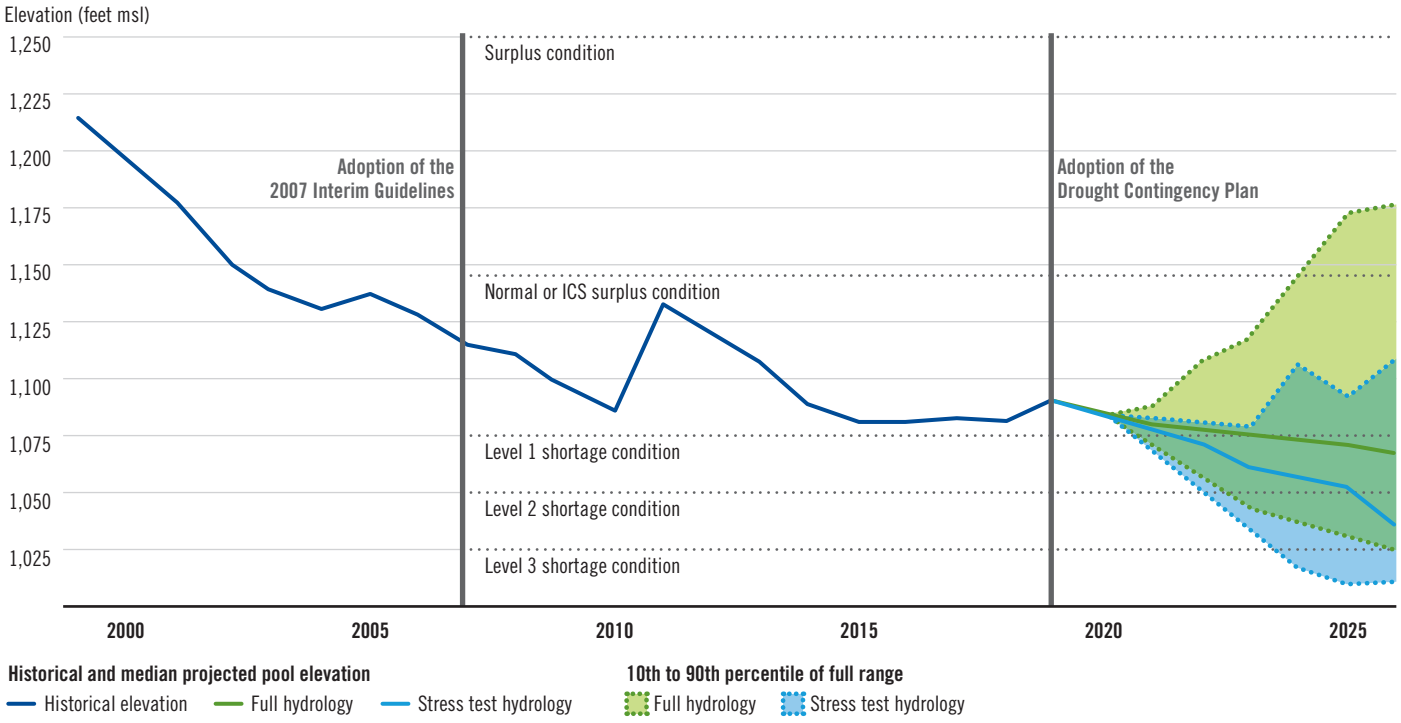
First, it is important that we point out that we don't expect the Colorado River water supply to impact major water utilities in the near to medium term. However, near-term investing can't ignore long-term impact and, as discussed in the introduction to this piece, we have a fiduciary responsibility to our clients' assets to understand these risks and how they will grow over time. As active managers, holistically understanding the risks allows us to both take advantage of gaps in information by more appropriately pricing risk and to move out of positions that are deteriorating in credit quality either from a supply risk standpoint or a financial standpoint.

When the clock strikes 1,075 feet

As seen in Exhibit 12, which indicates the level of the lake on December 31, 2019, the water level was at 1,090 feet. That is pretty good compared to recent history. As recently as 2018, the lake hovered within inches of 1,075 feet. In 2015, the lake dipped below the level for several months—hitting a historical low of 1,071 feet—but creeped back over the line when the final measurement of the water year was recorded.[31]

THE COLORADO RIVER'S DOOMSDAY CLOCK

Exhibit 12: Mean end-of-December elevation of Lake Mead and August 2020 CRSS
As of August 2020



Source: US Bureau of Reclamation, as of August 2020. There is no assurance that any estimate, forecast or projection will be realized. Note: The colored region, or cloud, for each alternative hydrology scenario represents the 10th to 90th percentile range of the projected reservoir elevations. Solid lines represent historical elevations (black), and median projected elevations for each alternative hydrology scenario (teal, yellow). Dashed gray lines represent important elevations for operations, and vertical lines mark the adoption of the 2007 Interim Guidelines and 2019 Drought Contingency Plans that lay out cuts in water deliveries to Arizona, California, and Nevada when elevations are reached. The method used to generate future inflows in the current projections includes resampling the historical natural flow record (1906-2018) using the Index Sequential Method (ISM), referred to here as "Full" hydrology. One alternative to the Full hydrology scenario applies ISM to a shortened period of the natural flow record, 1988-2018, and is referred to as "Stress Test" hydrology. The Stress Test hydrology scenario removes the earlier portion of the natural flow record and focuses on the recent (approximately 30 years) hydrology, which has a 11% drier average flow than the Full hydrology. Use of the Stress Test scenario is supported by multiple research studies that identified a shifting temperature trend in the Colorado River Basin in the late 1980s that affected runoff efficiency and resulted in lower average flows for the same amount of precipitation (McCabe et al. 2017, Udall and Overpeck 2017, Woodhouse et al. 2016).

Also shown in Exhibit 12 is a modeling scenario, called the Colorado River Simulation System (CRSS), which projects the likelihood of cuts in the near future. Under both the full hydrology, based on the river flows from 1906–2018, and stress test hydrology, based on the last 30 years and considered more accurate based on the recent climate, there is over a 50% chance of the lake dropping below 1,075 feet by 2026. The stress test hydrology predicts it happening a couple years sooner, likely in 2023, and the overall chance by 2025 at 77%.

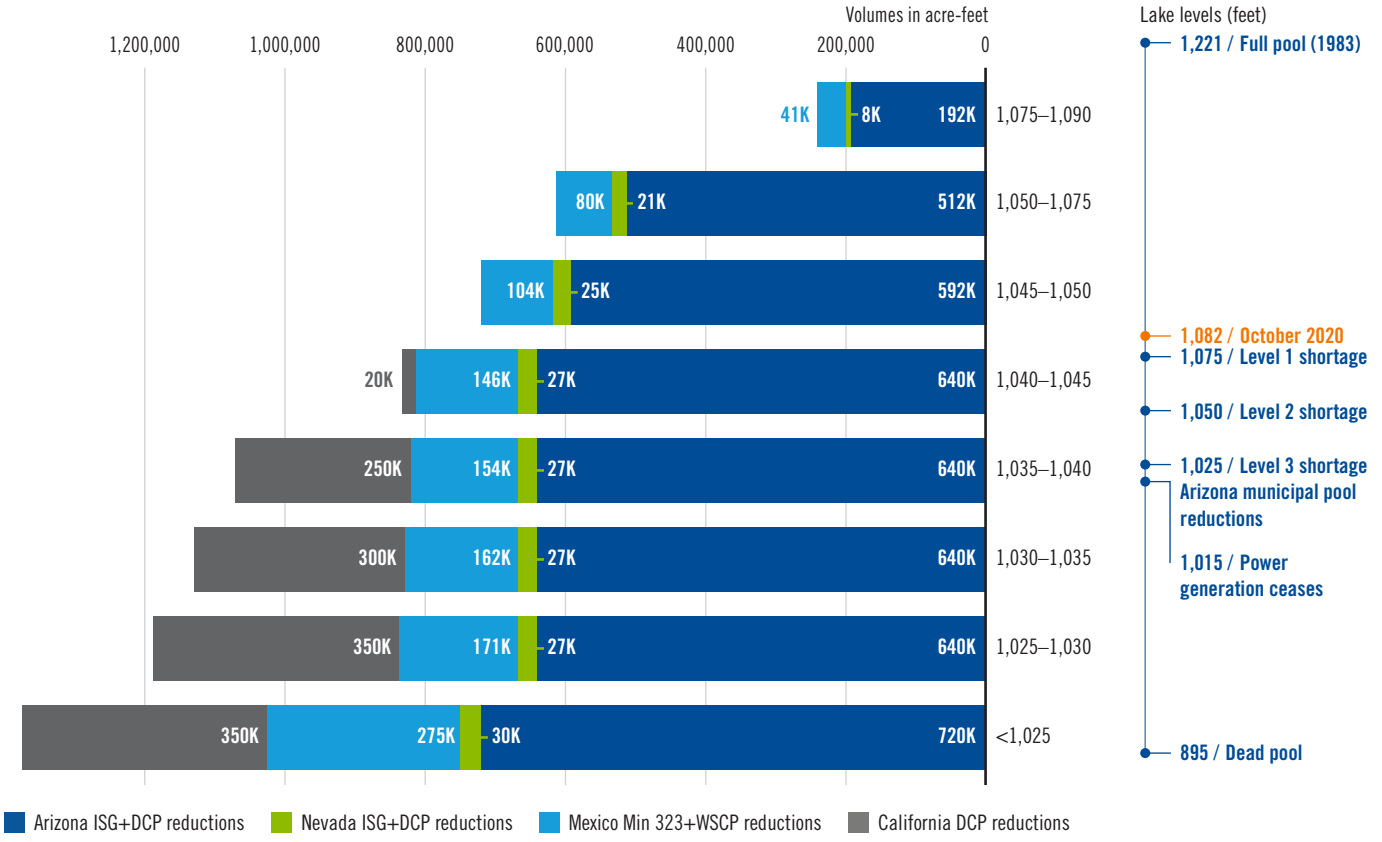
Once the lake drops below 1,075 feet, a shortage declaration triggers cuts to delivery of Colorado River water to Arizona, Nevada, and México—Arizona will lose just over 18% of its 2.8 million acre-feet (MAF) allocation. Starting at 1,050 feet, the cuts increase every five feet the lake drops. And, at 1,045 feet, they start triggering cuts in California, as seen in Exhibit 13. At 1,025 feet, the cuts are drastic—with each state and México cutting from nearly 10% to over 25% of their allocation. Also at 1,025 feet, the agreement must be renegotiated because at 1,015 feet, the hydropower station at Lake Mead (known as Hoover Dam) ceases to produce the 4.5 billion kilowatt-hours of electricity it supplies to over 8 million people in the region. Under the August 2020 CRSS, there is a 23% chance of the lake hitting 1,025 feet by 2026. The risk increases substantially after 2030—due to climate change projections and projected population growth—even with a conservative model, it is a matter of "when" not "if," barring major changes to how the river is allocated and managed.

Understanding material and liquid risk

As you can imagine, a 50% chance of the region experiencing drastic cuts in water availability from a critical source poses long-term material financial risk, including to the municipal bond sector that supports water and energy utilities' debt and capital projects. This risk is heightened in areas like the Lower Colorado River Basin, an already arid region with limited water supplies. By providing metropolitan areas in the region (e.g., Los Angeles, Phoenix, Las Vegas, etc.) water

ALLOCATION CUT TRIGGER POINTS

Exhibit 13: Planned lower basin reductions at each Lake Mead elevation



Source: US Bureau of Reclamation, Lower Colorado River Basin Drought Contingency Plan, 2019. Note: Full allocations are as follows: Arizona 2.8 MAF, California 4.4 MAF, Nevada 0.3 MAF, México 1.5 MAF

that is not available in their local watersheds and aquifers through massive infrastructure projects, in many ways the Colorado River is the Basin's, and investors' in the region, insurance policy—and it's an expensive policy to boot.[32]

Though municipalities and their water providers—both municipal and private—are among the highest priority users in the system and will not see reductions until the lake hits 1,025 feet, the uncertainty created by cuts to lower priority users (read: agriculture and some industrial users) will place further strain on the entire system. For example, agriculture producers in Arizona dependent on Colorado River water delivered through the Central Arizona Project (CAP) will see their entire allocation cut when the lake hits 1,075 feet. This will result in irrigators turning to groundwater pumping to maintain crops. The same groundwater farmers will turn to is also considered the long-term back-up plan for many municipalities dependent on Colorado River water. For example, Pinal County (a mostly rural agricultural area just two decades ago) is now home to some of the fastest-growing suburbs and exurbs of the Phoenix and Tucson metro areas. Over the next century, ground-water levels in Pinal County are predicted to drop from today's level of 200 feet below surface to approximately 1,300 feet below surface.[33]

Just looking at the utilities sector in the Phoenix metropolitan area, 45% of the water supply to the Arizona Municipal Water Users Association (AMWUA)—representing 10 municipalities and 3.5 million people—is supplied by the Colorado River via the CAP aqueduct.[34] Phoenix's growth over the last five decades was largely fueled by Colorado River water and would not have been possible at the current scale without this critical water source.

It is important to note the distinction between cuts and water availability to a customer base. Allocation cuts do not necessarily translate 1:1 into cuts to water utilized to satisfy current demand. Thanks to investments in diversified water supplies through secondary sources and sharing agreements, AMWUA members and other major utilities in the Lower Basin would not be under immediate threat of the water "shutting off" if they were to have their Colorado River allocation reduced or completely cut. As active managers, it is our job to properly price the risk and understand the potential impact on investments if such cutbacks were to occur.

To understand the impacts, we must fully understand the supply risk to municipal water systems; what federal, state, and local governments are doing, and not doing, to curtail the risk; and what steps municipal water providers are taking, or not taking, to strengthen and diversify their water portfolios. Poor disclosure by issuers has historically been a major challenge in understanding these factors in the municipal bond sector. Issuers may provide sufficient detail on deal structure and security package, financials, outstanding debt and high-level characteristics of the utility system in their Official Statements (OS); however, as highlighted in a key assessment of water risk in the municipal bond market by Ceres, there is a general need to improve disclosure of material water stresses and their potential impacts on supply.[35]

Essentially, our analysts must be water experts with the experience to see through generic statements, gaps in data and missing information.

For example, many OS's make general statements about water supply, such as: "[we] have adequate supply" or "[we're] taking steps to diversify our supply." Some asset managers may choose to take these statements as face value, but, as an active manager, we see such statements as a trigger to dig deeper and engage our research team to find out if these statements are backed by data and future plans. This framework and methodology were put to the test when our municipal bond team assessed the most severe impacts on California water utilities at the height of the recent drought by going through every issuer in our strategy, as well as other opportunities in the primary and secondary markets. Where we saw gaps in data and disclosure, we called issuers and asked for data and information to ensure that material risk was being covered under state-mandated municipal usage cuts that ranged from just under 5% to over 35%, depending on the water agency.

Essentially, our analysts must be water experts with the experience to see through generic statements, gaps in data and missing information.

Digging deeper

First and foremost, we believe the majority of utilities have strong balance sheet resources and several levers to pull in the midst of multi-year droughts to maintain compliance with rate covenants and meet ongoing principal and interest payments while maintaining strong credit ratings. That said, when it comes to disclosure of water supply, there are municipalities that stand out as good examples. Some of the key items we are looking for in our analysis of water utilities include, but are not limited to:

- Long-term planning: We're looking for evidence of capital improvement projects to improve delivery and/or prevent loss, as well as long-term agreements to secure future sources and supply. And, in the case of AMWUA, they have already announced future rate structures for each tier of potential shortage.
- Diversified supply: This can include mixes of groundwater and surface water—ideally coming from multiple reliable sources in the event a source has diminished or there is cessation of supply.
- Evidence of multiple use: This can include potable reuse, desalination, use of grey water for irrigation, and even mixing groundwater with surface water.
- Infrastructure investments: Investments in delivery infrastructure, storm water capture for treatment and recharge, increased water treatment capacity, and storage.
- Advanced metering infrastructure: Allows utilities to leverage technology to promote conservation, identify potential leaks and improve water loss efficiency. Additionally, it provides a tool for the customer to manage household or business water use and utilize that data to better partner in conservation efforts with the utility in periods of drought.
- Innovative agreements: This may include storage and delivery agreements, water wheeling, groundwater banking, and mutual-aid agreements.

On the other hand, we also must look for warning signs in disclosure, as there are cases in which multi-year droughts can lead to deteriorating credit quality. Additionally, lack of evidence of long-range planning, pre- and post-crisis, is concerning when evaluating investments. Below are some risk factors that raise concerns in terms of water supply reliability and disclosure.

- Lack of understanding and/or inability to articulate the amount of water supply available is a major concern: This applies in normal operating years but accelerates in drought or shortage conditions.
- Limited water supply diversification and/or single source supply: If a single source, we may have further concern if the source is imported and/or subject to third-party decision-making.
- Minimal, overlooked or undefined investments into water systems: This is further complicated if we see lack of investment into supply diversification, lack of meaningful renewal and replacement to promote system reliability and efficiency, and if annual investments are not aligning with long-range plans and/or long-range planning cycles are not being met.
- Unmetered customer base: This presents challenges in messaging to encourage conservation in times of drought and hampers enforcement during severe drought or mandated cuts.
- Lack of information: We have seen some issuers limit publicly available information, which creates challenges in truly identifying risks. This is especially concerning during a water scarcity crisis and can be a red flag if it occurs among weaker credits with weak financial fundamentals and/or risks associated with concentrated water supplies and/or reliance on imported water supplies.
- Outdated information: We have seen issuers fail to meet state-mandated deadlines on updating water plans. For example, we have seen several issuers in California fail to commission their 2015 water plans when currently they should be issuing their 2020 plan. Therefore, their water plan is from 2010. As a result, this may leave investors with minimal insight into any recent challenges faced by the utility and how the utility plans to address those challenges moving forward to ensure a reliable water supply. It also leaves investors in the dark if long-range plans established in the plan were met and successful.
- Lack of post-drought or crisis disclosure and evidence of lessons learned: This leaves investors unable to understand how the utility managed through drought or crisis both financially and from a water supply perspective. It is important for us to understand what worked or didn't work. Were they successful in reducing demand? Were they able to lean on and/or identify alternative short-term water supply if necessary? Utilities that continue to forgo and/or have not accelerated long-range planning post-drought are of concern.

Finally, there are areas in disclosure where we see room for improvement. While some issuers do a great job in outlining risks associated with water supply, we note a couple key areas for which there can be improvement.

- If an issuer is exposed to varying degrees of cuts to water allocations, we need to see a detailed look at the impacts of those cuts to the source water and overall water supply portfolio by drought severity level.
- In the event an issuer has not been to market recently and agreements such as the Drought Contingency Plan have been agreed upon, we would like to see updated disclosure on changes to the issuer's water supply availability and/or water risk in general to the issuer.

BEYOND THE OS

In addition to the OS, in the Colorado River Basin, here are a few examples of additional sources our analysts look to for a more holistic view of water risk in the region:

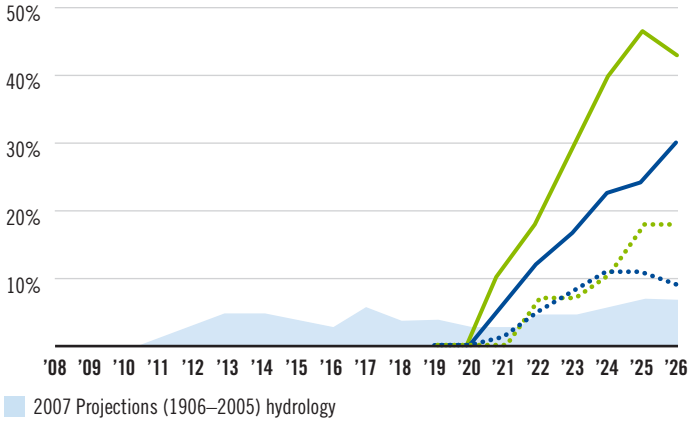
- Review of US Bureau of Reclamation (USBR), CAP documents, and other regional water providers
- Conversations with management teams
- City council reports
- Issuer-specific short-term and long-range planning documents
- Drought preparedness and response plans

Spreading the risk

So, what is being done beyond the local level to curtail this risk? For one, the Basin states and México signed an agreement in 2019 called the Drought Contingency Plan (DCP). The agreement attempts to spread the risk among seven states and México, which includes Arizona, Nevada, and México taking voluntary cuts starting in 2020 in an effort to keep more water in Lake Mead. As mentioned earlier, this region is the test lab for dealing with climate change—the intra-state compact combined with a series of groundbreaking binational agreements between the United States and México have become a global model for binational cooperation. Without these agreements, the doomsday clock would have struck 1,075 feet several years ago and we'd be well on our way to 1,025 feet, as the lake is projected to drop 12 feet per year in a "do nothing" scenario due to "structural deficits"—meaning, about 1.2 MAF more are withdrawn from the lake than currently flow into it because of over-allocation.[36]

DCP'S POSITIVE IMPACT ON RISK

Exhibit 14: Risk of Lake Mead falling below 1,025' without DCP vs. with DCP under full hydrology and stress test hydrology projections based on April 2018 CRSS.
As of June 2018



Source: US Bureau of Reclamation, Drought Contingency Plan planning documents.
There is no assurance that any estimate, forecast or projection will be realized.

As seen in Exhibit 14, the DCP essentially cut the risk in half, under both the full and stress test hydrology and without this historical agreement, of reaching 1,025 feet. As managers of municipal bond portfolios, these collaborative efforts reduce some of the risk to our investments. And as mentioned previously, AMWUA has agreed to rate increases tied to shortage cuts as part of the DCP. This proactive approach to planning provides our analysts a long-term view of how potential future cuts to supply will be managed, as well as how the likely reductions in usage will be handled from a revenue standpoint.

Actively engaged at the confluence

In conclusion, when looking at the Colorado River Basin, we are tracking these issues from a long-term risk standpoint. We don't believe major municipalities are at risk of losing water supply over the coming decades. However, we do believe it is important as stewards of our clients' assets that we understand the complexities of the Colorado River Basin and how shrinking water supplies in the coming decades will create mounting pressures on issuers and investors. When we come across issuers that don't provide adequate information, it is an immediate signal to engage further and dig deeper. As active managers, we view the confluence of gaps in data and information as a catalyst for mispricing.

Greg Wilkinson, CFA
Institutional Portfolio Manager
Franklin Real Asset Advisors

Water markets are key to properly valuing water

> **The things which have the greatest value in use have frequently little or no value in exchange; and, on the contrary, those which have the greatest value in exchange have frequently little or no value in use. Nothing is more useful than water; but it will purchase scarce anything; scarce anything can be had in exchange for it. A diamond, on the contrary, has scarce any value in use; but a very great quantity of other goods may frequently be had in exchange for it."**
> Adam Smith, Wealth of Nations

Obviously, Adam Smith didn't know about climate change when he wrote about water's value in exchange—if only he could see us now! What he did get right was that the value of any good is very much based on the value of exchange. When Smith was writing his magnum opus that formed the basis of free market capitalism, water was an abundant resource in many places. Over the last 250 years, this has obviously shifted—the value of water has risen in that time as it has become a more finite resource over much of the globe. And, as we've discussed throughout, growing demand and shrinking supply will only increase the value of water further in the future.

That said, water's value hasn't risen as quickly as one might expect due in large part to the complexities of pricing and valuing it—we won't go into detail here, as it is well-covered in water economics papers. Take our word, it is best summed up in a simple statement by three water economists in Australia: "The price of water almost never equals its value and rarely covers its costs."[37] Some of this pricing/valuation discrepancy is due to the absence of formal water markets over most of those 250 years. This is not to say markets don't exist—water has been traded for thousands of years. However, in the case of water, informal markets are often inefficient. And, in many cases, as seen in India's proliferation of tubewell drilling and selling groundwater pumped from those wells on non-regulated exchanges, for example, they compound water stress and do not address valuation discrepancies.[38]

We believe formal markets, like those in Australia and the western United States, are going to be established in more countries in the coming decades as we experience increasing competition for water. As pointed out by water economists Sarah Ann Wheeler and Dustin Garrick, of the University of Adelaide and University of Oxford respectively, how those markets form will be critical. In a recent piece in the Oxford Review of Economic Policy, the pair wrote, "As competition for water intensifies, economic policy must not only address where and how to develop more formal markets, but also how to facilitate gains from trade where the institutional preconditions already exist."[39] These institutional preconditions often refer to water rights and the government policies that regulate their exchange.

From a pure economic theory perspective (i.e., textbook stuff and Adam Smith), increased regulation is counter-productive to optimal market performance. However, in our experience, the concept of regulation as it pertains to formal water markets is different. Government regulation, especially in the case of the world's most established and robust water market—Australia's Murray-Darling Basin (MDB)—has been key to the formation of the market and will remain key into the future to ensure the market functions properly. For example, to lay the groundwork for market formation, it took the Council of Australian Governments (CoAG) landmark Water Reform Framework of 1994 to take the massive first step in market formation. This step was the separation, or "unbundling," of water and land rights, quickly followed by CoAG's National Competition Policy that allowed water to be moved to its highest valued use.[40] On the flip side, both these factors continue to be barriers for efficient market transactions in the western United States—the best-developed market after Australia.

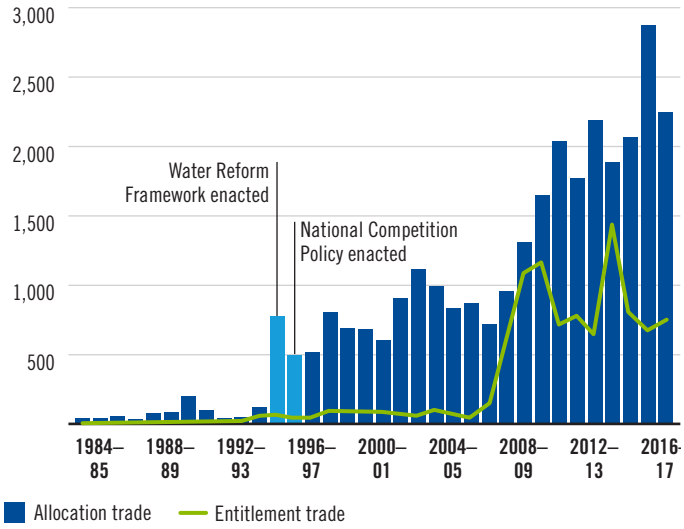
As a result of these policies, the Australian market has grown considerably in the last 30 years, as seen in Exhibit 15, which focuses on the southern MDB (sMDB), where the bulk of trade occurs. Take note of the spike in trading that occurred once the Water Reform Framework and National Competition Policy were enacted. To put this into context, if you have read other sections of this paper, and to provide scale of the amount of water moving on the market: in 2015–16, the trade in the sMBD alone was roughly equivalent to Arizona's 2.2 MAF Colorado River allocation.[42] Trade in the entire MDB market exceeded 5500 gigaliters (GL) that same year.

Over just the last eight years, the value of entitlement trades adjusted for inflation is estimated at A$10.1 billion (US$7.2 billion) and has grown in volume over that period.[43] More important than trade volume, is the fact the market has seen price fluctuation based on supply and demand. As seen in Exhibit 16, water prices have spiked in water scarce drought years and dropped in years with high water availability. Allocation prices peaked during the worst of the Millennium drought before declining to near zero during the 2011 and 2012 floods. In essence, the market is doing what it needs to do—more adequately valuing water. This is extremely important as Australia moves forward and the impacts of climate change increase.

To ensure the market functions properly into the future, the Australian Competition and Consumer Commission (ACCC) conducted a major inquiry into the MDB water market. The main takeaway of the ACCC's interim report (released in June 2020) focused on "…the need to reconsider governance frameworks focused on the proactive development and regulation of markets, to promote open and fair trade across the Basin. The ACCC will be considering governance and other options for improving water trading markets."[44] We agree with this conclusion and believe it is an important step in the

BUILD IT AND THEY WILL TRADE

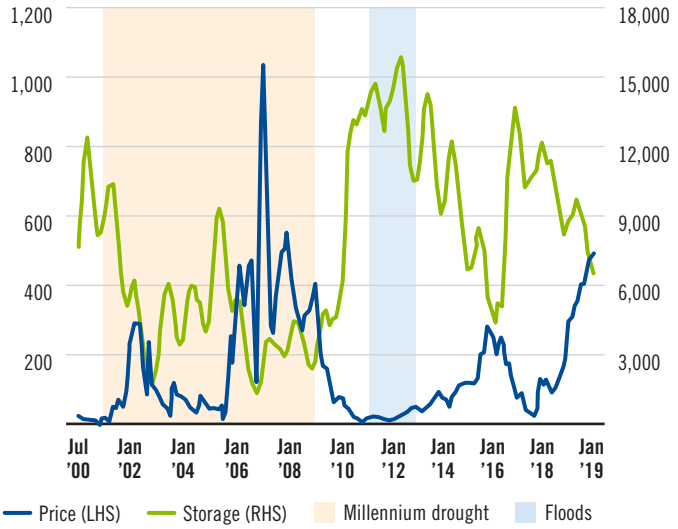
Exhibit 15: Annual volume of water allocation and entitlement trade in the sMDB, 1983–2017 (in GL)[41]



Source: ABARES. 1983–84 to 2009–10 taken from NWC (2011). 2010–11 to 2016–17 allocation data provided by the Murray–Darling Basin Authority, entitlement data produced internally by ABARES. Allocation data excludes environmental transfers. Entitlement data includes entitlements transferred to the Australian Government as part of the Murray-Darling Basin Plan.

SUPPLY AND DEMAND = WATER PRICE

Exhibit 16: Monthly allocation prices and storage volume in the sMDB, July 2000 to January 2019 (AUD millions/GL)



Source: ABARES. Volume weighted average price from BOM. Storages from Water NSW, SA Water and Goulburn-Murray Water. SMDB storages include Hume Dam, Dartmouth Dam, Yarrawonga Weir, Lake Victoria, Menindee Lakes, Blowering Dam, Burrinjuck Dam, Lake Elidon, Lake Eppalock, Cairn Curran Reservoir and Laanecoorie Reservoir.

maturity of the market. On the flip side, The Hamilton Project of the Brookings Institution, has openly called for expanded federal leadership and regulation in the western United States in order to develop a better market for water trading.[45] And market formation has been largely stalled or inefficient in other countries—China, Chile, Spain, Canada and South Africa, to name a few—due to the lack of regulation and government oversight.

Who's dipping a toe and why?

In the sMBD in 2018–2019, the majority of trades, making up 61% of transferees/buyers and 65% of the transferors/sellers in the market, are between irrigators and other water users. That said, they accounted for just over 20% of the volume of water both transferred and received.[46] Essentially, traditional users of water (read: agriculture) are doing a high number of trades but are buying/selling smaller volumes of water. On the flip side, the majority of high-volume transfers—making up 42% of water transferred and 32% received—is happening in an infrequent number (>1%) of large trades involving Environmental Water Holders (EWH).[47]

These EWHs are government-owned rights that were created under the 2005 Water Act, which created the legal foundation for water to be set aside to maintain environmental values of rivers and streams, and the 2012 Basin Plan that essentially created a cap-and-trade system to cap allocation in order to ensure long-term sustainability of the MDB's water resources and the market. It is important to note that the majority of their trades are zero price trades between EWH entities. Meaning that their trade volume does not impact the market cap or pricing in a significant manner.

Over the last four years, institutional investors' participation and share of the market substantially increased in the sMDB. In 2015–2016, they made up 1% of both buy and sale trades, and 4% of water volume purchased and 7% of volume sold. In 2018–2019, this increased to 16% of all buys and 5% of all sales, and 14% of volume purchased and 20% of volume sold.[48] Participants in the market are pension funds and institutional investors from both inside and outside Australia. This includes the largest holder in volume of water rights: the Canadian Public Sector Pension Investment Board, holding around 2% of all available rights on the market purchased.[49] The market is also attracting interest and participation from US, UK, Chinese and Japanese institutional investors, among others. In time, we expect these exposures to increase among institutional investors—who typically will not move meaningfully into an asset class unless they can build a large exposure—as the market matures and expands to parts of Australia outside the MDB.

Investors are attracted to water markets as a diversifier, but also to the income stream water rights provide that you might see in fixed income or other real asset investments.

Investors are attracted to water markets as a diversifier, but also to the income stream water rights provide that you might see in fixed income or other real asset investments. However, these real assets have been more reliable in a low global interest-rate environment, as Australia's growing demand for water has fueled price increases. This is not to say there is no market volatility; in years with above-normal rainfall or flooding prices can plummet, as seen in 2011 and 2012 in Exhibit 16.

The similarity to fixed income extends beyond income streams as water rights in the Australian system, where they are unbundled from the land, may have more value than the land itself and the rights are effectively allocated in tranches—similar to mortgage-backed securities (MBS) or commercial mortgage-backed securities (CMBS)—based on whether the right is a high or general security right.[50] High security rights receive their full water allocation first—as long as water is available—and are similar to the most senior tranche of CMBS. High security rights also have the highest value in temporary leasing markets and can provide stable income flows. A general security right has lower priority and is only filled when all the systems' allocation commitments are met. They are more similar to high-yield investments, as they are higher risk and are more subject to year-to-year variability. There may be years with high water demand when they do not

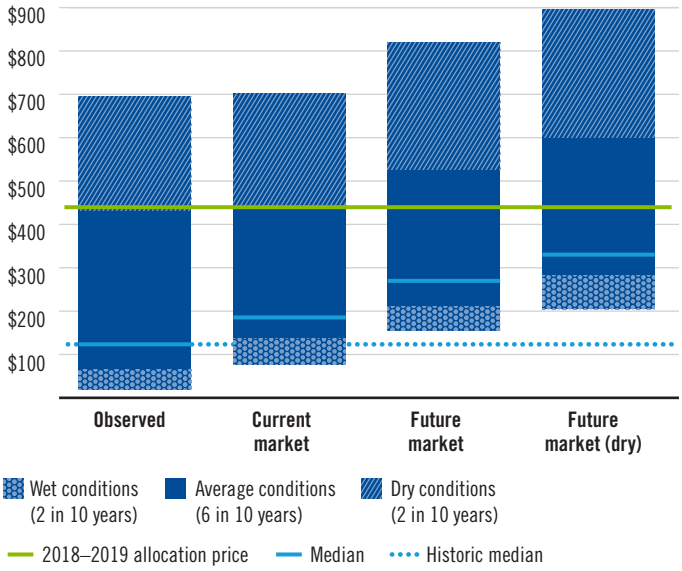
receive their allocation. Due to the higher risk profile and variability, general security rights are much more subject to trading and speculation.

Finally, this brings us to the significance of water investing from an ESG angle. The Australian water market is playing a critical role in water conservation through environmental allocations; by allocating water to the highest valued use; and through water pricing based on available supply. There is also a social element to this story. Water markets have created social benefits to the rural agricultural communities historically challenged by variance in rainfall and commodity prices. With climate change, these communities are going to suffer significantly unless mechanisms are created to smooth variability in revenue and income. We believe water markets are supportive of this goal.

We believe the Australian market could be the model of our global water future. And we are not talking hypotheticals or distant time horizons for this model to develop in other regions. We've already seen elements of the Australian market form building blocks to solve major water challenges in other markets. For example, large scale environmental allocations dedicated to the restoration of the Colorado River Delta are a key element in a recent binational agreement between the United States and México, which prevented major allocation cuts to agricultural users and municipalities in Arizona, California and Nevada. In order to sustain long-term supply, you cannot destroy the source.

IN THE FUTURE A DIAMOND IS WATER

Exhibit 17: sMBD weighted water allocation price by scenario*



Source: ABARES. February 2020.
*Note: For each scenario, a range of water supply conditions are simulated (based on the historical climate sequence 2005–2006 to 2018–2019) to provide a picture of potential water market and irrigation outcomes across representative 'dry', 'average' and 'wet' years. There are two key caveats to these scenarios. First, the climate sequence used (2006 to 2019) is particularly dry in the context of the longer historical record and may differ from average future climate conditions. Second, these scenarios are based on current farms using current capital and technology, and do not allow for long-term adaptation (innovation / technological change) or structural adjustment (changes in capital investment). Current market scenario based on current irrigation development (horticultural plantings), current water recovery under the Basin Plan, current trade rules and commodity prices. Future market scenario based on full maturity of recently established almond plantings, and future water recovery to meet Basin Plan requirements (3,200 GL target) via on-farm infrastructure upgrades. Future market (dry) scenario is as above, but with an 11% reduction in water supply and a 3% reduction in rainfall. There is no assurance that any estimate, forecast or projection will be realized.

Staving off further water starvation

There is no way around it—Australia is water-starved and has historically experienced high variability in rainfall. This has increased—and will continue to increase—with climate change. Focusing on just the MBD, stream flow has been on a decline since the 1970s and Commonwealth Scientific and Industrial Research Organisation (CSIRO) projections, based on a 1990 baseline averaged over the entire MDB and a middle of the road climate change scenario, projects reductions in average annual runoff of 9% by 2030, 15% by 2050 and 23% by 2070. Extreme drought scenarios, like those seen during the Millennium Drought of 2000–2010, project declines in the MBD of close to 40% by 2020, over 60% in 2050, and exceeding 80% by 2070.[51] It's important to note that these projections occurred before the 2012 Basin Plan. And, in fact, these projections were the catalyst for establishing the cap-and-trade system and formalizing EWHs' critical role in the market.

Water markets will be essential to properly valuing water as the impacts of climate change increase in the MDB. Just looking at a recent model that the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) developed for the sMBD that recreates the climate conditions in 2006–2019 and projects them into the future, there is likely to be a significant increase in water market prices. Taking those conditions and introducing an 11% reduction in water supply and a 3% reduction in rainfall, they predict future market prices 50% higher than the current market.[52] The model doesn't even take a crack at the extreme drought scenarios, but it is easy to imagine the impact it would have on the price of water. And that is entirely the point. In order to properly allocate water to the best use, it must be properly valued. This valuation is critical not just to market pricing but also to decrease the likelihood that we treat future water like a lump of coal when it is truly a diamond.

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From drought to deluge: when too much water is the problem

On August 25, 2017, Hurricane Harvey made landfall on the US coast just south of Houston, Texas. After pushing inland, the storm ran against a ridge of high pressure, blocking its forward movement. As most tropical cyclones do, the storm carried with it a prodigious amount of moisture. In the case of Harvey, the precipitation was made worse by its stalled location. With counter-clockwise circulation hovering partially over the Gulf of Mexico, the storm operated as a sort of planet-sized shop-vac, sucking up water from the Gulf and pouring it onto Texas. For three long days and nights Harvey tormented the Houston area, dumping biblical volumes of rain. The result was catastrophic flooding, massive property loss and, sadly, many deaths. A common misconception is that the primary threat from hurricanes is damaging winds. In reality, water causes most of the destruction.

Beyond the obvious and devastating humanitarian threat the risk of increased flooding presents to the world, there is a less recognized financial threat as well. In general, flood risk is an under-insured peril, in the United States and other countries globally. Even in places where insurance coverage is in-force, it is often found to be insufficient. For Hurricane Harvey, for example, total economic losses were around US$85 billion. Insured losses, however, were roughly US$30 billion–US$35 billion, revealing a significant protection gap. Around 80% of the homes inundated by floods in the Houston area were uninsured.[53]

The good news is private financial markets are beginning to provide a solution to the flood insurance problem facing the world today. In addition to traditional reinsurance, new forms of "alternative" risk transfer have also developed. For example, insurance linked securities (ILS)—financial products whose values are driven by insurance loss events, and which transfer major natural disaster risks to capital market investors—are being employed. The most common form is catastrophe bonds (or cat bonds), which operate somewhat like other bonds, but whose payout is dependent on the occurrence of a catastrophe. We're seeing a growing market for these instruments in the United States and globally. As these events become more common and destructive with climate change and sea level rise, we expect the market to grow.

Future forecast: more flooding

Flooding catastrophes such as Harvey are happening more frequently in recent years, and not just in the United States. This is a global phenomenon. In 2018, floods impacted over 35 million people worldwide, making them the most widespread natural disaster in terms of human impact.[54] In 2019, tropical cyclone Idai left in its wake devastating floods in Mozambique, Zimbabwe and Malawi. The cyclone made landfall over the city of Beira, Mozambique, a rapidly growing low-lying community on the coastline vulnerable to storm surges and rising sea levels. Ninety percent of the city was

> Although estimates for future sea levels vary substantially, some of the more dire predictions suggest a potential rise of three feet by the year 2100...this will have a major impact on flood severity and frequency.

destroyed, with flood waters reaching depths of 20 feet in some areas, according to the International Federation of Red Cross and Red Crescent Societies.[55]

Indeed, slow moving Hurricane Sally (2020) recently dropped 20–30 inches of rain in parts of the Florida Panhandle and coastal Alabama in the United States. Along with storm surges exceeding six feet, the deluge triggered catastrophic flooding.[56]

By all reasonable scientific measures, the reality of climate change cannot be denied. According to the World Meteorological Organization (WMO), record greenhouse gas concentrations are pushing global temperatures toward increasingly disruptive levels. A 2018 WMO report showed carbon dioxide levels rising from 357.0 parts per million in 1994 to 405.5 parts per million in 2017, and scientists expect these greenhouse gas concentrations will continue to trend upward.[57] As shown in Exhibit 18, the 10 warmest years on record have all occurred since 1998, and the last four years have been the warmest four on record.

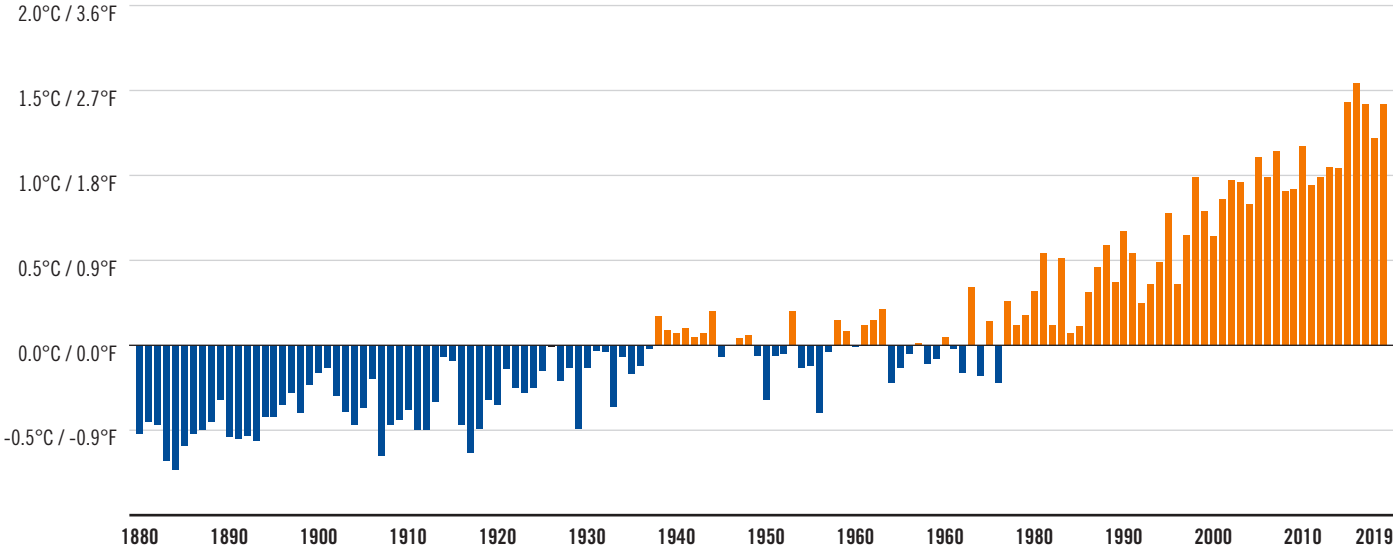
With rising temperatures comes rising sea levels, as sea ice melts and glaciers retreat. Although estimates for future sea levels vary substantially, some of the more dire predictions suggest a potential rise of three feet by the year 2100.[58] Implicitly, this will have a major impact on flood severity and frequency. As seen in Exhibit 19, planners in New York City are projecting significant portions of the city to be impacted by rising sea levels. To put this into context, many of the areas projected to be underwater in 2080 (portions) roughly correspond to where we saw inundation from the 14-foot storm surge during Hurricane Sandy in 2012.

There is high confidence among scientists that rising sea levels are playing a part in the increase in flood catastrophe risk. Rising sea levels increases risk of cyclone-related inundation to coastal properties from storm surge, as well as inland riverine flooding. In the United States, for example, almost 40% of the population lives in relatively high

LAST FOUR YEARS ARE THE WARMEST ON RECORD

Exhibit 18. History of global surface temperature anomalies since 1880

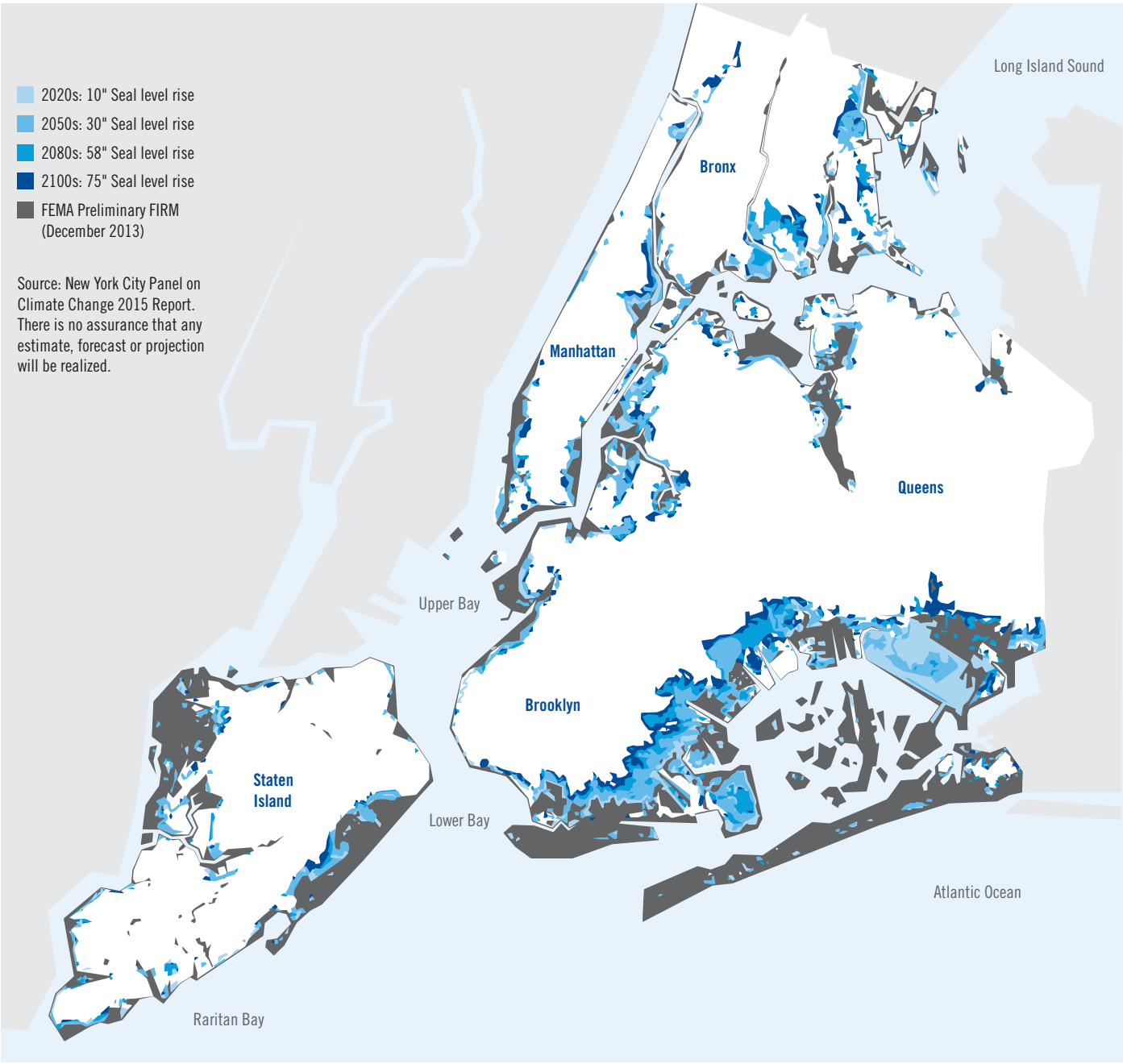
As of August 2020



Source: NOAA

RISING SEA LEVELS INCREASE FLOOD RISK IN DENSELY POPULATED AREAS

Exhibit 19: The New York panel on climate change future 100-year flood zones
2015



population-density coastal areas.[59] Globally, eight of the world's 10 largest cities are near a coast, according to the UN Atlas of the Oceans. Again, looking at Sandy's 14 feet of storm surge, it is easy to imagine a significant portion of Manhattan swamped if 2080's New York City were to experience a similar surge and no upgrades were made to sea barriers.

Beyond rising sea levels, the connection between climate change and increased flood risk is not as obvious as it may seem. Intuitively, the assumption is that—since hurricanes and cyclones feed on warm air and water—the increase in global temperatures is creating more and larger storms, and hence more flooding damage. There is mixed evidence to suggest this may be a factor, but there is no scientific consensus.

A more concrete (no pun intended) factor contributing to flood risk, in addition to higher sea levels, is physical changes to topography associated with human development—things like increased pavement, less natural drainage, and less foliage and green space to absorb and retain water.

Hurricanes are slowing down

Lastly, and perhaps most interestingly, recent research shows that storms are slowing down. And because they are slowing down, they are concentrating larger volumes of rain in certain areas—hence more flooding.

As Earth's atmosphere warms, the atmospheric circulation changes. These changes vary by region and time of year, but there is evidence that warming causes a general weakening of summertime tropical circulation. Because tropical cyclones are carried along environmental winds, the speed of tropical cyclones appears to have slowed with global warming. Over the period 1949–2016, tropical-cyclone translation speed has decreased globally by 10%.[60] The unprecedented rainfall totals associated with the "stall" of Hurricane Harvey over Texas in 2017, for example, provide a notable example of the relationship between regional rainfall amounts and tropical-cyclone translation speed. This may indeed be the greatest risk to flooding created by climate change.

FLOOD FACTOR: A USEFUL TOOL FOR PROPERTY OWNERS

Flood Factor is an interesting and free online tool for property owners in the United States looking for information on the flood risk associated with their properties. Created by the nonprofit First Street Foundation, the website makes it easy to find a property's current and future risk of flooding. Before Flood Factor, options to find a property's flood risk were limited, and it was difficult to assess how that risk may change over time. Historically, flood risk was largely defined by FEMA flood maps, which were broad-based regional assessments with no forward-looking analysis. Although useful for some purposes, FEMA flood maps did not give individual property owners direct data. In addition, finding flood history was also difficult, as flood disclosure laws vary by state, and individual flood insurance claims are protected by privacy laws.

The financial risk

For many property owners, the problem is two-fold: first, many are simply unaware of their flood risk. Second, for those who do have coverage, it is generally inadequate. In the United States, for example, most flood policies are covered by the federal government through the Federal Emergency Management Agency (FEMA) and the National Flood Insurance Program (NFIP), which already is severely underfunded.[61]

A recent study from flood risk analytics specialist KatRisk LLC and actuarial consultancy Milliman Inc. shows that 69% of metropolitan areas in the United States have 90% or more of their expected flood losses uninsured. As sea levels rise, total storm surge losses in these areas may increase 21% by 2050.[62]

In terms of cost, flood losses to single-family residences could be upwards of US$7 billion annually, with more than 87% of those costs uninsured by the NFIP.[63] If private flood insurance data were included, this estimate would only marginally decrease due to the small size of the residential private flood market relative to the NFIP.

THE IMMENSE POWER OF MOTHER NATURE

Meteorologists measure rainfall rates in inches per hour in the United States. A rate of 0.5 inches (1.27 centimeters) per hour is heavy, while anything above two inches is extreme. During Hurricane Harvey, in the Houston suburb of Clear Creek, 10.6 inches of rain fell in just two hours. The next night, the heaviest band of rain set up over an affluent suburb in western Houston. These neighborhoods were supposed to be protected against flooding by two large empty overflow reservoirs with a combined capacity of 400,000 acre-feet of water, roughly the same amount that goes over Niagara Falls in 10 days. After one night of rain from Harvey, the area was flooded.

Transferring risk to capital markets

As alluded to in this chapter's introduction, ILS and cat bonds are gaining traction globally as potential solutions to the financial risk posed by increased flooding. In the United States, the Homeowner Flood Insurance Affordability Act of 2014 (P.L. 113-89) revised the authority of the NFIP to look to the capital markets for financing. In this way, risk transfer to the private market is helping alleviate the financial burden on FEMA and the US Treasury.

In August 2018, FEMA entered its first transfer of NFIP risk through an ILS transaction, transferring US$500 million of the NFIP's risk to capital markets by sponsoring issuance of an indemnity-triggered cat bond.[64] More recently, after witnessing the significant impact of Hurricane Sandy in 2012 on its subway system, the NYC Metropolitan Transportation Authority (MTA) issued a cat bond.

Going forward, we anticipate the increasing frequency of flood events, like Harvey in the United States, Hagibis in Japan, or Idai in Africa, will accelerate the development of the private flood market.

The MTA chose a parametric mechanism[65] that triggers payments when storm surge reaches a particular water depth at select measurement stations around New York Bay. It is designed to provide a cash influx to the MTA of US$100 million—in the latest 2020 issuance—if those conditions materialize, allowing the city to deploy funds as required to repair infrastructure or respond to emergencies.

Globally the ILS market is showing appetite for flood risk as well—including inland flood risk—with several catastrophe bonds completed during 2017 for European flood risk (Generali's Lion II), and Japanese flood risk (MSI and ADI's Akibare Series 2018-1 Notes).

Going forward, we anticipate the increasing frequency of flood events, like Harvey in the United States, Hagibis in Japan, or Idai in Africa, will accelerate the development of the private flood market. More efficient risk pooling and risk sharing mechanisms will help to alleviate financial flood risk exposure. Clearly there exists a meaningful gap between potential economic loss and insured loss, and this gap will likely widen with climate change and rising sea levels. This will be a catalyst for the ILS market, as consumers seek efficiently priced coverage for their risk exposures.

With trillions of dollars in capital in the world, there is clearly enough liquidity to absorb event risk. The challenge is accessing the capital base in an efficient way. Moving flood perils from government pools to private insurers will be a slow evolution. It will take time, particularly if existing coverage is subsidized.

While we discussed prior the potential longer-term implications for New York City flood risk into the latter half of the century, a traditional reinsurance risk period is typically one year. Cat bonds can have a four-year maturity profile, but like traditional reinsurance, the risk period is usually annual and typically resets at the beginning of each year. This is an important characteristic to highlight, as the private market has the flexibility to reprice risk frequently to incorporate the latest scientific research and claims data. This will be important as we continue to see years with multiple events hitting a region consecutively, as well as periods of severe hurricane and typhoon seasons happening over consecutive years.

For private insurers, the solution is not just about flood risk modeling to ensure risk adequate pricing, but also about navigating government legislation. Furthermore, as ESG considerations are more widely adopted by the industry, we expect to see new investors enter this market, attracted to a diversifying income stream that provides an environmental market-based solution.

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31. The Colorado River Water Year is tied to the US Government's fiscal calendar, ending on September 30 of each year. Peak water levels usually occur in late spring or early summer after snowmelt, after which the level of the lake drops until the next spring.
32. Example: The US$4 billion Central Arizona Project (CAP), a 20-year construction project following an 11-year battle in the US Supreme Court, pumps Colorado River water over 300 miles uphill at enormous energy cost to supply two of the fastest growing metro areas in the United States, Phoenix and Tucson.
33. Source: Miller, S. "Arizona's Water Supplies Are Drying Up. How Will Its Farmers Survive?," *National Geographic*, November 12, 2019.
34. Source: AMWUA, Colorado River Structural Deficit.
35. Source: Leurig, S. *The Ripple Effect: Water Risk in the Municipal Bond Market.* Boston, Massachusetts: Ceres, PricewaterhouseCoopers, and Water Asset Management. 2010. Note: Ceres is a global sustainability nonprofit that engages investors and asset managers on issues around climate change, water scarcity and pollution, and inequitable workplaces.
36. Source: Central Arizona Project, "Critical to Arizona's Water Future: Fixing Lake Mead's Structural Deficit," News Release, July 6, 2016.
37. Source: R.Q. Grafton, L. Chu, and P. Wyrwoll. 2020. The Paradox of Water Pricing: Dichotomies, Dilemmas, and Decisions. *Oxford Review of Economic Policy*, 36(1), 86-107.
38. Source: Wheeler, S. and D. Garrick. 2020. A Tale of Two Water Markets in Australia: Lessons for Understanding Participation in Formal Water Markets. *Oxford Review of Economic Policy*, 36(1), 132-153.
39. *Ibid.*
40. Source: Hanemann, M. and M. Young. 2020. Water Rights Reform and Water Marketing: Australia vs the US West. *Oxford Review of Economic Policy*, 36(1), 108-131.
41. Definitions: **Allocation** is the specific volume of water allocated to a water access entitlement in a given water accounting period, defined according to rules established in the relevant water plan. The size of the allocation depends on how much water is available in the water resource in that season. Also referred to as a seasonal water assignment in Queensland. **Allocation trade** is a change of ownership and/or location of a particular volume of water allocation. **Entitlement** is a perpetual or ongoing entitlement, by or under a law of a state, to exclusive access to a share of the water resources of a water resource plan area. Also referred to as a water share (Victoria), water access license (New South Wales) and water allocation (Queensland). **Entitlement trade** is change of ownership and/or location of a water access entitlement (including through the establishment of a tagging arrangement).
42. 2800 gigalitres roughly equals 2.27 million acre feet or 7.4 billion gallons.
43. Source: Australian Competition & Consumer Commission, "Interim Report: Murray-Darling Basin water markets inquiry," June 30, 2020.
44. *Ibid.*
45. Source: P. Culp, R. Glennon, and G. Libecap. 2014. *Shopping for Water: How the Market Can Mitigate Water Shortages in the American West*, The Hamilton Project Policy Brief 2014-05. Washington, D.C.: The Brookings Institute.
46. Source: Australian Competition & Consumer Commission, "Interim Report: Murray-Darling Basin Water Markets Inquiry," June 30, 2020.
47. *Ibid.*
48. *Ibid.*
49. Source: Jasper, C. "PSP Investments, A Canadian Pension Fund, Could Now Be the Largest Owner of Water in the Murray-Darling Basin," *ABC Rural*, February 17, 2020.
50. In some parts of the MDB, these may be referred to as high and low reliability rights, and as high or low priority rights.

51. Source: CSIRO. "Water availability in the Murray-Darling Basin. A report to the Australian Government from the CSIRO Murray-Darling Basin Sustainable Yields Project," October 2018.
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61. Source: Congressional Research Service. "The National Flood Insurance Program (NFIP), Reinsurance, and Catastrophe Bonds," *INSIGHT*. April 17, 2020.
62. Source: Evans, D. *Residential Flood Risk in the United States*. Schaumburg, Illinois: Society of Actuaries. 2020.
63. *Ibid.*
64. Indemnity bonds are triggered by the losses experienced by the sponsoring insurer following the occurrence of a specified event (e.g., if an insurer's residential property losses from a hurricane in Florida exceeds US$25 million in a given year)
65. Instead of being based on any claims (the insurer's actual claims, the modeled claims, or the industry's claims), the parametric mechanism's trigger is indexed to the natural hazard caused by nature, so the parameter would be the windspeed (for a hurricane bond), the ground acceleration (for an earthquake bond), or whatever is appropriate for the peril. For example, if a typhoon generates windspeeds greater than X meters per second at 50 of the 150 weather observation stations of the Japanese Meteorological Agency, the cat bond is triggered.

Notes

WHAT ARE THE RISKS?

All investments involve risks, including possible loss of principal. Bond prices generally move in the opposite direction of interest rates. Thus, as prices of bonds in an investment portfolio adjust to a rise in interest rates, the value of the portfolio may decline. Investments in lower-rated bonds include higher risk of default and loss of principal. Changes in the credit rating of a bond, or in the credit rating or financial strength of a bond's issuer, insurer or guarantor, may affect the bond's value. Municipal bonds are debt securities issued by state and local governments and are generally exempt from federal income tax and also from state and local taxes for residents in the state where the bond was issued. They typically offer income, rather than capital appreciation potential. Corporate bonds are issued by corporations. Bonds with lower ratings and higher credit risk (risk of default) typically offer higher interest rates to compensate investors for the higher risk associated with the investment. Stock prices fluctuate, sometimes rapidly and dramatically, due to factors affecting individual companies, particular industries or sectors, or general market conditions. Treasuries, if held to maturity, offer a fixed rate of return and fixed principal value; their interest payments and principal are guaranteed. Investments in foreign securities involve special risks including currency fluctuations, economic instability and political developments. Investments in emerging market countries involve heightened risks related to the same factors, in addition to those associated with these markets' smaller size, lesser liquidity and lack of established legal, political, business and social frameworks to support securities markets. Such investments could experience significant price volatility in any given year. Investing in the natural resources sector involves special risks, including increased susceptibility to adverse economic and regulatory developments affecting the sector—prices of such securities can be volatile, particularly over the short term. Some strategies, such as hedge fund and private equity strategies, are available only to pre-qualified investors, may be speculative and involve a high degree of risk. An investor could lose all or a substantial amount of his or her investment in such strategies. Real estate securities involve special risks, such as declines in the value of real estate and increased susceptibility to adverse economic or regulatory developments affecting the sector. The companies and case studies shown herein are used solely for illustrative purposes; any investment may or may not be currently held by any portfolio advised by Franklin Templeton Investments. The opinions are intended solely to provide insight into how securities are analyzed. The information provided is not a recommendation or individual investment advice for any particular security, strategy, or investment product and is not an indication of the trading intent of any Franklin Templeton managed portfolio. This is not a complete analysis of every material fact regarding any industry, security or investment and should not be viewed as an investment recommendation. This is intended to provide insight into the portfolio selection and research process. Factual statements are taken from sources considered reliable but have not been independently verified for completeness or accuracy. These opinions may not be relied upon as investment advice or as an offer for any particular security. **Past performance does not guarantee future results.**

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