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Manulife Asset Management

ASIA INVESTOR GROUP ON CLIMATE CHANGE

Are Asia's Pension Funds ready for Climate Change?

Brief on imminent threats to asset owners' portfolios from climate and water risks

China Water Risk (CWR)

China Water Risk (CWR) is a non-profit think tank that aims to create a world where water and climate risks are embedded in business and finance so that better decisions can be made today, for a water secure tomorrow. Since its launch in 2011, it has worked from its Hong Kong base to engage with global business and investment communities to understand and manage water risks in Asia, especially China. Today, CWR publishes proprietary research including co-authoring policy briefs with government-related bodies in China and beyond and its website www.chinawaterrisk.org still remains a "go-to" resource on water risks.

CWR has also been commissioned by financial institutions as well as listed corporates to conduct research and assessments analyzing the impact of water risks across various sectors. Such reports have been considered ground-breaking and instrumental in understanding China and Asia's water challenges. CWR is part of China's Environmental Risk Analysis Task Force and a founding member of the Hong Kong Green Finance Association.

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Manulife Asset Management

Manulife Asset Management is the global asset management arm of Manulife Financial Corporation ("Manulife"). The firm provides comprehensive asset management solutions for investors across a broad range of public and private asset classes, as well as asset allocation solutions. It also provide portfolio management for affiliated retail Manulife and John Hancock product offerings.

Manulife Asset Management's investment expertise includes public and private equity and fixed income, real estate and infrastructure equity and debt, timberland and farmland, oil and gas, and mezzanine debt. The firm operates in the United States, Canada, Brazil, the United Kingdom, New Zealand, Australia, Japan, Hong Kong, Singapore, Taiwan, Indonesia, Thailand, Vietnam, Malaysia, the Philippines, as well as through a China joint venture, Manulife TEDA. The firm also serves investors in select European, Middle Eastern, and Latin American markets.

As at December 31, 2018, assets under management for Manulife Asset Management were approximately US$364 billion. Additional information may be found at ManulifeAM.com.

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Asia Investor Group on Climate Change

The Asia Investor Group on Climate Change (AIGCC) is an initiative to create awareness among Asia's asset owners and financial institutions about the risks and opportunities associated with climate change and low carbon investing. AIGCC provides capacity for investors to share best practice and to collaborate on investment activity, credit analysis, risk management, engagement and policy.

With a strong international profile and significant network, AIGCC represents the Asian investor perspective in the evolving global discussions on climate change and the transition to a greener economy.

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TABLE OF CONTENTS

Key risk highlights. 2

Asset owners are under pressure. 4

1. Pressure from largely ageing population in Asia 4
2. Asia's unique climate change challenge. 4
3. The Climate-Water-Nexus - Asia Faces a Triple Threat 7
4. Climate finance falls short. 10
5. Asian Asset Owners Further Exposed Due To Their Domestic Investment Skew 11

Portfolios are at risk 12

1. Logistics disruptions from rising sea levels and storm surges 13
2. Increasing risks from extreme weather events 15
3. Material and imminent regulatory risk triggered by water-nomic policies 7
4. Global trade and supply chain disruptions. 19
5. Magnitude of risks warrant investment policy revamp and financial reform 21

Key recommendations for asset owners 23

Recommended reading 25

Appendix I: The Water-Energy-Climate Nexus. 26

Appendix II: Basic Water-nomics 29

BACKGROUND

Asian pension funds and other asset owners (monetary authorities, central banks, and sovereign wealth funds) face significant short- and long-term threats from water and climate risks. In this brief, we assess the depth of these risks arising from both adaptation and mitigation and discuss how they are embedded in Asian market indices and current asset allocation practices of Asian pension funds. To help insulate the long-term savings of Asia-based investors and shore up the climate resilience of Asian pension funds and asset owners, three separate entities have pooled their research resources to conduct this study: CWR, a leading think tank on water and climate risks faced by financial and business operations in Asia; Manulife Asset Management, the global asset management arm of Manulife Financial with assets under management of US$364 billion (as of 31 December 2018); and the Asia Investor Group on Climate Change (AIGCC) who represents asset owners, managers and financial institutions from the Asia region.

KEY RISK HIGHLIGHTS

- **We are heading to a 3˚C world, with serious, severe impacts on water resources.** Scientists now agree that human activity is causing global temperatures to rise. According to the 2018 UNEP Emissions Gap Report, unless unprecedented actions are made, we are on track for global warming of 3°C[1]. Climate change will not only lead to sea level rise and more severe/frequent storm surges, floods and droughts, it will also impact river flow as it accelerates glacier and snow melt plus changes monsoon and rainfall patterns. These along with extremely hot temperatures will affect the health and spread of water-borne diseases amongst people as well as impact assets and stifle economic development.

- **Asia's climate-water nexus poses a triple threat where 1 in 2 Asian citizens and at least US$4.3trn of GDP is at risk.** The Asian region faces a triple threat:

  1. limited water resources to support development under the current economic model;
  2. climate change will exacerbate water scarcity; and
  3. assets are clustered along vulnerable rivers.[2]

  In Asia, 1.77bn people reside in just 10 major river basins which generate GDP of over US$4.3trn, according to the CWR "No Water, No Growth" report. Already half the basin areas of five of these major rivers face high to extremely high water stress. 280+ major cities, including capitals and economic powerhouses, lie along rivers that flow from the Hindu Kush Himalayas (HKH)[2]. Increased pressure on the river basin from rapid urbanisation is occurring alongside climate-induced changes in the source components of rivers (i.e. glaciers are melting, snow and rain patterns are changing). The report also projects that four of these rivers will see flows shrink in the next 50 years under a 2°C scenario[2].

- **Asian Asset Owners' portfolios are uniquely exposed to Asia's climate challenges, putting savings at risk.** We reviewed 30 large public pension funds, sovereign wealth funds, and central banks from 12 Asian markets and found a trend towards significantly concentrated portfolios in their domestic markets. On average, 64% of the allocation of these is invested in domestic equities and bonds which, aside from China and Japan,are extremely high relative to the size of these markets in the global economy; in some cases this is as high as 80-100%. Not only are investors in this region disproportionately exposed to the climate change-related transition and physical risks faced by investee companies, they are also already underfunded in the context of rapidly ageing populations. In some cases, this can be further compounded by regulatory requirements that prohibit geographic diversification; the ratio of asset owners' domestic investments to country GDP can be as high as 25-45%

- **92% of current climate finance doesn't protect assets; Asia is most exposed to policy risk but also has the biggest opportunities.** Asset owners need to act to invest in closing the emissions gap before irreversible climate change is triggered and locked in. By 2030, current emissions must be reduced by 25% to keep global warming to 2°C, or must be more than halved for 1.5°C.[1] Representing 415 investors with US$32trn in assets- under-management, the Global Investor Statement to Governments on Climate Change presented at COP 24 called for global leaders and governments to honour the Paris Agreement and step up action to tackle the emissions gap to limit warming to well below 2°C.[3]

- However, it is equally necessary for asset owners to urgently prioritise a push to invest in climate change adaptation. Around 92% of climate investments are currently focused on mitigation and therefore do not protect assets against climate impacts already baked into the system[4]. Analysis of 1.5°C, 2°C and 3°C temperature change scenarios shows that Asia is more exposed than the rest of the world to policy risk, but also has the greatest opportunity to benefit from low-carbon transition technologies.

- **The economy runs on water, so limited water points to policies for a new development model = transition and disruption risks**. China and India do not have enough water to grow under the current export-led economic growth model whilst simultaneously ensuring food and energy security. Transitioning to a new development model that generates more GDP with less water and pollution is an essential way forward, e.g. improving water use efficiencies while shifting economic, industrial and crop mixes. This means that governments will move towards "water-nomics": wedding future economic planning to water resource management. Ensuing regulations will likely disrupt global trade and multiple supply chains. Such regulatory risk is on the rise in China and has deep implications across sectors. India, whose water woes are more precarious, is expected to follow suit.

- **Climate and water-related risks bring both macro and micro challenges to portfolios; we identify five key areas for Asian asset owners to consider:**

  1. Rising sea levels & storm surges will impact ports, which have to adapt. Without this, Asia's highly export-oriented economies and companies will suffer severely;
  2. Increasing urbanisation means more is at risk, in terms of assets and people's lives and livelihoods;
  3. Material and imminent regulations will change current business models, impacting bottom lines of businesses and investors;
  4. Global trade and supply chains could be disrupted as a knock-on effect of the impacts above; and
  5. The magnitude of these risks warrants a revamp of investment policies and financial reform to ensure the risks are being considered and incorporated into the due diligence process, as financial institutions constitute a significant part of Asian equity indices.

- **To respond, asset owners can assess portfolios against various water, climate and regulatory risk scenarios.** We recommend they map their portfolios to the inter-linked, systemic risks posed by climate change to understand their real and clustered risk exposure along particularly vulnerable river basins. Scenarios regarding basin-level risk (physical and regulatory) can then be applied to gauge the long-term viability of investments. **We have set out a to-do list of key actionable recommendations in this brief to enable asset owners to better protect their portfolios and uphold their fiduciary duties.**

ASIAN ASSET OWNERS ARE UNDER PRESSURE

Asian Asset Owners provide the main form of long-term savings for the majority of people in Asia (via several government-sponsored, public pension funds), and provide key sources of capital to stabilise and fund Asian economies (via sovereign wealth funds and central banks). Unfortunately, Asian asset owners face significant challenges that could undermine their ability to fulfil these functions over the long-term, specifically:

1. **Ageing populations**, exacerbating long-term funding issues;
2. **Climate change costs**, which are projected to hit Asia harder than any other region; and
3. **Climate change-precipitated water risks**, which will disproportionately impact Asian economies and the assets and operations of companies operating in the region.

These challenges are further multiplied by the following factors:

4. **Shortfalls in investments** by governments and corporates to either reduce emissions that slows down rising global temperatures, or to adapt and protect economies from the inevitable impacts of climate change; and
5. Traditionally **higher allocations of Asian asset owners' investment portfolios to domestic** Asian markets relative to global markets.

1. PRESSURE FROM A LARGELY AGEING POPULATION IN ASIA

- **More people will draw from the pension pool than contribute to it:**
  - **the speed of the demographic transition** (lower birth and death rates, leading to an ageing population) in Asia is taking a quarter of the time that it took in Europe and North America;[5]
  - **the trend towards nuclear families** implies that more retirees will have to rely solely on their pensions;[6] and
  - **the slow pace of changing the statutory retirement age;** for example, in Japan retirement can begin at 60, which could result in ~45 years of retirement due to high life expectancy.[7]
- **US$230trn pensions shortfall for China, Japan & India by 2050**. A report by the World Economic Forum estimates that the total pension gap in China, Japan and India by 2050 will be over US$230trn, which is over twice the size of their predicted total GDP in 2050.[8]

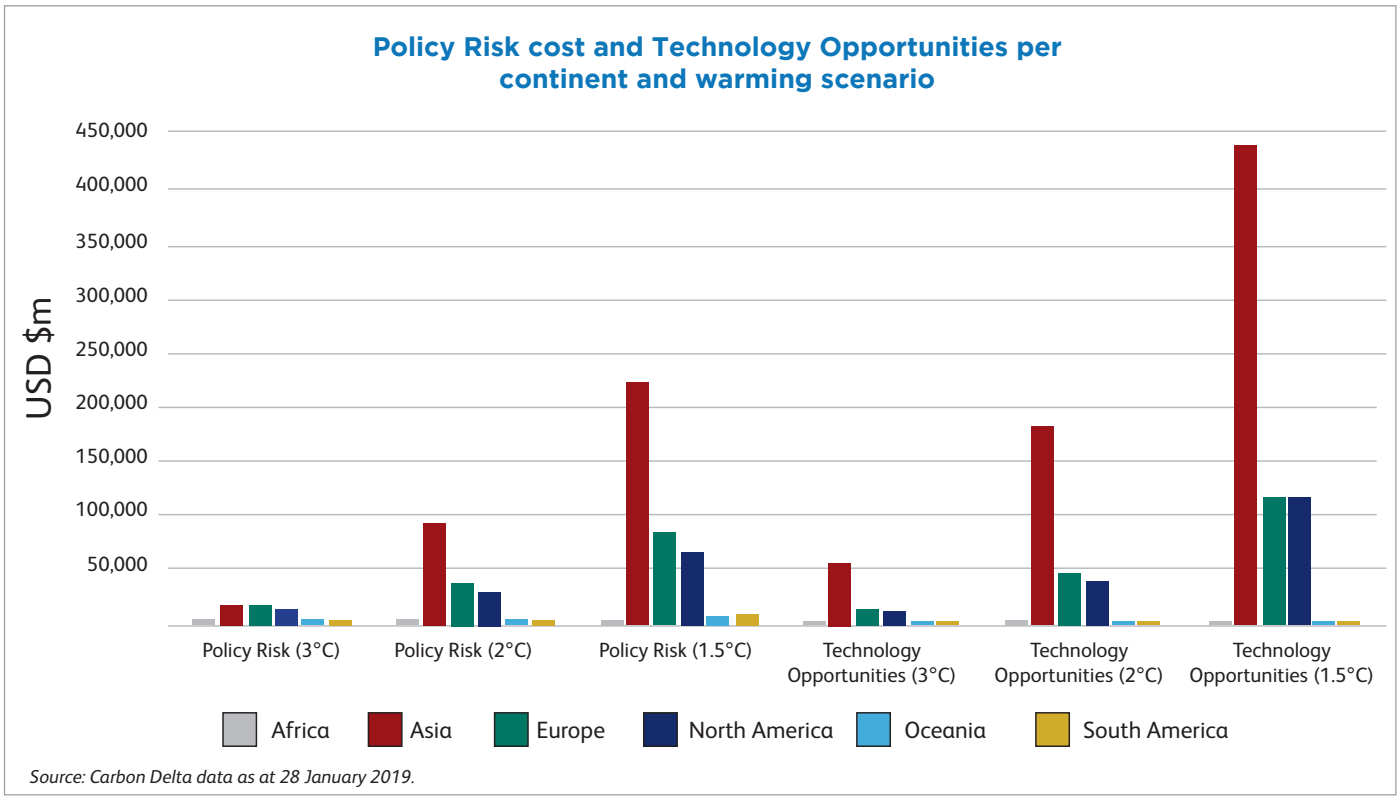
2. ASIA'S UNIQUE CLIMATE CHANGE CHALLENGE

In mid-2017, the Task Force on Climate-related Financial Disclosures (TCFD) released a taxonomy for defining and identifying climate-related risks and opportunities, which can be applied at the company level as well as to financial institutions and their investment portfolios. This taxonomy comprised:[9]

1. Transition risk (policy and technological disruption);
2. Physical risk (from chronic and extreme weather); and
3. Business opportunities driven by the transition to a low-carbon economy.

Applying this framework to the listed Asian companies on the MSCI All-Country World Index (as of 28 January 2019) with the aid of company-level analysis from the climate science firm Carbon Delta aided us to draw the following conclusions:

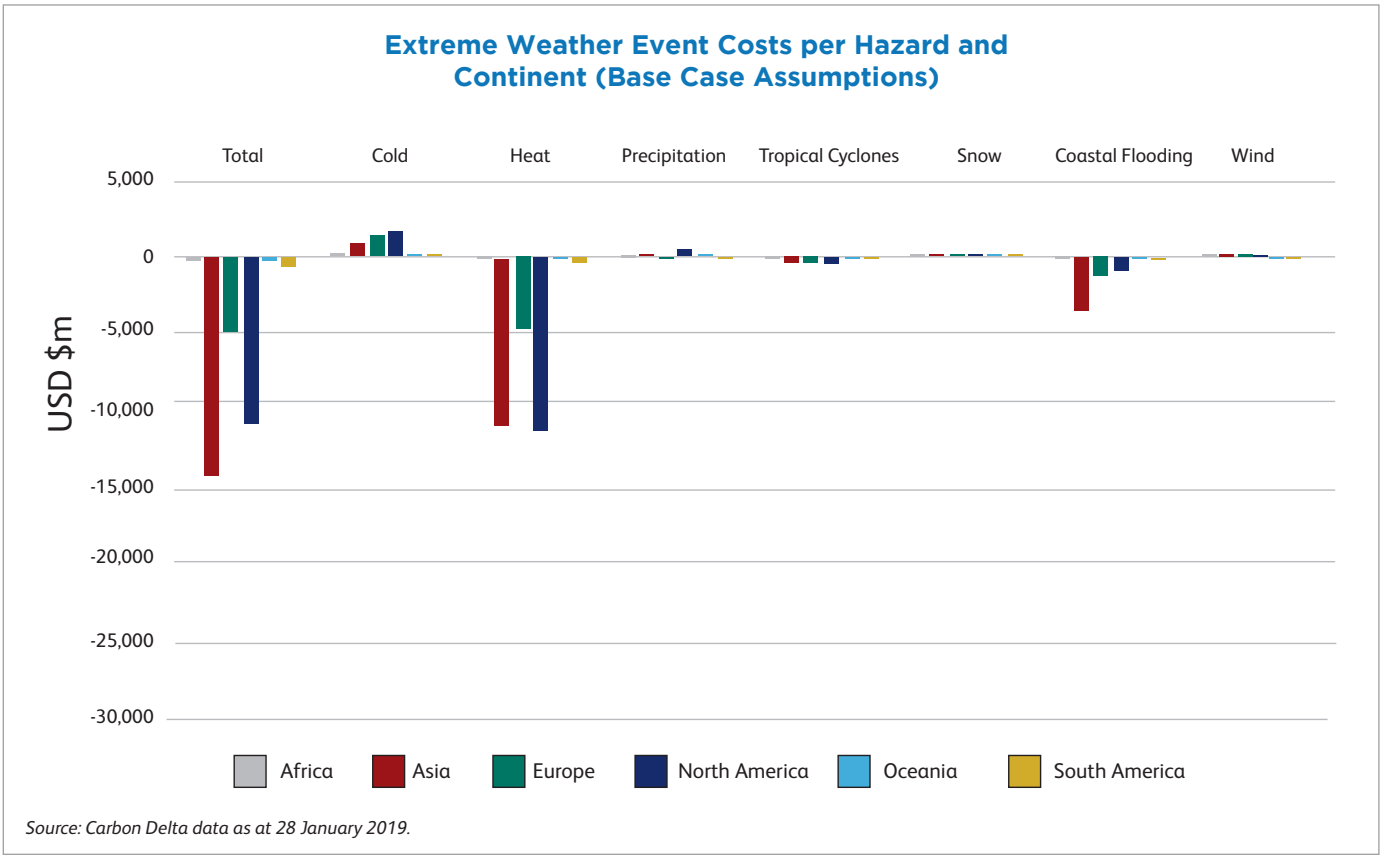
- **Asia faces most transition risk globally, but also faces the most opportunities.** Based on analysis of Scope 1 greenhouse gas emissions, policy changes associated with economic transition to either a 1.5°C, 2°C and 3°C average temperature rise scenario showed that Asian companies are more exposed than the rest of the world to transition (policy) risks. The aggregate annual losses exponentially increase between the 3°C and 1.5°C warming scenario, from US$16bn to $221bn. However, Asia also could offset these losses and enjoy the highest relative benefit from the necessary technology adaptation to a lower-carbon economy (as measured by low-carbon patents currently owned by all companies in the universe), estimated at U$181bn for 2°C and $440bn at a 1.5°C scenario – reflecting Asia's immense opportunity and potential early mover advantage:



Source: Carbon Delta data as at 28 January 2019.

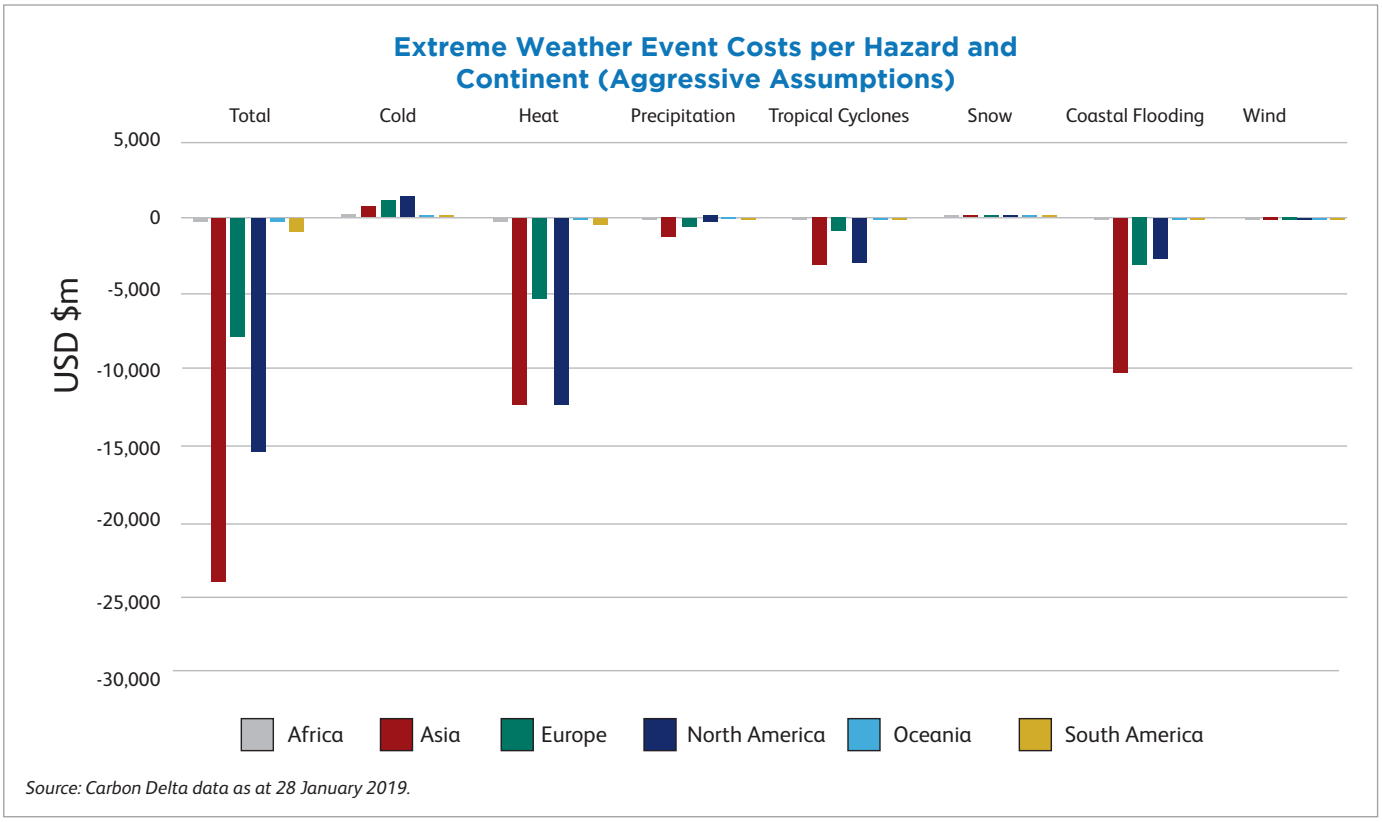
Figure 1

- **However, high costs from heat waves, cyclones and tropical flooding are already 'baked in', indicating an urgent need for Asian companies and governments to build resilience.** Despite the business opportunities story, the data also shows that Asia has the highest cost exposure of all regions globally to extreme weather, under either a base case or aggressive scenario of physical risks from climate change. This reflects the density of population, industrial production, and the high proportion of coastal areas in the region. The figures in the charts below represent annual projected costs by region and by hazard, according to Carbon Delta's physical risk methodology which looks at a 15-year time period.



Source: Carbon Delta data as at 28 January 2019.

Figure 2



Source: Carbon Delta data as at 28 January 2019.

Figure 3

3. THE CLIMATE-WATER NEXUS - ASIA FACES A TRIPLE THREAT

1. **Asia has limited water resources to develop.** Water is essential for economic growth across sectors, including agriculture, industry and power generation. The ADB estimates that by 2050, as demand for water rises by 30-40%, up to 3.4 billion people in Asia and the Pacific (APAC) will be living in water-stressed regions, which ADB warns is likely to constrain economic growth.[10] According to CWR, China and India do not have sufficient water to ensure food and energy security plus develop under the current export-led economic growth model.[2]

   To achieve a per capita GDP of over USD50,000, the US uses at least 1,543m^3 of water per person per year, which is only 16% of its total annual renewable water resources of 9,538m^3 per person. Yet China and India are only endowed with total annual renewable water resources of 2,018m^3 per person and 1,458m^3 per person, respectively.[2] Not only do their governments need to rethink economic and development models through a 'water-nomic' lens, it is also necessary for corporates and entrepreneurs to create a new paradigm of 'business unusual' to ensure continental Asia's water security.[2] This will bring about transitional and disruptive risks brought about by regulating for water scarcity.

2. **Significant systemic risk due to clustering in 10 major river basins.** A CWR report also highlights significant exposure to systemic risks in key river basins across Asia. Rivers are Asia's cradles of civilisation with much of its population and economy clustered there. Already today, material portions of half of the 10 major rivers in Asia are facing 'high' to 'extremely high' water stress, without even considering climate threats ahead.[2]

   The graphic on the following page illustrates such clustered risks. A population of 1.77 billion people across 16 countries reside in these 10 river basins and US$4trn of GDP is generated there each year. These 10 basins are also home to 280+ large cities, many of which are Asia's capitals and economic powerhouses.[2] Mega-cities here with more than 14 million people, include Delhi and Calcutta in India, Shanghai in China, Lahore in Pakistan, and Dhaka in Bangladesh.[2] This does not include large megacities in the rest of Asia outside these ten river basins, such as Tokyo, Osaka, Mumbai and Beijing, with over 18 million people. All of these cities are still growing.

   Rising urbanisation means more people are flocking to urban areas, putting more lives and assets at risk. For example, in the APAC region over 60% of the population is expected to be living in cities by 2050[8], and Asia is already home to some of the largest cities in the world.

3. **Climate change threatens these already scarce resources.** Beyond sea-level rise, storm surges and extreme weather such as floods and droughts, climate change also impacts water resources. The 10 major rivers discussed above, all flow from the Hindu Kush Himalayas (HKH), which, like the North and South Poles, is subject to climate change. The glacier and snow that melt from this "Third Pole" empties into these "10 HKH Rivers" (Amu Darya, Brahmaputra, Ganges, Indus, Irrawaddy, Mekong, Salween, Tarim, Yangtze and Yellow) and provide water to 16 countries in Asia (Afghanistan, Bangladesh, Bhutan, Cambodia, China, India, Kyrgyzstan, Laos, Myanmar, Nepal, Pakistan, Tajikistan, Thailand, Turkmenistan, Uzbekistan and Vietnam); these rivers sustain one in two and a half Asians across 16 countries.[2] Climate change can also affect monsoon patterns.

   CWR's report projects that four out of 10 HKH Rivers will see shrinkages in river flows in the next fifty years.[2] These projections, made by the Chinese Academy of Science, using five climate models, assume we stay within 2°C. Research published subsequently by the UNEP shows that we are now on track for 3°C[1], which means that the impact on river flows could be greater. There will also be increasingly frequent extreme weather events. All these compound the systemic risk due to clustering.

   As long-term investors, asset owners have a fiduciary duty to consider material risks and climate and water-related risks qualify as such. Therefore, asset owners can play a critical role by directing investments towards appropriate organisations and projects, and by engaging companies to ensure they are acting responsibly in the context of a future that will inevitably feel the impacts of climate change.

Figure 4

Asia's Water Challenge

1.77bn people and US$4.3trn of GDP at risk from just 10 river basins flowing through 16 countries in Asia

"Given significant exposure, it beggars belief that business and investment communities have yet to start assessing the exposure of their assets to basin water risk, let alone climate risks".

DEFINITIONS

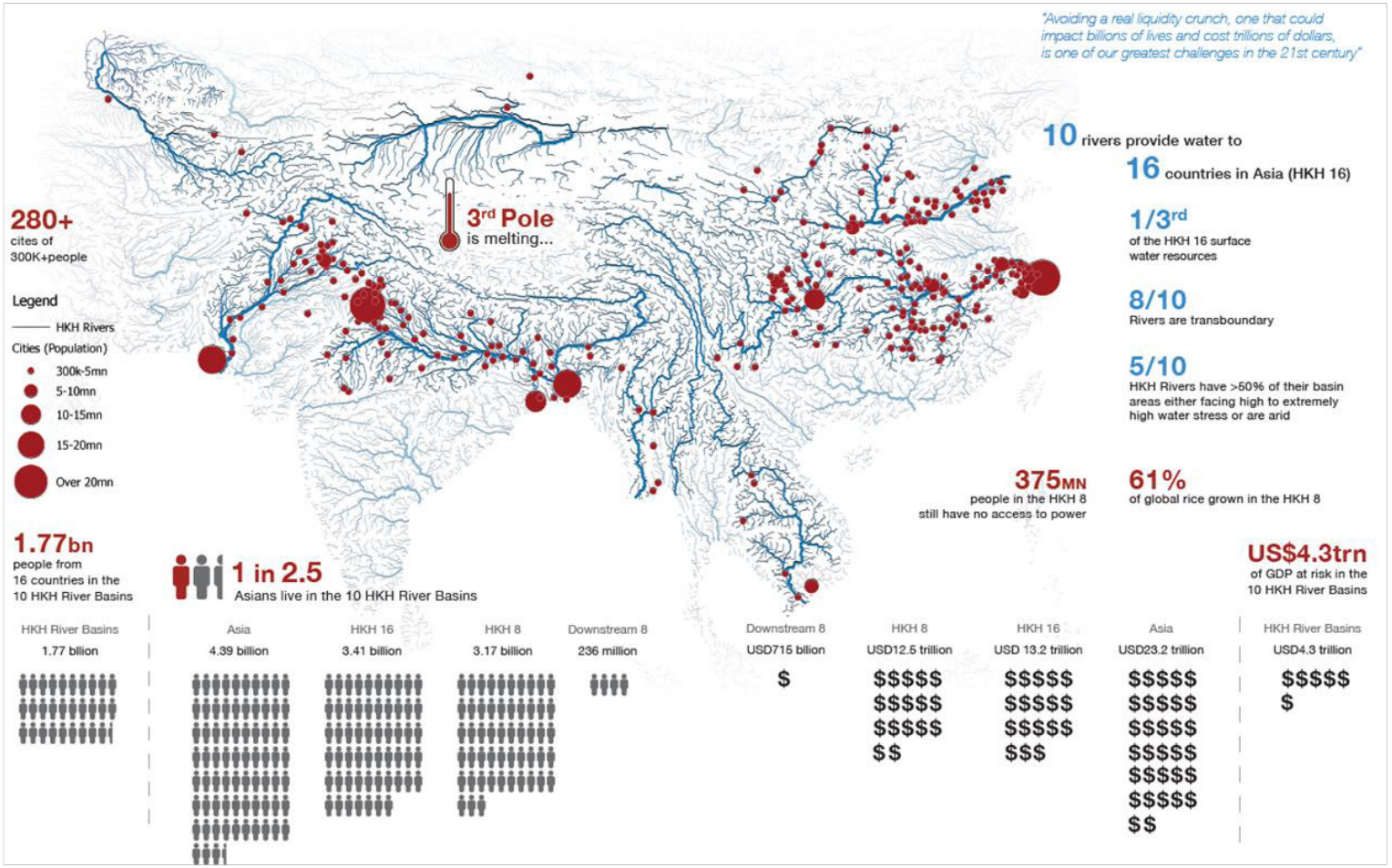
HKH / Third Pole – *The Hindu Kush- Himalayan (HKH) region is defined by ICIMOD and refers to a total area of >3.4 million km2 high mountains in Afghanistan, Bhutan, China, India, Myanmar, Nepal, and Pakistan.*

HKH River Basins *– the entire basin areas of the 10 major HKH Rivers*

HKH 8 *– refers to the 8 countries of Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal and Pakistan, where the HKH Region is located.*

Downstream 8 *– the 10 HKH rivers basins span beyond the HKH 8 into another 8 countries including Cambodia, Kyrgyzstan, Laos, Tajikistan, Thailand, Turkmenistan, Uzbekistan and Vietnam.*

HKH 16 *– collectively the 16 countries that are defined as* ***HKH 8*** *and* ***Downstream 8***



Source: CWR report "No Water, No Growth - Does Asia have enough water to develop?" 2018; Infographic © China Water Risk 2018, all rights reserved

Lives Are At Risk

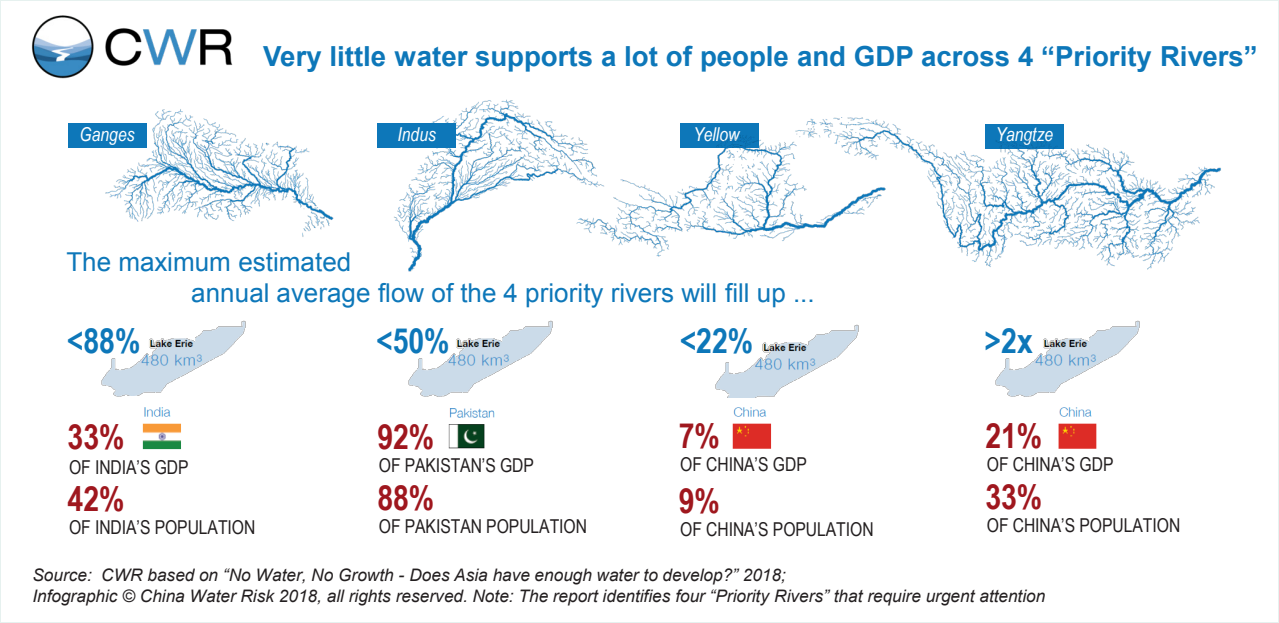


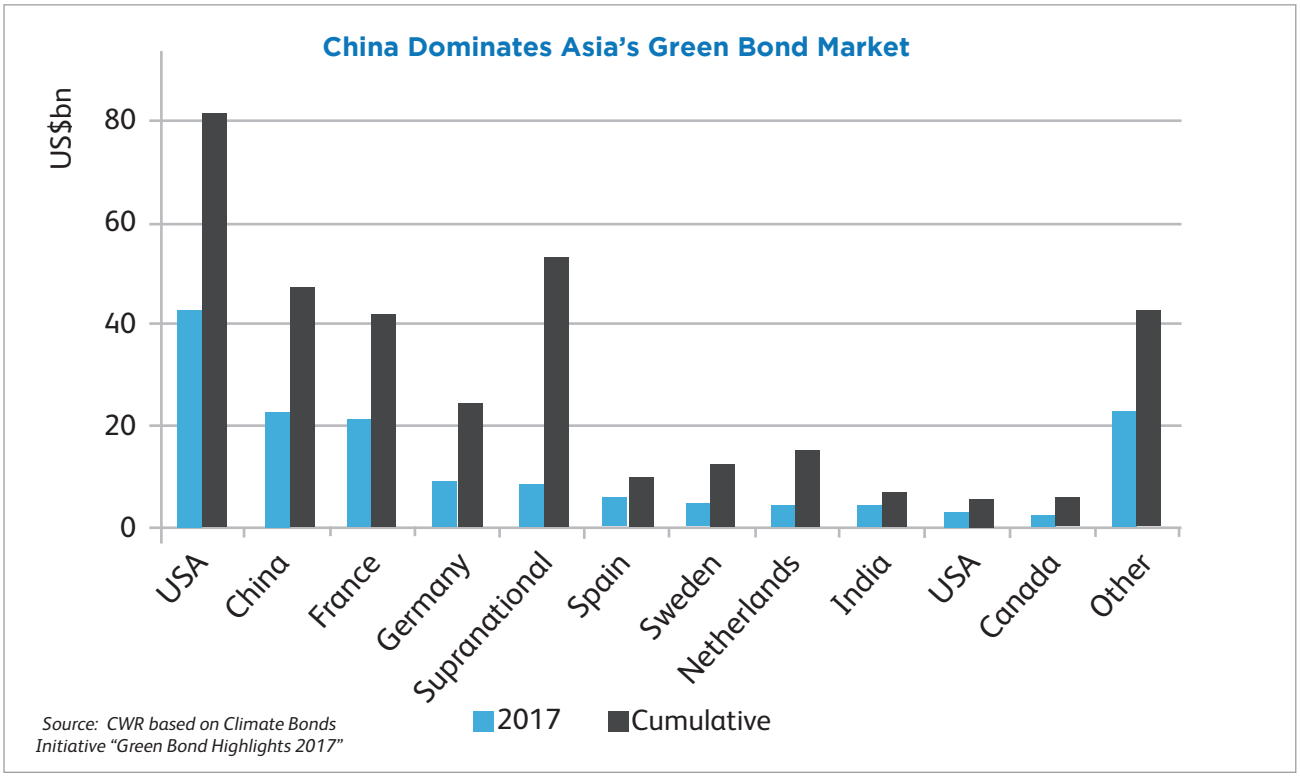
Figure 5

In addition to economic losses, climate change can also be detrimental to people's health and wellbeing. Rising urbanisation rates implies more people are moving to these areas; coupled with climate change this is putting more lives at risk:

- **Health:** More people will be exposed to frequent and intense extreme weather events such as floods and droughts, storm surges and typhoons that will disrupt their daily lives and cause fatalities. In addition, according to the WHO, malnutrition, malaria, diarrhoea and heat stress will cause ~250,000 additional deaths every year between 2030-2050. This is estimated to cost between US$2-4bn per year by 2030[11].
- **Migration:** The gradual and sudden changes brought on by climate change have already led to the movement of people within and across borders and this is expected to increase. The International Organization for Migration states that "future forecasts vary from 25 million to 1 billion environmental migrants by 2050, moving either within their countries or across borders, on a permanent or temporary basis, with 200 million being the most widely cited estimate. This figure equals the current estimate of international migrants worldwide."[12]
- **Resource constraints:** Water, food and land scarcity will become more acute due to climate change impacting these resources and population growth, especially in urban areas, causing demand to outstrip supply. We have already started to see this with water scarcity in India and China and this will continue to worsen if no action is taken.
- **Low income communities most vulnerable:** Climate change is a risk to the rich and poor alike; however, the poor will be impacted disproportionately more—for example, due to the asymmetric flow of information, lack of insurance and increasing food prices due to supply issues. According to the World Bank, "*without rapid, inclusive and climate-smart development, together with emissions-reductions efforts that protect the poor, there could be more than 100 million additional people in poverty by 2030.*"[13]

4. CLIMATE FINANCE FALLS SHORT

- **Significant investment is required** to ensure Asian economies are climate resilient. Climate finance refers to public and private financing at a local, national or transnational level that seeks to take actions to address climate change. [14]
  It is two-pronged:
  - **Mitigation** – addressing the root causes of climate change by reducing greenhouse gas emissions, e.g. renewable energy investments.
  - **Adaptation** – reducing the vulnerability of economies to the inevitable impacts of climate change, e.g. infrastructure to protect against sea-level rise; improving the quality of road surfaces to withstand high temperatures.
- **There are clear finance shortfalls – US$15bn vs US$7trn.** From 2003-2017 US$15bn was raised globally for climate investment, yet according to OECD estimates, by 2030 we will need up to US$6.9trn in infrastructure investments annually.[15] Getting to this amount will require action from both the public and private sectors.
- Adaptation investment is just as important as mitigation in a 3°C world. The 2018 UNEP Emissions Gap Report also warns that current nationally stated mitigation ambitions until 2030 need to be *"roughly tripled for the 2°C scenario and increased around fivefold for the 1.5°C scenario"*.[1] If this is not achieved, we are headed towards 3°C of global warming and irreversible "trigger points" such as disappearing glaciers are projected, making investment in adaptation solutions more urgent. (Please see Appendix I – The Water-Energy-Climate-Nexus for more information)
- **Yet 92% of climate finance doesn't protect assets.** According to Climate Policy Institute's 2017 data, climate investment and lending has been skewed towards mitigation (92% in 2016). However, without adaptation, all of these assets are at risk.[4] In Asia, for adaptation alone, ADB estimates that the region requires at least US$40bn annually by 2050.[16]
- **Need a galvanised green finance sector – China is ahead of the curve.** Currently, global and regional development organisations play a central role; however, public finance alone is insufficient. Therefore, private funding and green finance innovations must bridge the gap. China is ahead of the curve in rallying its financial markets towards green finance as it recognises that it has limited water resources and is already water-stressed. However, the rest of Asia is far behind.



Source: CWR based on Climate Bonds Initiative "Green Bond Highlights 2017"

Figure 6

5. ASIAN ASSET OWNERS FURTHER EXPOSED DUE TO THEIR DOMESTIC INVESTMENT SKEW

- **Systemic risk is compounded as a large proportion of asset owners' funds tend to be concentrated in their domestic markets.** We researched the asset allocation of 30 large public pension funds, sovereign wealth funds, and/or central banks in China, Hong Kong, India, Indonesia, Japan, Malaysia, the Philippines, Singapore, South Korea, Taiwan, Thailand and Vietnam – all of which play a critical long-term role in their markets to provide pensions and a default social security system. While the disclosure rate of investment allocations was weak at 50% of the institutions (either by asset class and geography), the disclosure that was available suggested a notable skew towards domestic investing, with an average of 64% of AUM in domestic markets. Some institutions show a domestic allocation as high as 80%-100%.
- **Diversification into global investments may not be available.** Several valid reasons may underpin Asian asset owners' domestic orientation – for example, regulatory requirements, familiarity of decision makers with their domestic capital markets, or the need to anchor country-based markets that could otherwise be volatile as liquid investments flow in and out. In the case of some pension funds, we estimate that the ratio of their domestic investments to country GDP could be as high as 25%-45%. Where these asset owners cannot easily diversify their asset mix, the long-term risk profile of their portfolios remains uniquely tied to the particular exposure of Asian economies and companies to climate change impacts.
- **Asian asset owners are showing increasing commitment to ESG; however implementation and disclosure is not yet the norm.** Of the 30 institutions reviewed, the majority disclosed no information about awareness of ESG/climate risks to their investments. Only four described ESG policies or investment principles (usually the actual policies remain undisclosed); eight described actions indicating that some level of ESG integration is occurring in investment processes or in fund manager selection, although how systematic this is remains in question; and eight have made or announced intention to make an allocation to an ESG-themed investment fund solution. On the latter, we note that some allocations have been to ESG index-based funds which will tend to favour a best-in-class company selection methodology, rather than a methodology that is adjusted for absolute locational climate and water risks. While we recognise that lack of disclosure does not necessarily equate to a lack of action or concern, Asian asset owners could catalyse much more rapid action in the capital markets if disclosure of ESG policies and systematic procedures was the norm.
- **Incorporating ESG factors into valuations is still not the norm.** When CWR surveyed 70+ investors to provide feedback regarding various water risk valuation methodologies used on 10 listed Chinese corporates in two sectors, 45% said they were doing the survey because they wanted to embed water risk in their discounted cash flow valuations, and yet only 0-4% admitted to using the tools available to assess water risks regularly.[17] Building consensus toward water risk valuation is an important step to sizing risk exposure.

PORTFOLIOS ARE AT RISK

Multiple inter-linked and disruptive risks clearly lie ahead in Asia. These present material risks to portfolios, but the likelihood of being blindsided is high as such risks are not obvious in company financial statements today, and popular awareness remains low in the business and investor community.

The chart below sets out various aspects of this web of inter-linked risks from the physical risk aspects of the 'triple threat' as well as policy risk from government regulations to ensure water and economic security (water-nomics). For example, finding a national road map to more GDP on less water and pollution in China has led it to pursue an "ecological civilisation" which has implications for resource use and pollution practices.[18] This has global repercussions. Asset owners need to understand such complexities in order to ensure portfolios are resilient and to take advantage of the transition, as opportunities are significant.

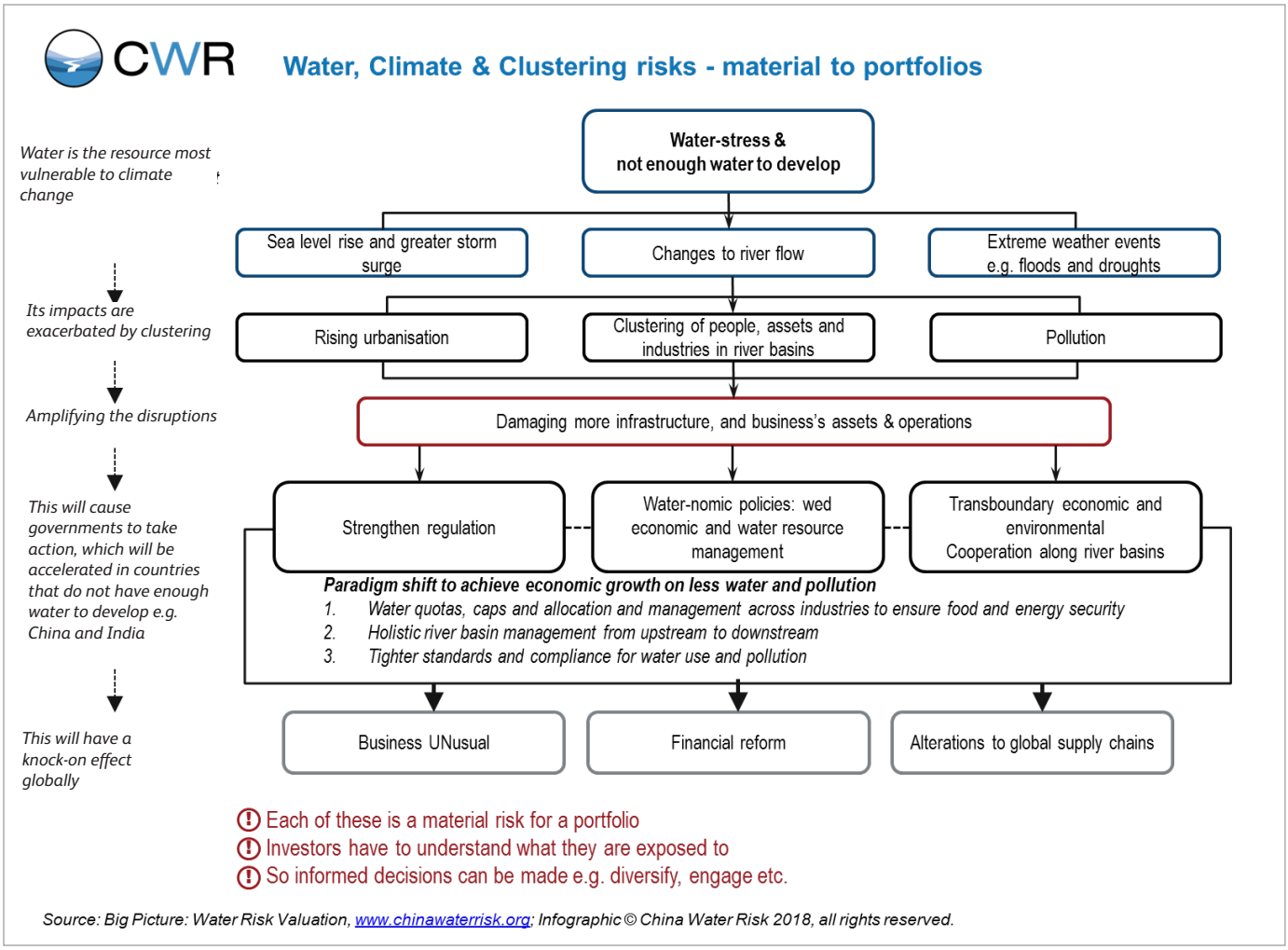


Figure 7

Set out in the following pages are some key interconnected and underlying risks that we recommend asset owners consider. It should be noted that these examples are not exhaustive; they merely aim to illustrate that asset owners need to understand the direct and indirect impacts of climate change.

- Logistics disruptions from rising sea levels and storms urge;
- Increasing risks from extreme weather events;
- Material and imminent regulatory risk triggered by water-nomic policies;
- Global trade and supply chain disruptions; and
- Magnitude of risks warrant investment policy revamp and financial reform

1. LOGISTICS DISRUPTION FROM RISING SEA LEVELS AND STORM SURGE

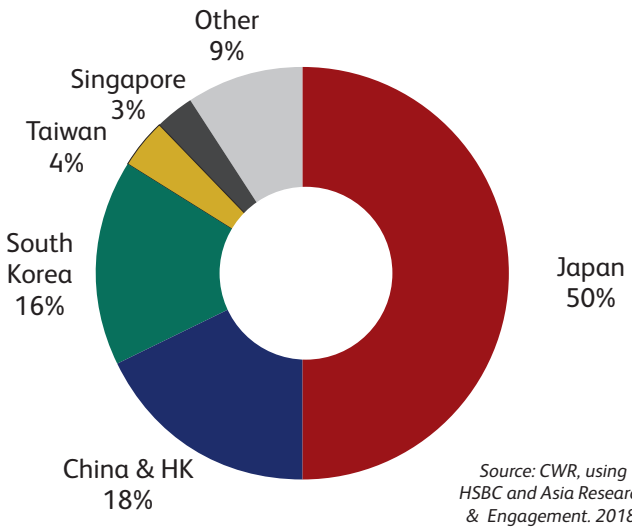
Key concerns

Storm surges already reaching unprecedented levels. IPCC estimates that global sea level rise will reach 0.34m to 0.63m by 2100 in the scenario where global temperatures increase by 1.5-2°C relative to the average from1850-1900 (RCP4.5). In the worse-case scenario of RCP 8.5, this will be 0.45m to 0.82m by 2100.[19] However, with more frequent and intense typhoons and cyclones predicted, storm surges will be much higher; for example, it reached an unprecedented 4.7m in Hong Kong during Typhoon Mangkhut in 2018, 6.5x the average sea level rise projected for Hong Kong of 0.74m under RCP4.5 by 2100.[20,21]

- **US$28bn to US$47bn to adapt for ports.** Nine of the top ten ports globally, in terms of capacity, are in Asia.[22] Ports have been key to Asia's export-led economic growth, but they will be negatively affected by sea level rise and storm surge. A recent report by HSBC highlights the significant investment necessary to adapt ports in 10 countries in Asia.[23]

- **Half of this cost will be borne by Japan; Nagoya, Japan's biggest export hub, is most at risk.** Japan's costs are estimated at between US$14bn to US$23bn due to higher labour and material costs, and the requirement to elevate and/or move a large proportion of buildings and warehousing compared to others. Worryingly, Japan's port in Nagoya, which is the country's biggest export centre among its seaports and airports, has been identified as the most at risk globally due to potential losses from natural disasters.[24, 25]

Half of port adaptation costs in Asia borne by Japan



Source: CWR, using HSBC and Asia Research & Engagement. 2018. Climate Costs for Asia Pacific Ports

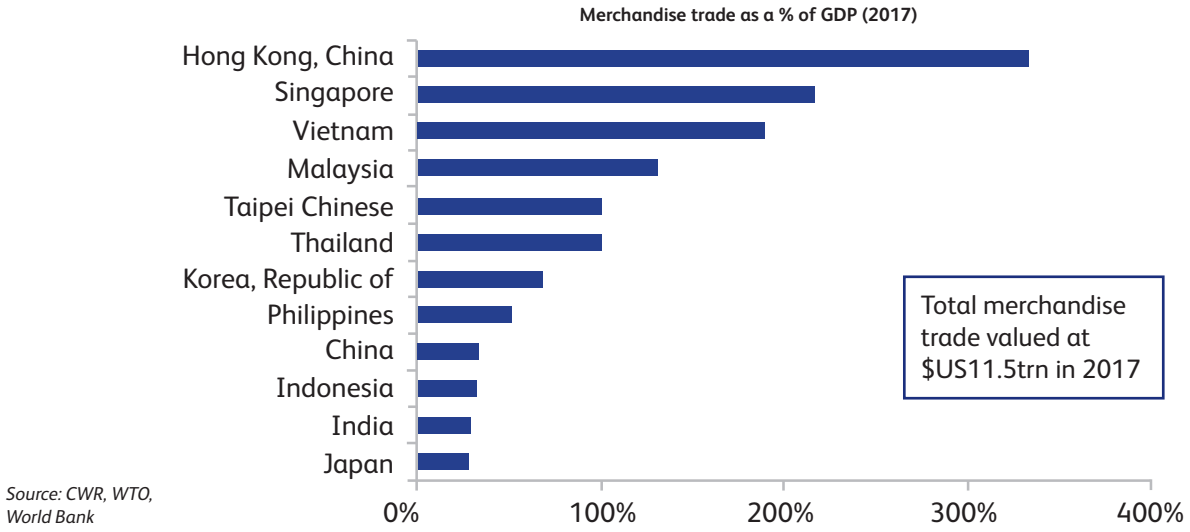
Figure 8

- **Potential material impact to 25% of GDP: global trade disruptions.** In 2016, merchandise trade was 25% of Japan's GDP, therefore an impact on airports and seaports would have severe repercussions domestically and globally – out of Japan's 10 largest export partners, seven are based in Asia, and China is its largest trading partner to whom 19% of exports are sold and where 24% of imports originate.[26]

Impact on capital markets

- **US$11.5trn of trade in Asia is vulnerable:** Rising sea levels and greater storm surges can lead to physical damage and reduce landmass, but they can also disrupt trade, supply chains and business operations, and thus capital markets. Importantly:
  - 90% of merchandise trade is moved through sea ports;[27, 28]
  - As the chart below highlights, Asia is highly reliant on this trade; and
  - Asian capital markets are highly correlated with export-heavy industries; companies that rely on exports have global supply chains that can be disrupted.

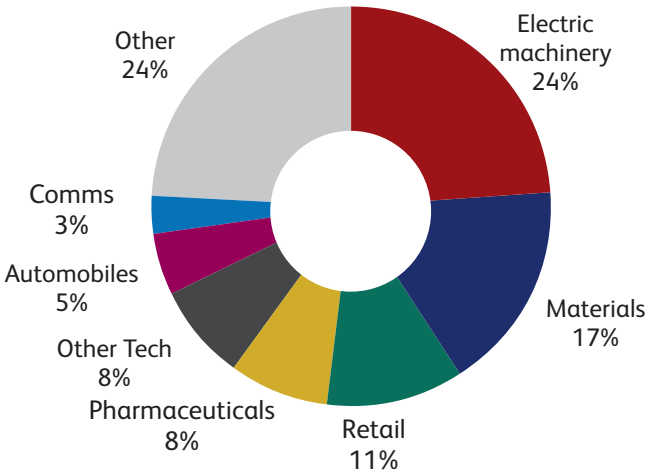
Asian economies are highly reliant on trade



Source: CWR, WTO, World Bank

Figure 9

Nikkei 225 heavily weighted towards industries that would be affected by port disruptions



Source: CWR, Nikkei Index, March 2019

Figure 10

- **Japan still vulnerable; ~30% of Nikkei 225 likely affected by port disruptions**: When compared with the rest of Asia, the impact of a port disruption looks minor in Japan. However, markets will still feel severe pressure due to the high correlation between capital markets and export industries as:
  - ~35% of Japan's GDP is made up of manufacturing and retail trade;[29]
  - ~57% of Japan's main exports are vehicles, machinery and electricals, the majority of which would be transported via ports;[30] and
  - ~30% of the Nikkei 225 is weighted towards these sectors[31]

For more on trade disruptions please see Risk 3.

Airports exposed: sea level rise, heat and too much rain preventing take off

Airports are the gateway for international tourism, business and trade. But they are also at risk because, surprisingly, a number of airports in Asia are built in low-lying areas that could easily be impacted by rising sea levels and storm surges. This includes Sendai and Nagasaki airports in Japan, and Busan airport in South Korea, which are all at less than 2.5m above sea level and are at a short distance from the seafront. In addition, airports are also affected by extreme weather events, which can cause high speed winds or make the runway too hot or too wet, which leads to safety issues for landing or departing flights. Some examples include:

- Typhoon Jebi in 2018 flooded a terminal building and runway in Kansai Airport in Japan, forcing the airport to shutdown for three days and to close one runway for 10 days. Passengers and staff were also left stranded due to damaged roads.[32]
- Typhoon Mangkhut in 2018 caused the Hong Kong airport to ground to a halt, with more than 543 flights cancelled, affecting about 96,000 passengers.[33]

2. INCREASING RISKS FROM EXTREME WEATHER EVENTS AFFECTING DENSE AREAS

Key concerns

- **Extreme weather events are on the rise and are more damaging:** The chart below highlights how extreme weather events are causing more economic damage in Asia. From 1970-2013, natural disasters led to almost US$160bn in economic losses in the APAC, almost 50% of which occurred in the last three years of this period; ~40% of this was from floods and droughts.

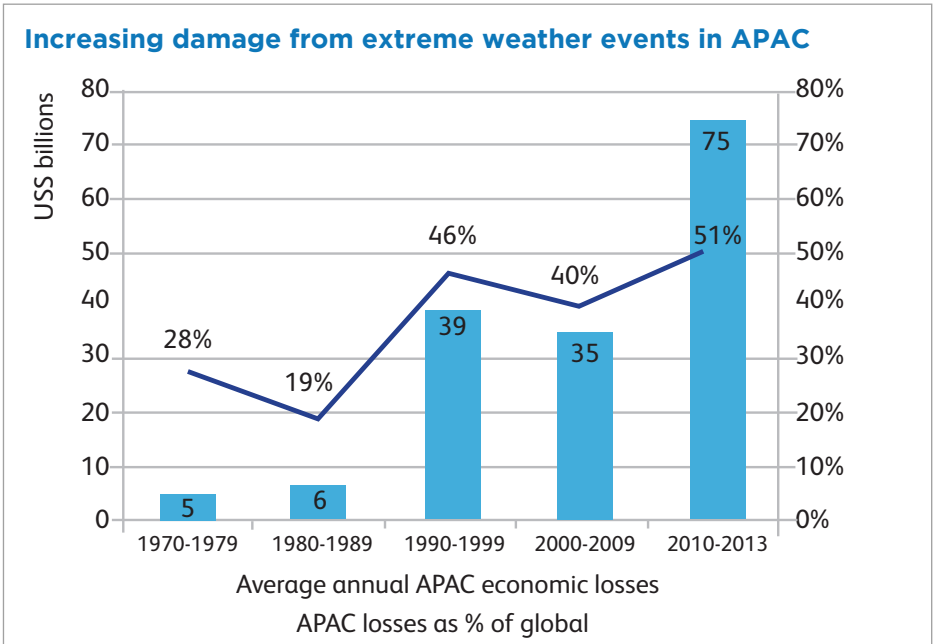


Figure 11

- **Urbanisation rates are on the rise in Asia, so more is at risk.** Many Asian cities have been built along river basins. As the clustered nature of civilisation attracts more people and business to these already densely populated areas, these cities will become more vulnerable. For example, India's current urbanisation rate stands at 33% and it is expected to reach 53% by 2050. CWR's report *"No Water, No Growth"* cautions that a large percentage of the Ganges is water stressed, yet it already supports a significant proportion of India's GDP and its population; therefore, with increasing urbanisation, much more will be at risk by 2050.[2]

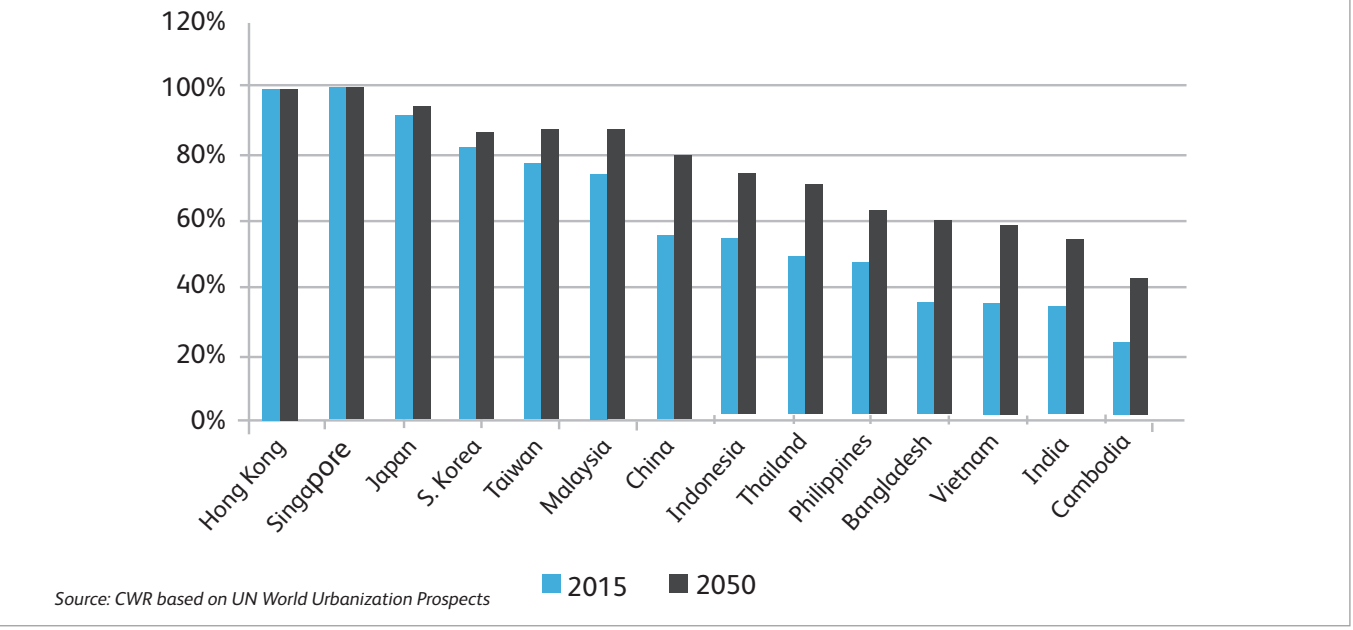


Figure 12

- **Rising frequency of extreme weather events + urbanisation = double whammy for clustered assets:** Rising urbanisation has led to the increased clustering of assets along river basins, making them more exposed to more frequent extreme weather events. CWR's report "*No Water, No Growth*" highlights this rising clustered risk: *"Rising urbanisation adds further pressure on basin water resources as people flock to the 280+ major cities (including capitals) located in the 10 HKH River Basins. Such "clustering" also increases exposure to climate change in the form of 1) changes in river flows as well as 2) extreme weather events such as floods and droughts."*

- **13 of the top 20 cities with the largest growth of annual coastal flood losses from 2005-2050 will be in Asia.** A study in 2013 reported that without adaptation investment, annually US$1trn would be at stake globally by 2050; and over US$30bn of this will be from the 13 cities in Asia that are most at risk.[34] As four of these 13 cities are financial centres (Shenzhen, Bangkok, Ho Chi Minh City and Jakarta) and home to key stock exchanges in the region, the cost of the potential damage could be higher than estimated.

Guangzhou, China (rank #1)
Mumbai, India (#2)
Kolkata, India (#3)
Shenzhen, China (#5)
Tianjin, China (#7)
Ho Chi Minh City, Vietnam (#9)
Jakarta, Indonesia (#11)
Chennai, India (#13)
Surat, India (#14)
Zhanjiang, China (#15)
Bangkok, Thailand (#18)
Xiamen, China (#19)
Nagoya, Japan (#20)

Examples of impact on capital markets

- **Credit ratings can be downgraded.** Not only can climate change cause physical damage, it can also lead to a downgrade by ratings agencies. For example, S&P has stated that between 2015 and 2017 environmental and climate information affected 717 cases (~10% of corporate ratings assessments) and resulted in a ratings impact (an upgrade, downgrade, outlook revision, or CreditWatch placement) in 106 cases.[35] *See Risk 5 for more detail on factoring these into credit policies.*

- **Extreme weather events in India in 2016 led to US$21bn in losses** due to a mixture of heatwaves, extreme monsoons and landslides. The World Bank estimates climate change could cost India 2.8% of its GDP by 2050.[36]

- **In 2018 authorities closed all of Macau's casinos for the first time in history** due to Typhoon Mangkhut. This led to ~US$186mn of losses and the Bloomberg Intelligence index for Macau casinos fell as much as 2.1% in early Monday trading.[37]

- **Thai floods in 2011 caused US$34bn of losses for one clustered sector, causing the Index to dip by 24%.** The floods affected automotive and electronics manufacturers, which led exports to fall by ~US$7.9bn and the manufacturing sector suffered US$34bn of losses.[38] This caused the Thai SET Total Return Index to fall by 24% two months after the start of the floods.[39] Due to the significance of the manufacturers affected in the floods, multiple international companies were also affected, with global digital camera companies losing market value.[40]

- **Global commodity and supply chain impacts: ~20-25% of U.S. refining capacity and U.S. crude oil prices were affected** due to Hurricane Harvey's impact on Houston's clustered petrochemical industry.[41] Given Asia's exposure to climate-induced extreme weather,this region could be up next for a Harvey-like event. Investors need to be aware of the economic losses associated with these events on a global scale.

3. MATERIAL AND IMMINENT REGULATORY RISK TRIGGERED BY WATER-NOMIC POLICIES

Key concern

- **Not enough water to develop = business unusual.** As highlighted by CWR's "*No Water, No Growth*" report, India and China, the world's most populous countries, do not have enough water to grow under the current export-led economic growth model,whilst simultaneously ensuring food and energy security. A paradigm shift is necessary to achieve more GDP growth based on less water and pollution.
- Governments are already taking actions to implement' water-nomics':

China

- **Paradigm shift to more GDP based on less water and pollution has started** with the march towards a Beautiful China[42] that includes a green and high-tech future and circular economy plans for 10 industries plus plans to use trade to manage water resources, by importing more water-intensive goods, instead of exporting them (Please refer to Appendix II – Basic Water-nomics for more detail). This rebalancing of the economy and the environment was further reiterated this year when China enshrined its mission to build an 'ecological civilisation' into its constitution. This is all part of its water-nomic roadmap to more GDP based on less water and pollution.
- **Water caps and quotas limit GDP growth:** Concerns over water demand outstripping supply had already led the Chinese government to set caps on its national water use as early as 2011 for the 12th and 13th Five Year Plan as well as for 2030. These caps limited GDP growth to no more than 5.7% between 2020 and 2030 unless the environmental targets were surpassed.[43]
- **War on pollution and more stringent standards:** the tighter pollution standards plus new tougher environmental laws have meant that enforcement is on the rise. Companies now face material fines and in some cases have been shutdown. The PBOC has also pushed Chinese banks to start stress testing their loan books for compliance to these new standards (see impacts for the fashion industry below).
- Water-nomics means trade-offs and competition for water ahead as local and provincial governments decide which industries they keep or restrict in order to meet their environmental and GDP targets. Investors ranked this to be the #1 risk that they are most worried about, ranking it higher than physical risks:[17]

Investors concerned about regulatory risks

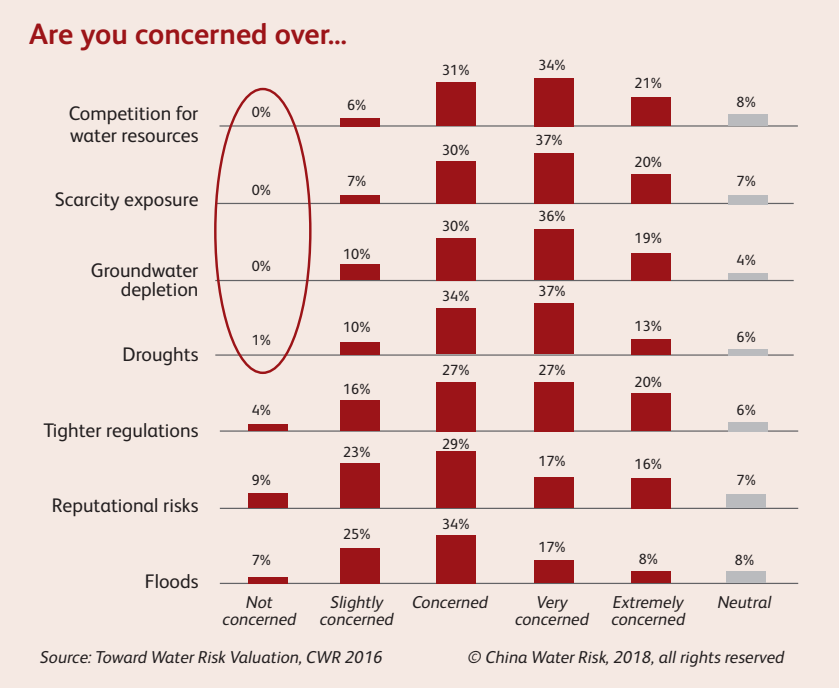


Figure 13

India:

- **Government acknowledges water crisis.** India is at an earlier stage in this journey vis-à-vis China. India's federal policy think tank NITI Aayog, chaired by India's Prime Minister, acknowledges that India's water demand will be double its supply by 2030, causing a ~6% loss in GDP, in its recent Composite Index Water Management Report.[44]
- **New policies to tackle excess water use and pollution.** Water is governed by the state and groundwater rights allowed unrestricted water use and pollution. Therefore, since 2014 India has implemented some policy changes, including:
  - Centralising river authorities to manage the whole river;
  - Limiting water use through a new bill put forward for ground water to be held in public trust, so that water use can be managed and monitored; and
  - Partnering with Israel to learn from its experience, where water rights are governed centrally and receipt of water is granted based on purpose, allowing the government to control sectors from over-using water. [45, 46]
- **Future stringent policies expected; could limit access to water and affect the bottom line.** NITI Aayog's Three Year Action Plan (2017-2020) advocates for: [47]
  - **More control over entire river basin:** independent regulator to control water use and pricing; and an authority to manage interstate river basins; and
  - **Limiting water use and pollution by industries and companies:** Establish a water use benchmark in water-intensive industries and recycling rules.

Impact on capital markets

- **Material impact of regulations will change current business models.** These types of regulations can be highly disruptive and costly due to the CAPEX and OPEX outlay to adhere to policies. These CAPEX requirements are for both improving water use efficiencies as well as meeting the more stringent pollution standards. These costs can be punitive for industries with low margins and lead to shutdowns or consolidation of smaller players. Indeed, investors surveyed by CWR view regulatory risk to be tangible, material and immediate, with 73% of those surveyed viewing cost of compliance to tighter regulations as material.[17] Note that these investments do not adapt assets to protect against water and climate risks.
- **The end of dirty-thirsty-fast fashion:** The textile sector is one of the most targeted in China's "Water-Ten" plan as it was amongst the top 3 most water-intensive and water-polluting industries.[48] In 2015, CWR-CLSA predicted that this would eventually lead to the shutdown of 90% of textile factories.[49] More recently, CWR's report *"Insights From China's Textile Manufacturers: Gaps to overcome for clean & circular fashion"*, surveyed 85 textile manufacturers to learn about the impact. This report found:[50]
  - 14% said they face shutdown risk;
  - 74% have felt more pressure from regulations over the last two years;
  - over 50% made significant CAPEX investments of more than RMB2 million(~US$300,000) to upgrade their factories; and
  - More worryingly, 33% say operating costs rose by more than 20% to 60-80%. [50]

  These rates threaten the future of cheap and fast fashion.[49]

4. GLOBAL TRADE AND SUPPLY CHAIN DISRUPTIONS

Key concerns

- **As China and India shift their export-led growth model, supply chain disruptions are inevitable.** As the previous section 3 explained, China is already changing its future trade trajectory in light of its limited water resources – it is optimising its economic mix, and crop and industrial mix through its Beautiful China policies, plus circular economy plans for 10 industries as well as trade initiatives (Please see Appendix II – Basic Water-nomics for more on G20 virtual water trade)
  - **India is in a more precarious position:** it has less water resources per capita and the graph in the previous page highlights that it is importing even less water. Thus, it will have to follow suit.
  - **Multiple disruptions locally and globally imminent** as India and China shift away from exporting water-intensive goods towards importing more water-intensive goods. China is already taking action; this risk is more imminent than most realise.
- **South Korea and Japan likely to face the most transitional risk**. South Korea and Japan "use other people's water" through trade. They "outsource" some of their water use by importing water-intensive goods which means their external water footprint is 78% and 77% respectively. Comparatively, China and India use their own water (internal water footprint is 90% and 97% respectively) to drive export-led economic growth. As China tackles this, South Korea and Japan's supply chain could be affected as they are recipients of China's exports. (Please see Appendix II – Basic Water- Water-nomics for more on G20 virtual water trade).
- **Critical Raw Materials (CRM)** – even small amounts traded matter: China supplies the world with a significant portion of key CRMs, including rare earth elements (REE), which are vital for the high-tech industry.[51] The extraction of these ores is highly polluting and given that China is fighting a war on pollution, it is clamping down on illegal mining and polluting enterprises, especially along its key rivers. For example:
  - **Toxic Rare Earths:** Mining 1kg of REEs can produce up to 1.4kg of radioactive waste. This means that the 212 million iPhones Apple sold in 2016 could have produced 71 tonnes of radioactive waste – which is more than half of the UK's radioactive waste stockpile. With no responsible sourcing platform for rare earths, Apple can neither confirm nor deny this.[52]
  - **CRM production in Xi's focus region for green deve**lopment: The Yangtze River Economic Belt (YREB) accounts for 78% and 84% of China's tungsten and antimony production, both CRMs. However, the YREB is also President Xi's focus region for green development and the War on Pollution.[53]
  - **Pollution crackdown can drive global CRM prices:** Antimony prices rose sharply in 2009-2011, almost tripling to US$14,300/t due to the shutdown of >100 illegal mines and processing facilities in Lengshuijiang. This remote area of Hunan province is part of the YREB and produces around 60% of global supplies.[53]

Rare earth black market is an open dirty secret.

REEs have a dirty, polluting and toxic supply chain, which is made worse by a sizable black market. The black market has meant that REE prices are kept low, as the extra supply it offers avoids taxes, environmental costs and other related operational costs. These artificially low prices make new mines outside of China economically difficult.

Leading technology brands are complicit as there is currently no responsible sourcing platform and traceability system in place for these minerals. In addition, these brands are using more REEs instead of less; for example, the iPhone produced in 2012 had 9 REEs whereas the iPhone 6 from 2016 had 16 REEs. Therefore, commitments made by these large brands for black market free raw materials cannot be verified. That being said, Apple is leading the way by committing to end REE mining, but concrete plans are still lacking.[52,53]

- **Global supply will be constrained.** China is cleaning up, many of these CRMs have no/poor substitutes, and China needs more for its domestic industry. China has capped REE production at 140,000 tonnes by 2020 under the 13th Five Year Plan, and is projected to require 140,000-168,000 tonnes of REEs for domestic production by 2020.
- **Who is going to supply the rest of the world?** China supplied the rest of the world with 51,199 tonnes of REEs in 2017 (52,610 forecast).[53] Japan, USA, Germany and South Korea are leaders in global high and clean tech; as the top importers of REEs from China, they are at risk of losing their supply by 2020.

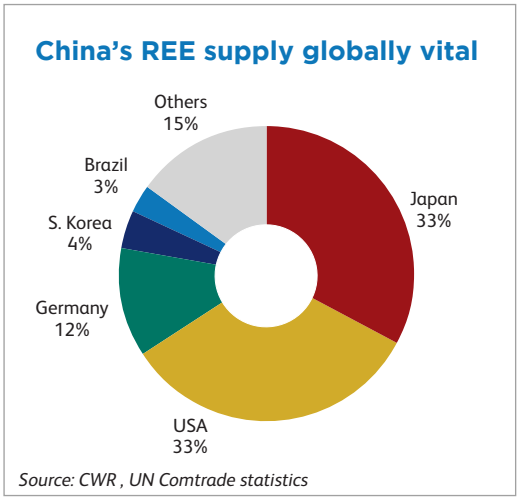


Figure 13

Impact on capital markets

- **Alterations to just one product's supply chain can have significant repercussions:** as high-tech sectors are the largest components of indexes in Asia, future changes to the REE supply chain and REE prices could have significant ramifications.

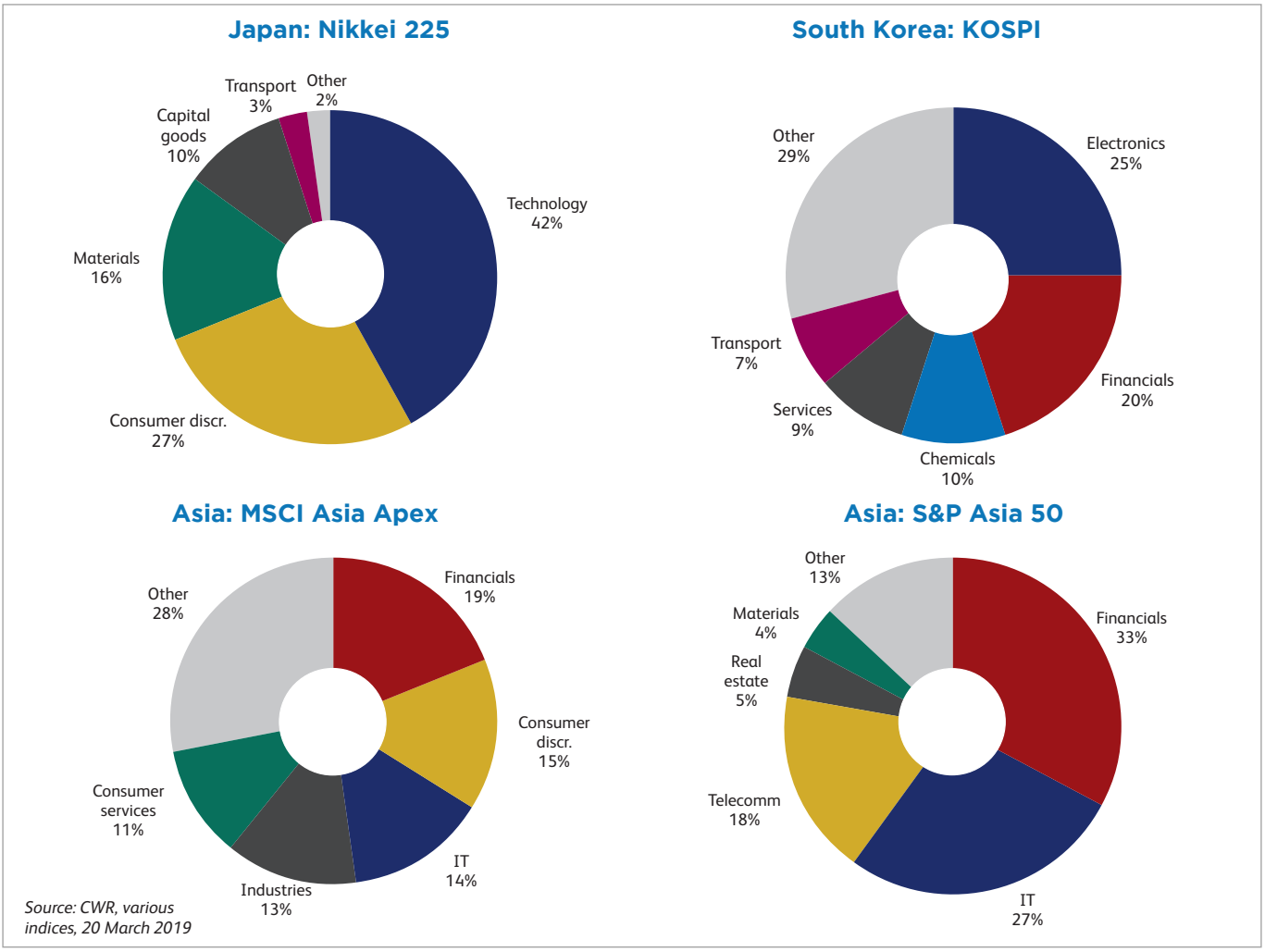
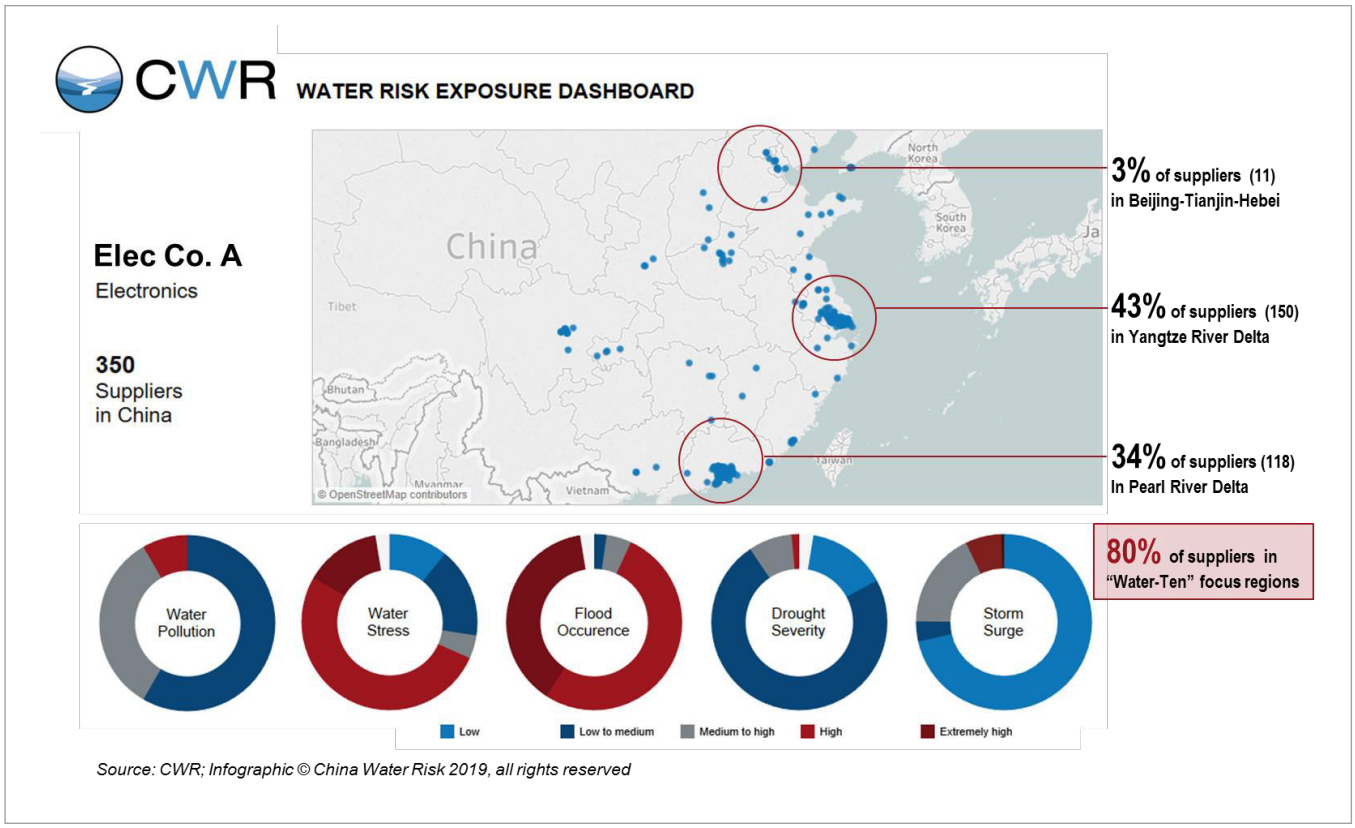


Figure 14

5. ASIAN BANKS AND INSURERS INHERIT WATER AND CLIMATE RISKS OF CLIENTS

Key concerns

- **Financial institutions ar**e not immune to water and climate risks, which are becoming more material in the form of operational, regulatory and market access impacts to companies that manifest as credit risks, equity risks, insurance risks, linked to the assets located in areas affected by climate change. It is not just businesses which impact the environment but the environment is also now affecting the ability of businesses to operate.[54] The risks highlighted in prior sections of this report will therefore be faced by all Asian financial institution (FIs), including banks to insurers.
- Banks show little evidence of factoring in clustered asset risk exposure to water and climate risks to lending. Water and climate risks are locational in nature. Given the rising systemic risk due to clustering in river basins, it is important to map assets in the loan book. The graphic below shows an example of an electronic company's key supply chain exposure to water risks; as this illustration suggests, these risks are not just physical, they are also regulatory in nature, as 80% of the suppliers face tougher regulations.



Source: CWR; Infographic © China Water Risk 2019, all rights reserved

Figure 15

- Traditional ways of evaluating credit risk spread by favouring the "better" companies within a sector or diversifying the risk across sectors will not be sufficient. Cross-sectoral exposure also needs to be properly assessed as FI s are likely to be lending to multiple sectors in one area, making them prone to systemic shocks. FIs need to evaluate their loan books by basin to understand their river basin risk exposure.
- **Insurers may start increasing premiums & stop writing policies.** In the short term, insurers may suffer underwriting losses as they haven't fully mapped the risks, which could lead them to increase premiums. They may eventually completely stop writing policies in vulnerable areas leaving banks exposed as the end bearer of the risks. This has already happened in the US and Europe, for example, 9,000 households in flood-prone areas in England and Wales were excluded from a flood insurance subsidy agreement and Warren Buffet points out that insurers will cope with climate change by increasing premiums, which could make insurance unaffordable.[55,56]

- **Increasingly clustered risks and more frequent events=more action needed from FIs.** As people flock to cities in river basins that have increasing exposure to extreme weather events, it is imperative to find out how much GDP each river basin carries,which are already facing water stress, which will be more susceptible to floods and droughts, and which will likely see reduced run-offs in the next 50 years. Scenarios must be built and consensus must be reached regarding the assessment and valuation of risks.[2,17]
- **The financial sector is one of the worst at disclosure.** An AIGCC report highlights that asset owners and asset managers have the lowest quality and coverage of TCFD reporting. Banks fare better, but the quality is only at 32%.[57] Mapping portfolios to identify the definite risks is required to address this lack of transparency,and will also help to identify opportunities.
- **Beyond TCFD, China's action toward quantification = embed risks into credit policy.** China co-chairs the G20 Green Study Finance Group with the Bank of England and is leading the way. Dr. Ma Jun, a member of the Monetary Policy Committee of the People's Bank of China, the central bank, recently published a 400+ page report titled "Environmental Risk Analysis (ERA) by Financial Institutions", which CWR co-authored. Disclosure, or rather the lack of it, hampers such analysis. To this end, China is currently targeting mandatory environmental disclosure for publicly listed companies by 2020.[58] Ultimately, China's State Council wants to embed environmental risks into the credit lending policy, thereby ensuring financial resilience.[54]

Impact on capital markets

Global banks are currently preoccupied with transitional risks associated with carbon, but we argue that transitional risks regarding water and climate risks are more pervasive and disruptive. They also have the ability to cause much greater damage to value, yet they remain "hidden". The nature of locational risks will mean that banks will have to "adapt" the way they assess credit to ensure resilience. In turn, how banks are valued will also evolve. We are highlighting the financial sector in this brief specifically because:

1. **Financial institutions are yet to fully embed water and climate risks**, and the resultant regulations, into their insurance policy, credit policy and equity valuations;
2. They form a **large part of equity indexes in Asia;** and
3. **Savings could be at risk**.

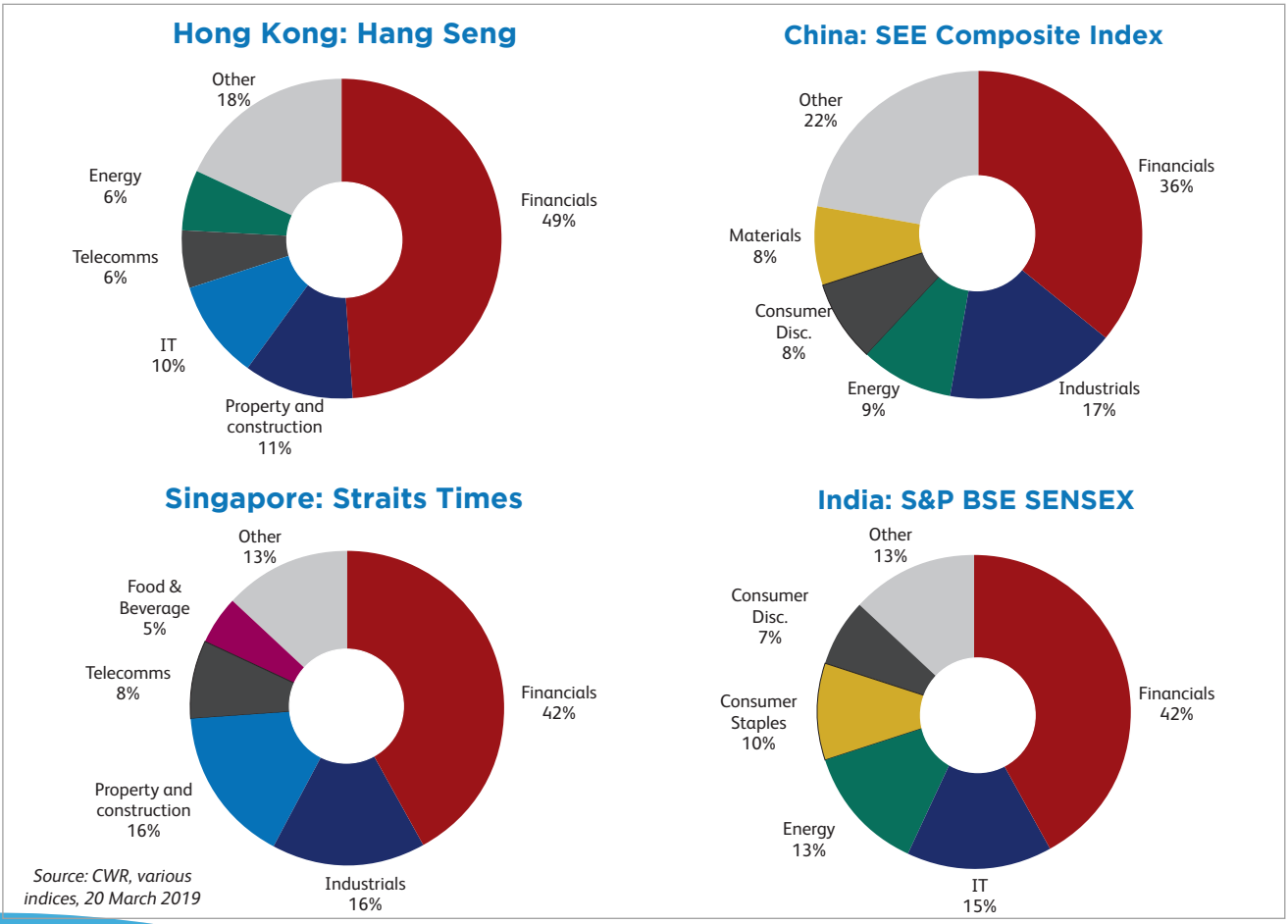


Figure 16

KEY RECOMMENDATIONS FOR ASSET OWNERS

Climate and water risks are a matter of fiduciary duty and fund governance. While corporate climate risk disclosure is still evolving, publicly available information to date (corporate disclosure, NGO/IGO reports and scientific research) already clearly highlights the financial materiality of climate and water-related risks. Therefore, an investor that fails to account for these risks may be putting savings at risk. This will become more evident as the detrimental impacts of climate change unfold, affecting portfolios that have yet to assess and act on such risks.

We recommend asset owners and their fund managers take an active stance by:

- **Assessing "real physical risk" exposure of portfolios:**
  - **Use geo-spatial mapping and analysis** to determine physical exposure of assets and cash flow exposure (either at portfolio level or company level) to water and climate-related weather risks. Mapping can help identify hotspots to build better scenarios;
  - **Determine investee companies' clustered risk exposure** along particularly vulnerable river basins. Climate/water scenarios regarding basin-level risk can then be applied to gauge the long-term viability of investments; and
  - **Size the materiality of the risks to portfolios using various methodologies.** Models should be adjusted to account for additional CAPEX and OPEX costs arising from dealing with such risks as well as possible downward revisions of future revenue depending on various climate scenarios. Shadow pricing can also be used to estimate the water risk impact on P&L.

- **Considering the impact of regulations:**
  - **Price in the cost of water-nomic regulations.** This will be particularly relevant for companies operating in highly polluted or water-stressed/scarce locations; in a sector that is water-intensive and polluting; or where water use and discharge permits are being implemented or discussed by policy-makers. In some circumstances, loss of water permits could lead to an asset write-down in the balance sheet. Do not just focus on water-tariffs; and
  - **Beware of regional and sectoral regulations (i.e. transition risk).** Some governments may have regionally focused regulations that have tougher targets, higher compliance standards, more monitoring and higher penalties. Such regulations can also be sector specific. For example, the Chinese government is managing water by optimising industrial mix – this highlights the need to bear in mind that not all the regulations relevant to climate and water are explicitly environmentally focused.
  - **Assess level of government action on climate change and water risks.** If these issues are not being sufficiently tackle data policy level, then businesses and investors will still be exposed to physical risk precipitated by a limited strategy in place to protect assets at a national level.

- **Creating genuinely diversified portfolios.** Favouring better companies within a sector or diversification across sectors will not entirely eliminate portfolio risk given climate and water risks are locational and absolute. Asset owners can also consider asset allocation approaches, such as:
  - Driving investment towards companies that catalyse or benefit from the transition to a new climate economy;
  - Allocating away from locations vulnerable to climate and water risks, especially if a significant proportion of the portfolio is already located there;
  - Allocating away from sectors and companies globally that accelerate climate change; and
  - Allocating away from sectors and companies most exposed to water and climate risks.

- **Engaging portfolio companies to ensure they:**
  - **Map their own assets and supply chains** with geo-spatial data and a climate-related physical risk overlay, so they are aware of the potential risks they might already face and can plan and act to reduce this;
  - **Are aware of environmental and water-nomic regulatory implications**. This is helped by using mapped exposure to inform potential hotspots and tighter regulations going forward;
  - **Understand the magnitude of risk** by using the various methodologies discussed above;
  - **Incorporate these risks into company risk registers and long-term strategic plans**. This should include recognition that extreme weather may not be an anomaly, and should lead to climate scenario analysis and planning.
  - **Adopt better decision-relevant disclosure** for improved industry-wide benchmarking. TCFD is a good start.
  - **Sector specific engagements:**
    - **Key logistics and infrastructure companies should be prioritised,** to ensure climate resilience has been built into their plans. These sectors are more vulnerable and can have a knock-on effect on the rest of the economy;
    - **Encourage companies to form a platform for the traceability of their resources, especially REEs to tackle the black market.** A platform similar to the RSPO for palm oil would allow better traceability to shut down black markets. This will let prices increase,which will make opening new mines more feasible. Following CWRs reports, in 2016 the UNPRI tabled Rare Earths in China as an emerging ESG issue alongside cybersecurity and antibiotics, however, the urgency has yet to be recognised by the high-tech industry and investors, as there has been a lack of action;[51, 52, 53]
    - **Ensure financial institutions are mapping assets, incorporating basin-level exposure and disclosing this.** Portfolios could easily be clustered in high-risk regions. Traditional ways of evaluating portfolio risk by favouring the "better" companies and diversifying across sectors is insufficient; and
    - **Government-linked companies/state-owned enterprises (GLCs/SOEs) could be engaged, especially if there is government inaction.** Engaging governments can be cumbersome and lengthy; investors might have better traction if GLCs/SOEs are directly engaged on the need for adaptation plans to protect the country, as their own assets are at risk.

- **Undertaking a range of complementary initiatives, such as:**
  - **Collaborating with like-minded investors to support companies to become climate resilient.** This can lead to a clearer message to companies and stronger engagement outcomes. An example is the Climate Action 100+ global collaborative investor engagement initiative.
  - **Voting rights can be utilised to send a stronger message**. Investors can proactively choose when to use this avenue, generally after a period of focused engagement has proven unsuccessful.
  - **Requiring fund managers to report on their ESG investment policies and procedures, and to provide information about climate risk in investments.** Asset owners can lean on their service providers for climate-adjusted investment services, and greater transparency in how these services are provided, e.g. through TCFD reporting. This can be effectively achieved by either incorporating ESG integration requirements into all investment mandates(process approach), and/or through issuing specific investment mandates focused on low-carbon, climate resilient investing (asset allocation approach)
  - **Engaging with regulators to ensure alignment and consistency with policies with the Paris Agreement, and address any issues with implementation of ESG engagement among investors.** This could help to reduce and avoid transition risk brought about by potentially sudden changes in the regulatory landscape, and address any inconsistencies with existing policies and/or voluntary codes such as Stewardship and Corporate Governance codes.

RECOMMENDED READING

Latest reports on climate & water risks included in this brief:

Briefing Paper on the 2018 Global Investor Statement to Governments on Climate Change, Dec 2018

Developed by the Asia Investor Group on Climate Change, CDP, Ceres, Investor Group on Climate Change, Institutional Investors Group on Climate Change, Principles for Responsible Investment, UN Environment Program Finance Initiative.

Emissions Gap Report, Nov 2018

UN Environment

Fourth National Climate Assessment, Nov 2018

U.S. Global Change Research Program

Building on the Base: TCFD Disclosure in Asia, Oct 2018

Asia Investor Group on Climate Change

Global Warming of 1.5C, Oct 2018

Intergovernmental Panel on Climate Change (IPCC)

No Water, No Growth – Does Asia Have Enough Water to Develop? Sep 2018

China Water Risk in collaboration with the Chinese Academy of Science

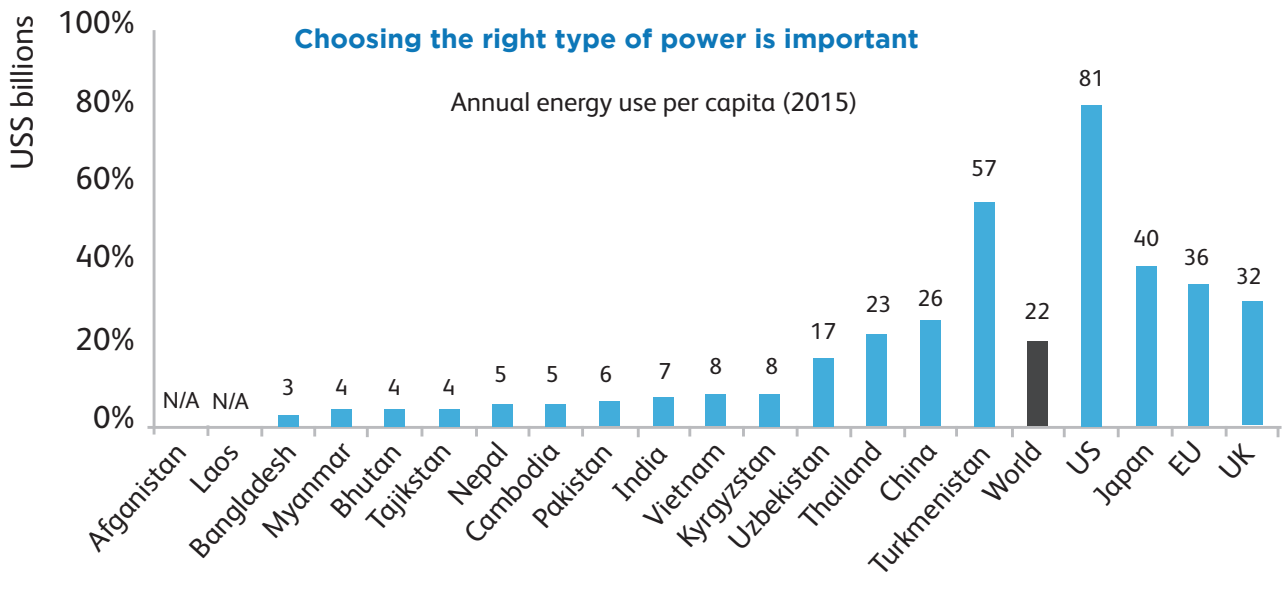
APPENDIX I:
THE WATER-ENERGY-CLIMATE NEXUS

By CWR

UNDERSTANDING COMPLEX LINKAGES – NAVIGATING A TIGHT NEXUS AND VICIOUS CYCLE IN ASIA

Water is used to generate power, but power is also used to clean and supply water from source to tap. The type of power we choose to add today could accelerate climate change, which in turn exacerbates water scarcity. Moreover, water solutions like desalination may also be limited given the amount of power it currently requires; similarly, climate solutions like carbon capture technologies or biofuels are highly water intensive. Energy, water and climate solutions are thus limited for countries that have limited water resources but also hungry for power like China and India.[2]

In Asia, most countries are still developing and have a long way to go in terms of power per capita compared with the developed world, as the chart below shows. Hundreds of millions of Asians still have no access to power while a few hundred million Asians have no access to improved water sources.[2] In many developed countries (such as the US and the UK) the power sector, not agriculture, is the largest user of water, leading to possible trade-offs in food and energy security in the future. Decisions made today at the water-energy-climate nexus are thus important in helping safeguard water resources tomorrow.



Source: CWR based on World Bank Statistics

Figure 17

Avoiding investment choices that shoot yourself in the foot

Smart investment and energy choices must be made for both climate and water today, not just in Asia but across the world as emissions globally will impact water resources locally. The current status is not encouraging. Global emissions are now rising after a four-year plateau to 53.5 gigatonnes of CO2 equivalent (GtCO2eq) for 2017.[1] We are on track to fail as this current path leads us to 3-5°C by 2100:

- Do not act and go about with "business-as-usual" = 4.5°C
- Execute current policies = 3.5°C
- Meet current pledges under Paris Agreement = 2.9°C

Because we are already at +1.2°C as of 2016, there's not much margin for error in decision-making today[59]. In short, we have 12 years to change course, otherwise irreversible trends will be triggered and locked in (see boxes below for more details).

By 2030, global emissions need to be at 40GtCO2eq to stay within 2°C by 2030 or halve to 24GtCO2eq to stay within 1.5°C.[1] This means that developed countries, which are not on track to meet their NDCs under the Paris Agreement, including the US, EU, Australia, Canada and South Korea, must act to drastically cut their emissions. Not meeting their NDCs under the Paris Agreement or setting more aggressive targets will also accelerate climate change and exacerbate water scarcity in Asia.[2]

Our water challenges related to climate change are grave and pervasive. AOs have an important part to play in the water-energy-climate nexus to ensure that the correct power choices are made, not just in Asia but beyond to help mitigate the risks posed to people and economies. AOs should also allocate away from sectors and companies that accelerate climate change as well as drive investment towards companies that catalyse/benefit from the transition to a new climate economy.

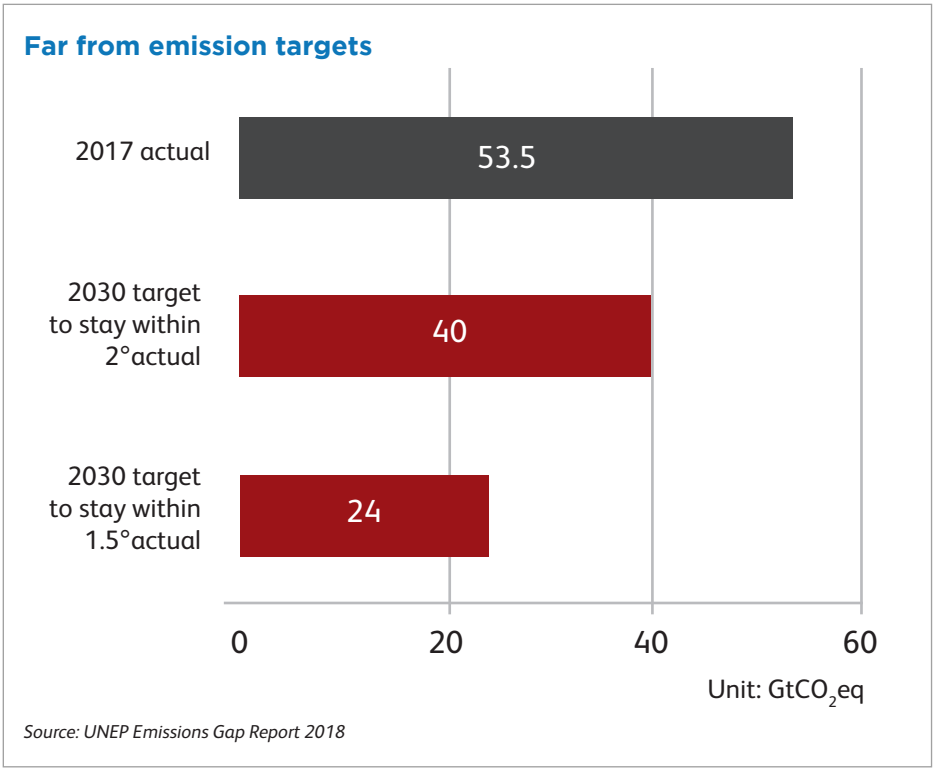


Figure 18

Our Current Path Of 3°C:

Complete loss of most mountain glaciers.

Complete loss of portions of the West Antarctica Ice Sheet & parts of Greenland leading to a slow but unstoppable sea-level rise of 4-10 metres; more if vulnerable East Antarctica is triggered.

Complete annual loss of summer Arctic sea ice plus permafrost thaw and related release of GHGs.

Source: Thresholds & Closing Windows, 2015

Key Impacts At 2°C versus 1.5°C

Severe Heat – 2.6x worse: Over a third of the global population will be exposed to severe heat at least once every five years compared to 14% at 1.5°C. This could cause issues for thermal cooled power generation plus air-conditioning units struggle to function above ~45°C.

Sea-Ice-Free Arctic–10x worse: We will see a sea-ice-free Arctic at least once every 10 years compared to once every 100 years. Arctic ice cover over the summer reflects the suns' rays and cools the planet; it has played this role for 200,000 years. Changes carry significant weather and ecological consequences related to influences on the jet stream.

Mountain Glacier Loss – 2x worse: We could see mountain glacier losses of up to 80% compared to 36% at 1.5°C.

Almost No Coral Reefs – Compared to 10-30% left in a 1.5°C world.

Ecosystem Losses – 1.9x worse. More than a tenth of the Earth's land area will see ecosystems shift to a new biome compared to 7% at 1.5°C.

Species – 2-3x worse depending on whether vertebrates, plants or insects plus decline in marine fisheries of 3mn tonnes at 2°C compared to losses of 2mn tonnes at 1.5°C.

Source: CWR, IPCC Special Report "Global Warming of 1.5C", Oct 2018

The United States Is Sounding The Alarm On The Impact On Water Resources, So Asia Must Not Delay

Climate change impacts water resources globally. The US released its "4th National Climate Assessment" in November 2018, lamenting that mitigation and adaptation efforts have not yet reached the "*scale considered necessary to avoid substantial damages to the economy, environment, and human health over the coming decades*", and that "*substantial and sustained global mitigation and regional adaptation efforts*" are needed. It is important to remember that water risks are not just "developing world" problems; even the US will feel the pain. The assessment succinctly summarises the impacts of climate change on US water resources and the various ways they will be impacted is summarised below:

- Rising air and water temperatures and changes in precipitation are intensifying droughts,increasing heavy downpours, reducing snowpack, and causing declines in surface water quality, with varying impacts across regions.
- Future warming will add to the stress on water supplies and adversely impact the availability of water in parts of the United States.
- Changes in the relative amounts and timing of snow and rainfall are leading to mismatches between water availability and needs in some regions, posing threats to, for example, the future reliability of hydropower production in the Southwest and the Northwest.
- Ground water depletion is exacerbating drought risk in many parts of the United States, particularly in the South west and Southern Great Plains.
- Dependable and safe water supplies for U.S. Caribbean, Hawaii, and U.S. -Affiliated Pacific Island communities are threatened by drought, flooding, and saltwater contamination due to sea-level rise.
- Most U.S. powerplants rely on a steady supply of water for cooling,and operations are expected to be affected by changes in water availability and temperature increases.
- Aging and deteriorating water infrastructure, typically designed for past environmental conditions, compounds the climate risk faced by society.
- Water management strategies that account for changing climate conditions can help reduce present and future risks to water security, but implementation of such practices remains limited.

Source: The above impacts are summarised from the US 4th National Climate Assessment, 2018

APPENDIX II: BASIC WATER-NOMICS

By CWR

CWR first explored the concept of 'water-nomics' in a 2015 report commissioned by HSBC, titled '*No Water More Tradeoffs*.[60] Since then, CWR applied the discussion to the Yangtze River Economic Belt (YREB) – a river basin that is of strategic importance to China – together with the Foreign Economic Cooperation Office of the Ministry of Environmental Protection of China.

Below are excerpts from "***WATER-NOMICS OF THE YANGTZE RIVER ECONOMIC BELT: Strategies & recommendations for green development along the river***", jointly published by CWR and the Foreign Economic Cooperation Office of the Ministry of Environmental Protection of the People's Republic of China (MEP FECO). A Chinese journal article based on this joint brief was published in the national academic journal "Environmental Protection" (Issue 15, 2016).

It is evident that water is important for development. As China develops, the demand for water will likely rise, adding pressure to its already limited water resources. These challenges are explored by looking at the relationships between water and development across the G20 countries below.

G20 WATER-NOMICS

Water is essential for economic development. Analyses of per capita GDP and water use as well as GDP contribution across the G20 countries are set out in Chart 1 below. Generally, agri-heavy economies fall in the lower left quadrant, while more services-heavy economies use more water and have higher GDP.

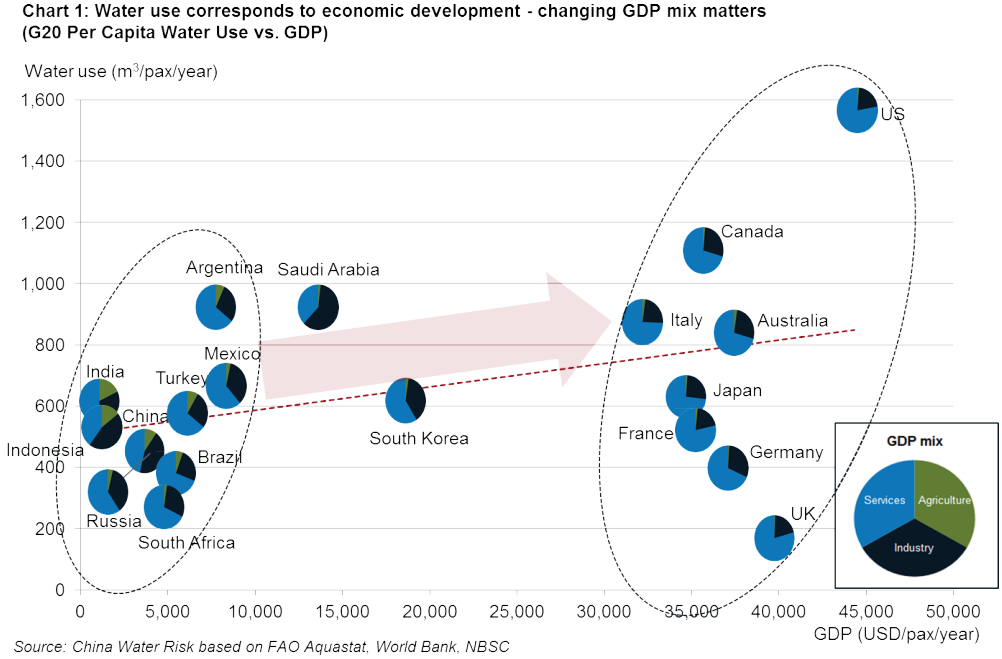


Figure 19

Economic mix matters and can help countries with limited water manage water stress. China aims to double the 2010 GDP and per capita personal income by 2020,[61] but can it achieve this with limited water resources? In theory, higher GDP with less water can be achieved with a shift away from agriculture towards more services. However, in practice, the agriculture sector in China employs 314 million people;[62] moreover, it is imperative for China to maintain food security. Have any G20 country managed to grow their service industries with less water, while maintaining food security?

VIRTUAL WATER TRADE PROFILE OF A COUNTRY MATTERS FOR NATIONAL WATER USE

Some developed countries such as Japan, France, Germany and the UK have succeeded to develop with limited water resources. A closer look shows that this has been made possible by outsourcing part of their water use through higher external water footprints facilitated by the import of water-intensive goods.

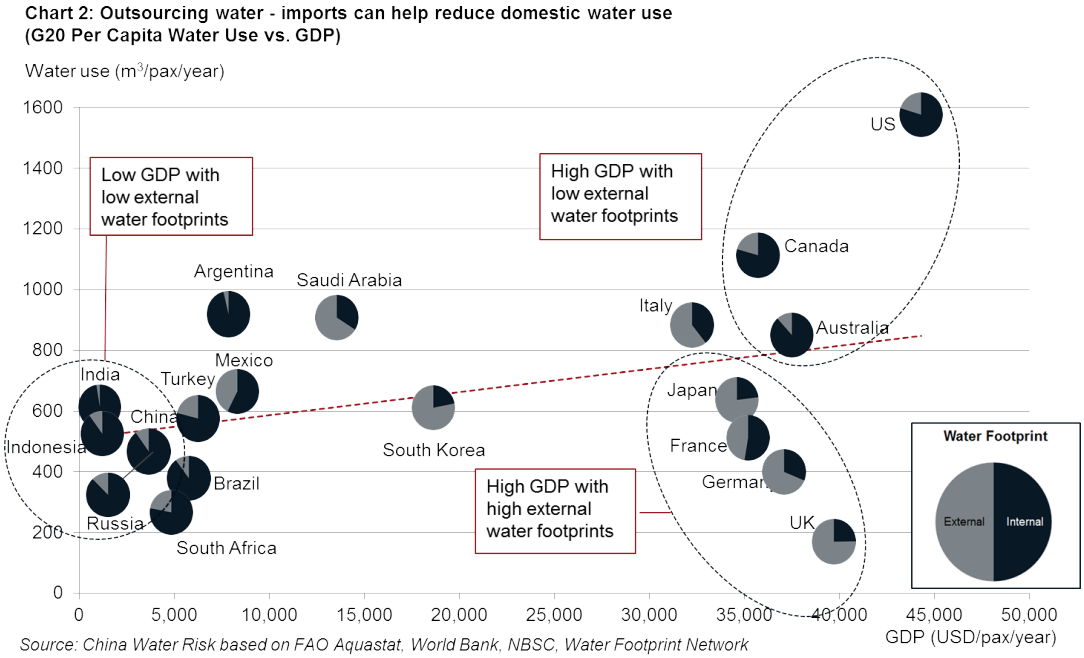


Figure 20

Key takeaways from the above Chart 2 are:

- High GDP with high external water footprints: Japan, France, Germany and the UK have managed to achieve a high GDP with low national water use by having a larger external water footprint. This cluster is using the water resources of other countries by importing water-intensive goods.
- High GDP with low external water footprints: US, Canada and Australia, on the other hand, are primarily self-sufficient, with internal water footprints of 80%, 79% and 88%,respectively.
- Low GDP with low external water footprints: China and India, which have low per capita GDP, are primarily self-sufficient, with internal water footprints of 90% and 97%, respectively. In fact, many of the developing economies in Asia not only have low external water footprints, they are in many cases even exporting water–like China with 'Made in China'.

The path of self-sufficiency, like the US, Canada and Australia, points to more water use. However, given limited water resources and the Three Red Lines, China needs to look beyond water saving efficiencies to manage its limited water resources. This includes:

1. Optimizing its economic mix;
2. Optimizing its industrial and crop mix;
3. Importing more water-intensive goods and exporting less water-intensive goods;and
4. Shifting output and recycling within China to match local water resource availability.

Solutions to achieve national water security need to be cohesive and comprehensive. Policy decisions across all aspects of the economy matter for water and development.

Source: based on excerpts from "WATER-NOMICS OF THE YANGTZE RIVER ECONOMIC BELT: Strategies & recommendations for green development along the river", jointly published by CWR and the Foreign Economic Cooperation Office of the Ministry of Environmental Protection of the People's Republic of China (MEP FECO). A Chinese journal article based on this joint brief was published in the national academic journal "Environmental Protection" (Issue 15, 2016).

REFERENCES

1. UNEP. Emissions Gap Report 2018 (2018)<https://www.unenvironment.org/resources/emissions-gap-report-2018>
2. China Water Risk. No Water, No Growth – Does Asia Have Enough Water to Develop? (2018) <http://www.chinawaterrisk.org/wp-content/uploads/2018/09/CWR-Report-No-Water-No-Growth.pdf>
3. AIGCC, CDP, IGCC, IIGCC, PRI, UNEP FI Briefing Paper on the 2018 Global Investor Statement to Governments on Climate Change. 2018. <https://theinvestoragenda.org/wp-content/uploads/2018/05/GISGCC-briefing-paper-FINAL.pdf>
4. Climate Policy Initiative, Global Landscape of Climate Finance 2017 (2018)<https://climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2017/>
5. OECD. Pensions in Asia Pensions in Asia/Pacific: Ageing Asia must face its Pension problem (2009)<https://www.oecd.org/finance/private-pensions/46260941.pdf>
6. A. Hussain, R. Cassen, T. Dyson. Demographic transition in Asia and its consequences (2006) <https://opendocs.ids.ac.uk/opendocs/bitstream/handle/123456789/8403/IDSB_37_3_10.1111-j.1759-5436.2006.tb00271.x.pdf?sequence=1&isAllowed=y>
7. World Economic Forum. We'll Live to 100–How Can We Afford It? (2017)<http://www3.weforum.org/docs/WEF_White_Paper_We_Will_Live_to_100.pdf>
8. PWC. The world in 2050.<https://www.pwc.com/gx/en/issues/economy/the-world-in-2050.html#keyprojections>
9. TCFD, Recommendations of the Task Force on Climate-related Financial Disclosures: Final Report (June 2017), p8. <https://www.fsb-tcfd.org/>
10. ADB. Asian water development outlook 2016: Strengthening water security in Asia and the Pacific. (2016)<http://www.adb.org/sites/default/files/publication/189411/awdo-2016.pdf>
11. WHO. Climate change and Health. 1 February 2018.<https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health>
12. IOM. Migration, Climate Change and the Environment.<https://www.iom.int/complex-nexus#estimates>
13. World Bank. Managing the Impacts of Climate Change on Poverty (2015)<http://www.worldbank.org/en/news/infographic/2015/11/08/managing-the-impacts-of-climate-change-on-poverty>
14. UNFCC. Introduction to Climate Finance.<https://unfccc.int/topics/climate-finance/the-big-picture/introduction-to-climate-finance>
15. OECD. Investing in climate, investing in growth. (2017)<https://www.oecd.org/environment/cc/g20-climate/synthesis-investing-in-climate-investing-in-growth.pdf>
16. ADB. Addressing Climate Change and Migration in Asia and the Pacific (2012) <https://www.adb.org/publications/addressing-climate-change-and-migration-asia-and-pacific>
17. China Water Risk. Toward Water Risk Valuation – Investor Feedback on Various Methodologies Applied to 10 Energy ListCo's. (2016). at <http://www.chinawaterrisk.org/wp-content/uploads/2016/08/China-Water-Risk-Report-2016-Toward-Water-Risk-Valuation-WebM.pdf>. The majority of those surveyed (77%) were "mainstream investors"; with the remainder classifying themselves as "ESGinvestors".
18. China Water Risk article. Two Sessions, Five Highlights For Water. By Yuanchao Xu, Debra Tan, Woody Chan, 16 March 2018. <http://www.chinawaterrisk.org/resources/analysis-reviews/two-sessions-five-highlights-for-water/>
19. Hong Kong Observatory. Projections of Hong Kong Climate for the 21st Century (2014)<http://www.hko.gov.hk/climate_change/ClimProj20140317-e.pdf>
20. Hong Kong Observatory website. Storm surge records in Hong Kong during the passage of tropical cyclones<http://www.hko.gov.hk/wservice/tsheet/pms/stormsurgedb_e.htm?t=SEARCH&v=2010-2018>
21. Hong Kong Observatory. Projection of Extreme Rainfall Trend and Mean Sea Level Rise in Hong Kong for the 21st Century (2016)<https://www.dsd.gov.hk/rdforum/2016/files/en/presentation/D1T1.pdf>

22. Top 50 World Container Ports. World Shipping Council website.<http://www.worldshipping.org/about-the-industry/global-trade/top-50-world-container-ports>
23. HSBC and Asia Research & Engagement. Climate Costs for Asia Pacific Ports (2018)
24. RMS. Ten World Ports at Risk of Highest Insurance Loss Due to Catastrophe (2016) <http://www.rms.com/newsroom/press-releases/press-detail/2016-08-08/rms-analysis-reveals-the-ten-world-ports-at-risk-of-highest-insurance-loss-due-to- catastrophe>
25. Tomoo Yatsuhashi. Nagoyaport keeps top Japanese export hub title(2017)<https://www.joc.com/port-news/nagoya-port-keeps-top-japanese-export-hub-title_20170220.html>
26. e-Stat Portal Site of Official Statistics of Japan<https://www.e-stat.go.jp/en/stat-search/files?page=1&toukei=00350300&tstat=000001013141>
27. IMO (International Maritime Organization) profile.<https://business.un.org/en/entities/13>
28. World Bank Data. Merchandise trade (% of GDP)<https://data.worldbank.org/indicator/TG.VAL.TOTL.GD.ZS>
29. Statistics Japan. National Accounts.<http://www.stat.go.jp/english/data/nenkan/68nenkan/1431-03.html>
30. World Integrated Trade Solutions Website. Japan Product exports and imports 2017. <https://wits.worldbank.org/CountryProfile/en/Country/JPN/Year/2017/TradeFlow/EXPIMP/Partner/WLD/Product/All-Groups>
31. Nikkei Stock Average Component (Weights)<https://indexes.nikkei.co.jp/nkave/archives/file/nikkei_stock_average_weight_en.pdf>
32. The Japan Times. Kansai airport reopens runway 10 days after typhoon flooding, 14th September 2018. <https://www.japantimes.co.jp/news/2018/09/14/national/kansai-airport-reopens-runway-10-days-typhoon-flooding/#.XATS7NszaUk>
33. South China Morning Post. Typhoon Mangkhut derails travel plans for tens of thousands passing through Hong Kong International Airport. Naomi Ng, Denise Tsang, Cannix Yau, 15 September 2018 <https://www.scmp.com/news/hong-kong/transport/article/2164380/super-typhoon-mangkhut-derails-travel-plans-tens-thousands>
34. S. Hallegatte, C. Green, R. Nicholls, and J. Corfee-Morlot. Future flood losses in major coastal cities. Nature Climate Change(2013)<https://www.researchgate.net/publication/260701937_Future_flood_losses_in_major_coastal_cities>
35. S&P Global Ratings. How Does S&P Global Ratings Incorporate Environmental, Social, and Governance Risks Into its Ratings Analysis (2017) < https://www.spglobal.com/our-insights/How-Does-SP-Global-Ratings-Incorporate-Environmental-Social-and-Governance-Risks-Into-its-Ratings-Analysis-.html>
36. World Bank Press release. Climate Change Could Depress Living Standards in India, says New World Bank Report. (2018) <https://www.worldbank.org/en/news/press-release/2018/06/28/climate-change-depress-living-standards-india-says-new-world-bank-report>
37. Bloomberg News. Macau Casinos to Reopen After $186 Million Loss From Storm Halt. Daniela Wei & Stephen Tan, 16 September 2018.<https://www.bloomberg.com/news/articles/2018-09-16/macau-suspends-casino-operations-as-typhoon-mangkhut-looms>
38. The World Bank. Thai Flood 2011: Overview (2012)<http://documents.worldbank.org/curated/en/677841468335414861/pdf/698220WP0v10P106011020120Box370022B.pdf>
39. SET website<https://www.set.or.th/en/market/tri.html>
40. Lubis, M. F., Shirota, Y.. and Sari, R.F. Thailand's 2011 Flooding: Its Impacts on Japan Companies in Stock Price Data. Gakushuin Economics Papers 52, no. 3 (2015):101-121.
41. Tom Di Christopher. US crude jumps 2.9% to three-week closing high of $48.66 as refineries restart after Harvey. CNBC Article.September2017<https://www.cnbc.com/2017/09/05/oil-surges-as-refineries-restart-after-harvey-irma-is-trouble-for-gas.html>
42. China Water Risk article. Green Development for a Beautiful China. Yuanchao Xu, 17 November 2017 <http://www.chinawaterrisk.org/resources/analysis-reviews/green-development-for-a-beautiful-china/>

43. China Water Risk article. China Water-nomics. Debra Tan, Hubert Thierot and Feng Hu, 15 September 2015<http://chinawaterrisk.org/resources/analysis-reviews/china-water-nomics/>

44. NITIAayog. Composite Water Management Index– June 2018(2018)<http://niti.gov.in/writereaddata/files/document_publication/2018-05-18-Water-Index-Report_vS8-compressed.pdf>

45. Huffington Post article. Israel Isthe Unsung Heroin Water Management. Jennifer Schwab, 6 December 2017<https://www.huffingtonpost.com/jennifer-schwab/israel-is-the-unsung-hero_b_9212810.html>

46. Library of Congress.Legislation on Use of Water in Agriculture: Israel.<https://www.loc.gov/law/help/water-law/israel.php>

47. NITI Aayog. India: Three Year Action Plan 2017-18 to 2019-20. (2017) <http://niti.gov.in/writereaddata/files/coop/IndiaActionPlan.pdf>

48. China Water Risk article. Dirty Thirsty Wars – Fashion Blindsided. Debra Tan, 17 September 2014<http://chinawaterrisk.org/resources/analysis-reviews/dirty-thirsty-wars-fashion-blindsided/>

49. China Water Risk article. Water Ten & Fashion: 8 Reasons to Leap or Fall. Feng Hu, 16 June 2015 <http://chinawaterrisk.org/resources/analysis-reviews/water-ten-fashion-8-reasons-to-leap-or-fall/>

50. China Water Risk. Insights From China's Textile Manufacturers: Gaps to overcome for clean & circular fashion (2017)<http://chinawaterrisk.org/wp-content/uploads/2017/08/Insights-From-China%E2%80%99s-Textile-Manufacturers.pdf>

51. China Water Risk. "Rare Earths: Shades Of Grey – Can China continue to fuel our clean and smart future?" (2016)<http://www.chinawaterrisk.org/notices/cwr-rare-earths-shades-of-grey/>

52. China Water Risk article. Apple & Rare Earth Recycling. Hongqiao Liu, 18 September 2017

53. China Water Risk article. Toxic Phones: China Controls the Core. Debra Tan, 18 September 2017. Covering report of CWR/CLSA "Toxic Phone: China Controls the Core" (2017) <http://chinawaterrisk.org/resources/analysis-reviews/toxic-phones-china-controls-the-core/>

54. China Water Risk article. Banking in the Age of Water Risk. Debra Tan, 19 September 2016. <http://chinawaterrisk.org/opinions/banking-in-the-age-of-water-risk/>

55. Inside Climate News article. Warren Buffett Delivers Cold-Blooded View of Global Warming to Shareholders. John Cushman Jr., 29 February 2016.<https://insideclimatenews.org/news/29022016/warren-buffett-tells-shareholders-climate-change-not-entirely-bad-business-berkshire-hathaway-insurance>

56. FT article. Up to 9,000 homes miss out on UK government flood insurance deal. Jim Pickard and Alistair Gray,10 January 2014<https://www.ft.com/content/c72eb73a-79e1-11e3-a3e6-00144feabdc0>

57. AIGCC, EY and FTSE Russell. Building on the Base: TCFD Disclosure in Asia.(2018)<https://www.aigcc.net/wp-content/uploads/2018/10/AIGCC_Building-on-the-base_TCFD-Disclosure-in-Asia_FINAL.pdf>

58. China Water Risk article. Where Is The E In ESG Disclosure In China? Dawn McGregor, 16 May 2018. <http://www.chinawaterrisk.org/resources/analysis-reviews/where-is-the-e-in-esg-disclosure-in-china/>

59. Yale Environment 360 article. 2016 Temperatures Measure 1.2 Degrees C Above Pre-Industrial Levels. 14 November 2016 <https://e360.yale.edu/digest/2016_hottest_year_on_record_wmo_12_degrees_c>

60. HSBC Climate Change Research Centre. No Water, More Trade-offs – Managing China's growth with limited water. (2015).

61. Xinhua News. China can double 2010 GDP with 6.3% growth in 2018-2020. (2017)<http://www.xinhuanet.com/english/2017-12/23/c_136847644.htm>

62. National Bureau of Statistics of China. The Third National Agricultural Census.(2017).

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