WWF

OPEN SUPPLY HUB

Avant-Garde:

THE WATER RISKS AND OPPORTUNITIES FACING APPAREL AND TEXTILES CLUSTERS

PART II
EXPLORING WATER RISKS IN THE TEXTILE INDUSTRY'S VALUE CHAIN

3 PART REPORT

As part of a series of reports done in collaboration with H&M Group, **Part I** explores the touchpoints of water along the industry's value chain, while part II (this report) unpacks water risks and opportunity for key clusters, Lastly, in Part III we lay out WWF's vision on water and our water stewardship program within the apparel and textiles industry. Part III is scheduled to be released in Spring 2023. We thank H&M Group's support in the work towards problem identification and solution development of these shared water challenges.

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PREFACE BY WWF

Water is inherently a local issue. It matters in the here and now. Not only do all living things require water (some daily, some monthly, some even yearly), but so too do humans - to live, play and conduct business.

As we explored in our previous report with H&M Group, **Eau Courant: Water stewardship in Apparel & Textiles**, fashion has an array of water impacts and dependencies. Yet "where" we produce arguably has a greater impact than "how much" water we use and is critical in informing how much wastewater can be safely discharged. Much of the footprint of the apparel and textiles industry has deep roots in the geography of water: not only have cities developed around the deltas of the world's great river systems, but so too did the combination of abundant water for processing textiles, and the availability of abundant, skilled labour. This has resulted in global clusters in the apparel and textiles industry – clusters that are increasingly facing basin water risks; risks that are only being exacerbated by our increasingly unstable climate. In just the past few months (July-September 2022), we have witnessed severe droughts facing production clusters in Europe, and extreme floods faced by producers in Pakistan and India, highlighting the urgent need to take action.

Yet there is an upshot to these shared challenges. These clusters, which share certain risk profiles, also offer up the opportunity to tackle these basin water risks. They say that "many hands make for light work" and our freshwater ecosystems do indeed require many hands worth of work. But neither companies, nor their suppliers, need to – or can – single-handedly solve the freshwater challenges facing them in these key clusters.

The open data movement and platforms like Open Supply Hub are ushering in a new era of collaboration. Transparency brings with it opportunity, and we are now able to leverage open datasets to offer intelligence back to the sector on not just water risks, but water opportunities as well.

Through our work with Open Supply Hub, this second report offers insights into a hydro-geography of hope for rivers tied to the apparel and textiles industry. We believe it will help companies and industry allies to begin to think about how we can better collaborate with each other and scale our solutions to tackle the significant challenges facing people and nature.

THROUGH OUR WORK WITH OPEN SUPPLY HUB, THIS SECOND REPORT OFFERS INSIGHTS INTO A HYDRO-GEOGRAPHY OF HOPE FOR RIVERS TIED TO THE APPAREL AND TEXTILES INDUSTRY.

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PREFACE BY OPEN SUPPLY HUB

Consider some of the biggest social and environmental challenges supply chains are facing today, like modern slavery, deforestation and climate change.

These are not problems that any one person, organization or sector can solve alone. But time and again we've seen that gathering together the right set of stakeholders to tackle these problems is too time-consuming and inefficient for many to even attempt. Why? It all boils down to the data and two broad issues with it:

- **Lack of standardization:** There is endless variation in how production locations are named or identified across organizations, making it almost impossible to compare and combine datasets.
- **Inequitable or closed access:** Data lives in multiple closed or paid-for platforms, blocking equitable usage and making it difficult to get a complete picture of global supply chains.

To begin the work of collaborating at the scale necessary to solve complex and interwoven problems, we need high quality and open data. This report is an example of the potential that can be unlocked when reliable, open data is harnessed to create change. With a shared purpose of creating free tools designed for equitable use and interoperability, WWF and Open Supply Hub hope to show that supply chain transparency does not exist just to check a box. When implemented collaboratively, unlimited opportunities for impact are possible.

1. INTRODUCTION: THE APPAREL AND TEXTILES INDUSTRY AND WATER RISK

Over the past decade, the World Economic Forum has consistently shown that the top five risks facing the world presently, and that are projected to impact it over the next 5-10 years, are all environmental[1].

These five risks, including climate action failure, extreme weather, biodiversity loss, natural resource crisis, and human environmental damage, all relate to water. The World Bank's recent research suggested that growth in key apparel production regions, such as Pakistan, India and China, are projected to decrease by up to 6% by 2050 due to water-related impacts[2]. Lived experience suggests that these estimates are indeed realistic. Recent years have illustrated the reality of economic impacts due to water repeatedly throughout the world. From the droughts facing the western United States and Europe, where GDP has been materially impacted[3], to the floods affecting Pakistan and India[4], the economic impacts of water are here, and here to stay. Indeed, the latest Intergovernmental Panel on Climate Change (IPCC) report[5] made it clear that water-related climate impacts will only worsen.

As our climate changes, water patterns are growing increasingly unstable and extreme. In the face of such large-scale challenges, one thing is clear: there is a growing need to understand where and how we can work together on these immense, shared water challenges. Nowhere is this more true than for the apparel and textiles industry. With apparel and fiber production often located in fertile river valleys, water is an acute issue for the industry – not only its dependency upon water as a key input resource, but also the exposure that workers have to water challenges, and the impact the industry has on rivers and ecosystems through pollution.

This report is **Part II** in a series of apparel and textiles industry reports that aims to drive the industry towards embracing water stewardship through the notion of collective action at the basin level.

In **Part I**, the objective was to develop a shared understanding of how water and fashion are connected. The report outlined the level of materiality of water impacts and dependencies along every step of the industry's value chain, from raw material extraction to the end-of-life stage of a garment, to show how vital water is to the industry. Each of the tiers and use phases within the value chain have not only some level of impact upon water systems, but are also dependent upon water systems, hence the need to take a full value-chain perspective when working on water. Further, the report showed the need for the industry to recognize that water is made up of multiple, interconnected issues including water quality, water quantity, water governance, WASH, and freshwater ecosystems, and these issues also interact with climate change and biodiversity, and vary through space and time.

While climate is a global challenge, water is a local challenge. Water varies temporally and spatially, making it a highly dynamic issue. While Part I highlighted the the apparel and textiles industry's impacts and dependencies on water, Part II takes us into the geography of the industry's clusters and their context.

To understand water risk, one must understand how water risk varies by cluster and in turn, appropriate responses for any given cluster to tackle its shared water challenges. In short: when it comes to water, local context is key to driving response.

The aim of this report (Part II) is to explore the apparel and textiles industry's exposure to water risk using spatial analysis to understand not only the patterns of water risks within clusters of sites, but also how different clusters may be able to learn from each other to respond. Further, the report highlights opportunities for collaboration between sectors. At the core of the analysis, this report harnesses a key tool, the WWF Water Risk Filter, and combines this with a key data set from Open Supply Hub (formerly the Open Apparel Registry). The report goes on to flag two cases where clusters are mobilizing collective action in response to water challenges. These solutions, and WWF's broader efforts in the Apparel and Textiles industry, will be the focus of Part III.

THE FIVE RISKS, INCLUDING CLIMATE ACTION FAILURE, EXTREME WEATHER, BIODIVERSITY LOSS, NATURAL RESOURCE CRISES, AND HUMAN ENVIRONMENTAL DAMAGE, ALL RELATE TO WATER.

BOX A

INTRODUCTION TO THE WWF WATER RISK FILTER

Launched in 2012, the **WWF Water Risk Filter** is a free, practical, online tool to help companies better assess and respond to water risks and opportunities across their operations and supply chain. It has become a leading and trusted tool for over 4 thousand active users from a broad range of sectors, including apparel and textiles companies such as H&M Group, Ralph Lauren Corporation, and PVH Corp.

Designed to be used as a corporate-level screening and prioritization tool, it enables companies to identify water risk hotspots and prioritize action on what and where it matters the most to address water risks for enhancing business resilience and contributing to a sustainable future.

To do so, the WWF Water Risk Filter provides a comprehensive assessment of water risks by taking into consideration:

Basin risks

Risks related to a company's geographic location are assessed using 32 state-of-the-art basin risk indicators covering different aspects of physical, regulatory and reputational water risks.

Operational Risks

Risks related to a company's impact/performance are assessed using either a short (10 questions) or a more detailed (45 questions) site-level questionnaire covering different aspects of physical, regulatory and reputational water risks.

With the support of the UK Development Finance Institution, British International Investment (BII), the WWF Water Risk Filter was enhanced in 2020 to provide climate and socio-economic scenarios of water risks (Optimistic, Current trend and Pessimistic pathways) for 2030 and 2050. This new functionality enables companies to better understand future water risks and drive more effective corporate action on climate and water resilience, as recommended by the Task Force on Climate-related Financial Disclosures (TCFD).

Water Risk Filter

BOX B

INTRODUCTION TO OPEN SUPPLY HUB

Open Supply Hub (OS Hub) is an accessible, collaborative, supply chain mapping platform, used and populated by stakeholders across sectors and supply chains. With the goal of opening up supply chain data for the benefit of all, its model is centered around three core pillars:

One Common Facility Registry

Cross-sector supply chain data is collected in a single place, accessible to all.

Reliable Data

All data contributed to the platform is reviewed by the OS Hub team deduplicated by a matching algorithm, and then assigned an industry-standard ID.

Global Collaboration

The user-generated dataset gives visibility into which organizations are connected to which facilities, accelerating collaboration.

From 2019 - 2022, OS Hub existed as the Open Apparel Registry, focused solely on the apparel sector. In November 2022, with the support of cross-sector funders and data contributors, it expanded to become Open Supply Hub and serve retail supply chains more broadly. It now contains data from some of the world's largest retail brands, including Amazon, Target and The Walt Disney Company, and is used to advance the missions of cross-sector stakeholders, including Worker Rights Consortium, Fair Factories Clearinghouse, the Alliance for Water Stewardship, Global Labor Institute and more.

Open Supply Hub is a neutral, non-profit organization incorporated in Delaware, USA.

OPEN SUPPLY HUB

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2. THE WATER RISK OF APPAREL AND TEXTILES CLUSTERS

2.1 The clusters in the Apparel and Textiles Industry

Before discussing the water risks facing the apparel and textiles industry, it is worth establishing a common understanding of global distribution of the industry's clusters. From a country perspective, the answer is: Bangladesh, Brazil, China, India, Italy, Pakistan, Turkey, USA, and Viet Nam. However, as seen on the heatmap (Figure 1), the industry's clusters are actually concentrated in much smaller regions, typically in major urban agglomerations, especially those associated with either (a) large river deltas (e.g., Yangtze delta, Mekong delta, Ganges delta, Pearl delta) or (b) fertile growing regions with a history of industrialization (e.g., Po valley, Punjab, Greater Sao Paulo).

For this report we focused on 82 clusters, which were identified as the basins (catchments) with highest spatial density of apparel and textiles sites (See Appendix A for more details). Altogether these clusters encompass over 75 thousand sites (which represent 78% of all the sites that were listed in Open Supply Hub at the time of analysis[6]). These clusters are presented in this report under the name of the major urban agglomeration that they surround – or the most populated agglomeration[7], where clusters overlap multiple ones.

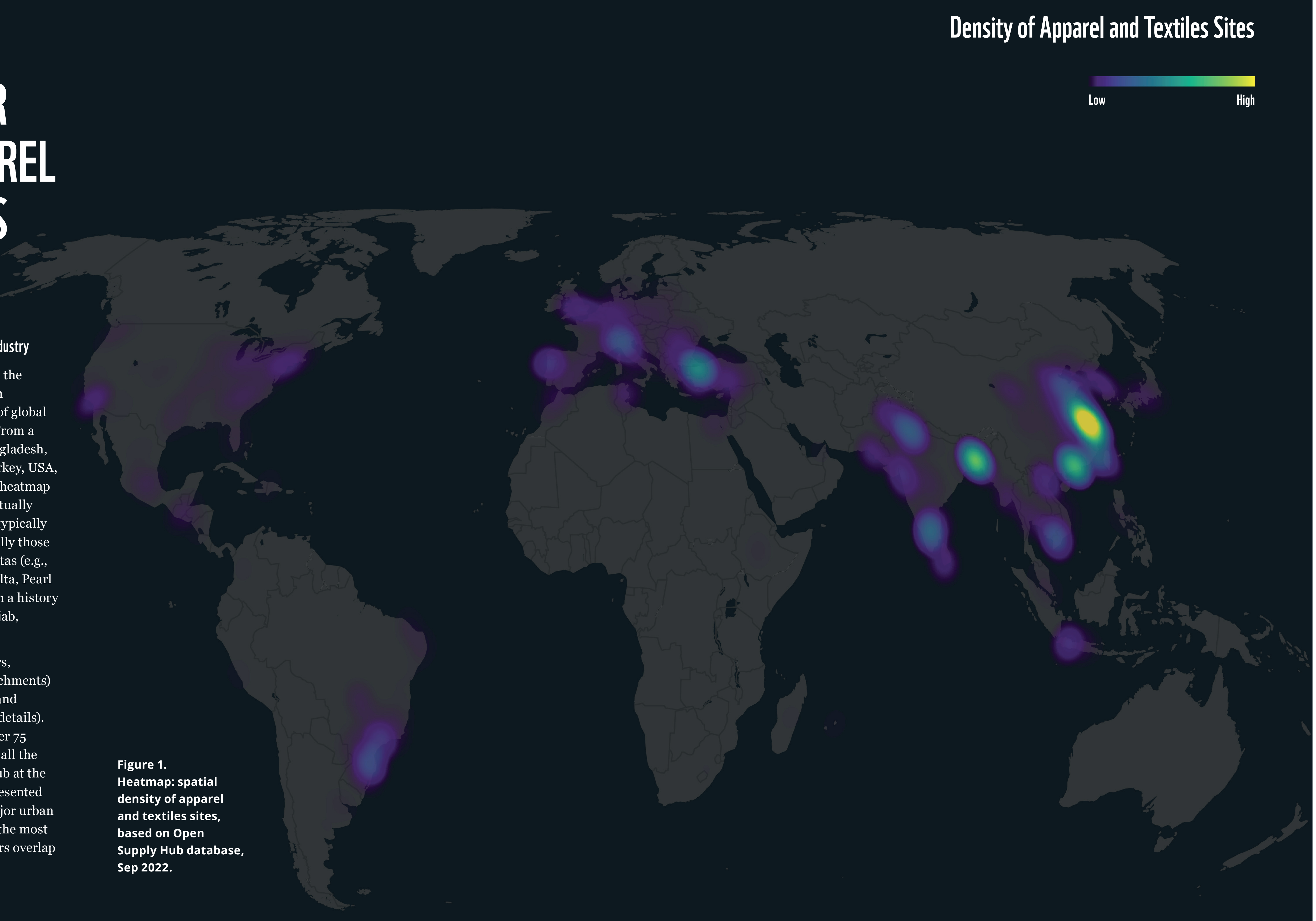


Figure 1. Heatmap: spatial density of apparel and textiles sites, based on Open Supply Hub database, Sep 2022.

2.2 The largest clusters of sites worldwide

Perhaps the first striking aspect of the data breakdown is that a disproportionate number of sites are clustered into a few massive clusters:

1. **Shanghai (China):** The cluster around the Yangtze delta, located in the Yellow Sea and East China Sea basins, contains the highest number of sites (16,450). This cluster is home to 60 major urban agglomerations with a population of over 114 million people.
2. **Dhaka (Bangladesh)**: Located in the Meghna river basin (within the Brahmaputra-Ganges-Meghna delta), Dhaka is the second largest cluster (8,226 sites) and also the densest (number of sites/area). It is home to 5 major cities and over 32 million people.
3. **Guangzhou (China)**: The third largest cluster is located in the Zhu Jiang river basin (which includes the Zhu Jiang or Pearl River delta) and contains 7,345 sites. It is a relatively large cluster spreading across 64 thousand km^2, covering 19 major cities and over 62 million people.
4. **Istanbul (Turkey):** The cluster around Istanbul, which is located in the Aegean Sea river basin (with much of the production within the Ergene basin), is the fourth largest cluster in terms of number of sites (4,906) and has the fourth highest density of sites. It is home to 5 major cities and over 19 million people.
5. **Qingdao (China)**: The cluster around Qingdao, which is located in the Yellow Sea and East China Sea basin (and tied into the Huang He or Yellow River delta), is the fifth largest cluster in terms of number of sites (2,692).
6. **Delhi (India):** The cluster around Delhi, which is located in the Ganges river basin, is the sixth largest cluster with 2,687 sites. It is home to 8 urban agglomerations and over 36 million people.

Considering that many clusters are actually close to other clusters, it is worth mentioning that Bangalore, Chennai, and Coimbatore are all in close proximity in Southern India and boast a combined total of 3,608 sites. This represents more of a regional cluster. Similarly, there are two key clusters around Shantou and Xiamen in China, neighbours on the coast of the South China Sea, that make up a regional cluster of 2,592 sites.

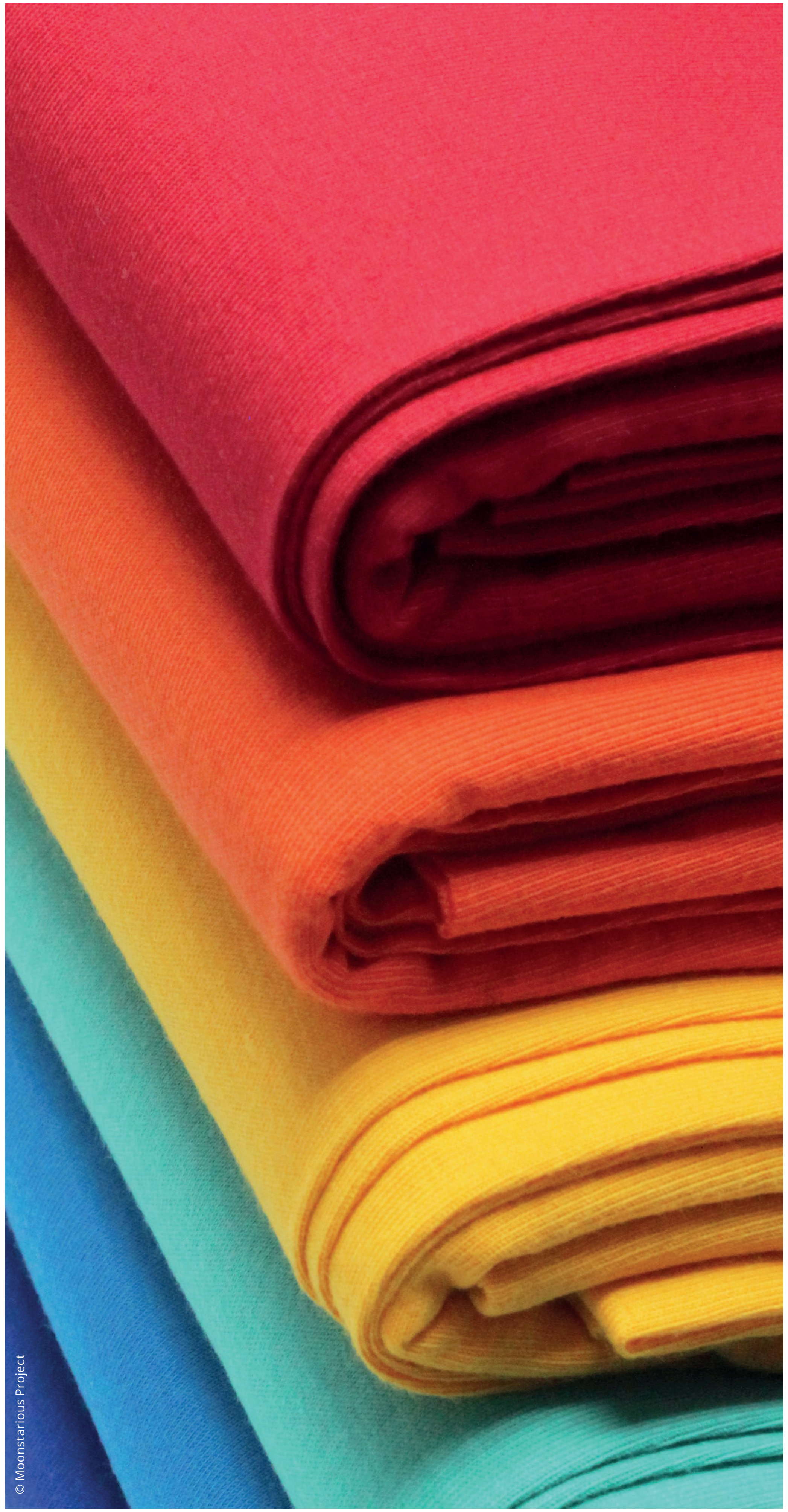
Collectively, these 8 clusters comprise 48,506 sites, and constitute 50% of the total sites listed in the OS Hub database making them critical clusters for the industry's overall economic well being.

It is also worth noting that a few of these clusters – **Dhaka, Porto, Karachi, Yuzhong, and Denizli** – are particularly dense clusters, which makes them particularly well suited to collaboration, but also places them at even greater risk as water events are likely to affect many (even potentially all) of the sites in those clusters.

2.3 The physical water risks of the clusters

To assess the physical water risks associated with each cluster, we harnessed the **WWF Water Risk Filter**. Using this tool, we identified physical risks in the year 2020 (as the baseline) and also analyzed how these risks will evolve by 2050 considering the changes in climate and socio-economics, according to a pessimistic pathway (See Appendix A for more details). While the tool also has the ability to unpack regulatory and reputational water risk, for the purposes of this analysis, we have restricted our assessment to physical water risks. Physical water risks account for whether water in the river basin is too little (**water scarcity**), too much (**flooding**), unfit for use (**water quality**), and/or the surrounding ecosystems are degraded, and in turn, negatively impacting freshwater ecosystem services (**ecosystem services status**). These represent some of the key dimensions affecting the industry, its workers and nature.

Water risk is critical to businesses because it drives various financial impacts, which in turn affect shareholders. As noted in the first report (**Eau Courant: Water Stewardship in Apparel & Textiles**, Figure 2), TCFD offers a framework that links physical (water) risks to various financial impacts from decreasing revenues (e.g., production constraints driven by water scarcity) and increased expenditures (e.g., increased costs of treating poor water quality) to asset write-downs (e.g., damaged infrastructure from flooding) and increased financing costs (e.g., degraded credit ratings due to poor water risk management).



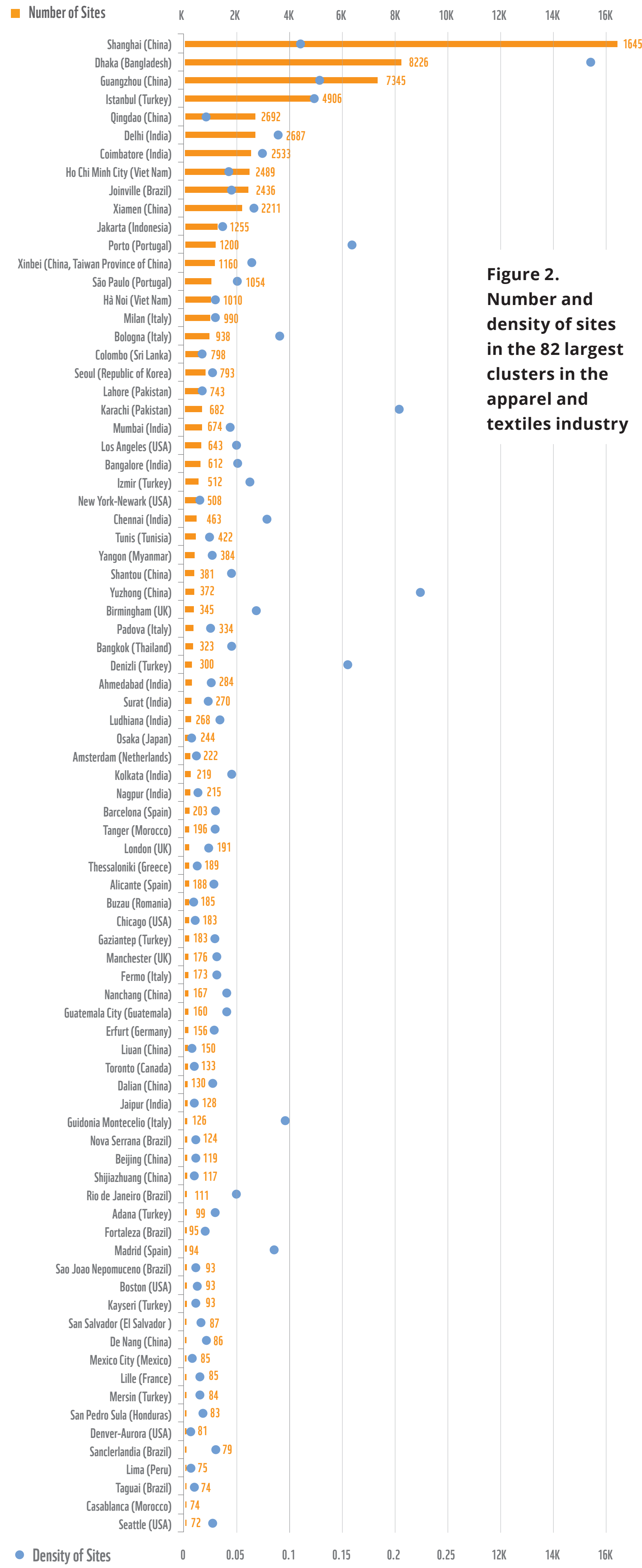


Figure 2. Number and density of sites in the 82 largest clusters in the apparel and textiles industry

The Physical Water Risks of the Apparel and Textiles Clusters

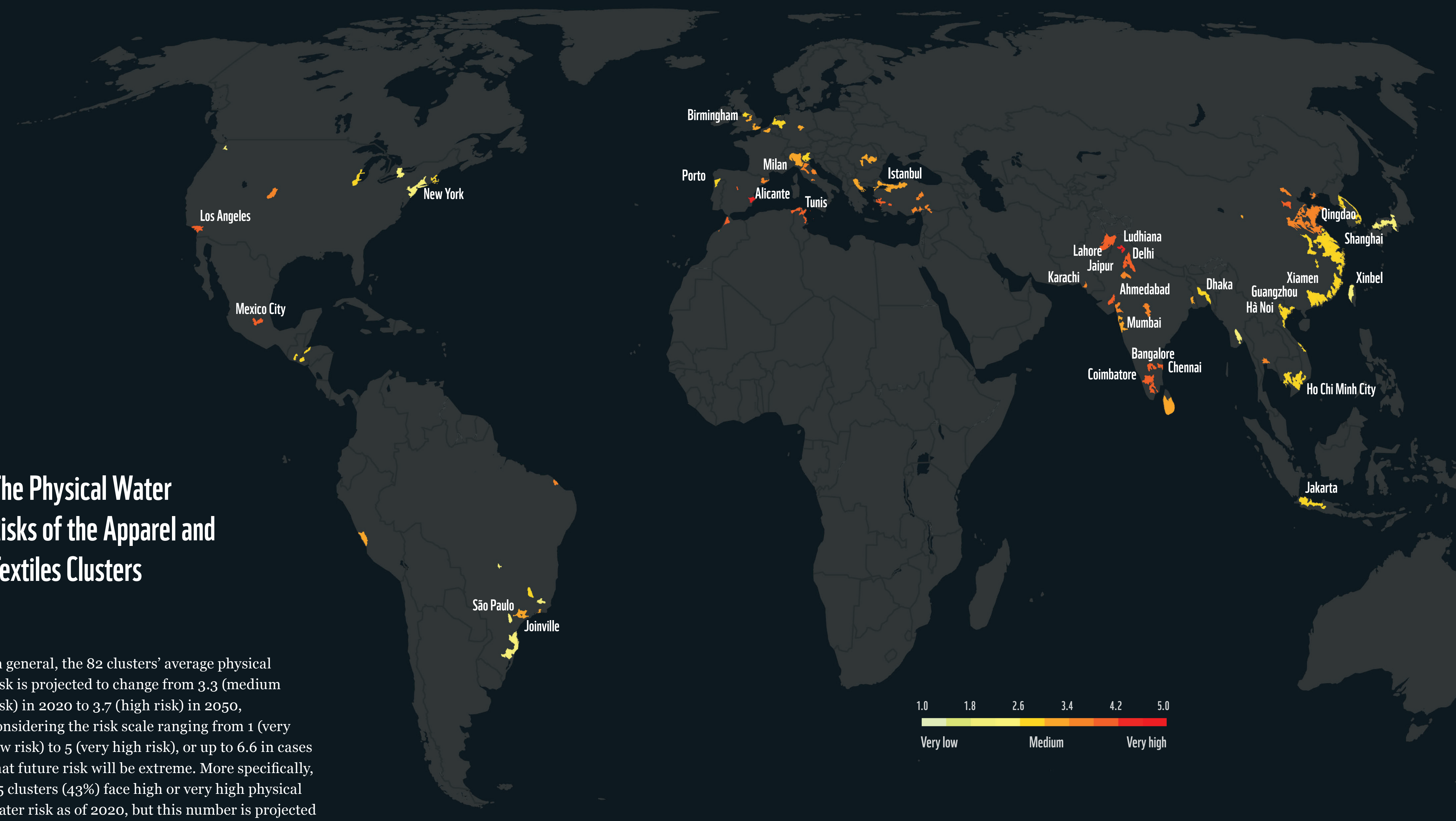


Figure 3. Map: Spatial distribution of the largest apparel and textiles clusters, and their respective physical water risk in 2020 [Baseline].

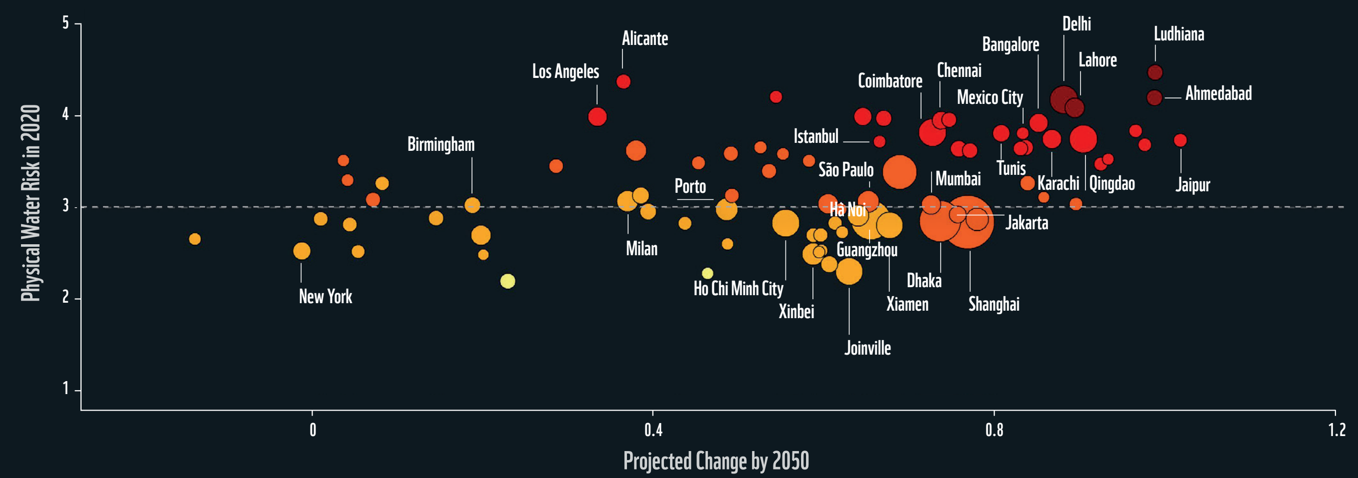


Figure 4. (Below): Scatter plot: clusters' physical water risk in 2020 (Baseline) and how it is projected to change by 2050 (pessimistic pathway). Color of dots represent the risk in 2050. Size of dots represent the number of sites.

In general, the 82 clusters' average physical risk is projected to change from 3.3 (medium risk) in 2020 to 3.7 (high risk) in 2050, considering the risk scale ranging from 1 (very low risk) to 5 (very high risk), or up to 6.6 in cases that future risk will be extreme. More specifically, 35 clusters (43%) face high or very high physical water risk as of 2020, but this number is projected to rise to 47 (57%) by 2050, with an additional 4 clusters (5%) projected to face extreme risk, namely Ludhiana, Ahmedabad and Delhi in India, and Lahore in Pakistan.

The key takeaways from this are:

- Physical water risks are already high for many of the larger clusters.
- All of the largest clusters are projected to face increases in physical water risk by 2050, making it critical to prioritize basin resilience planning.
- The clusters most exposed to physical water risk are in India and Pakistan.
- In short: there are already significant water challenges, and they're only going to get worse.

In the WWF Water Risk Filter, physical water risk is composed of four different risk categories: water scarcity, flooding, water quality and ecosystem services status. As these different physical risk categories affect the apparel and textiles industry in different ways, the following pages will describe in detail these four risk categories and highlight the clusters facing highest risk.

13 clusters, comprised of more than 7 thousand apparel and textiles sites, are projected to face extreme risk of water scarcity by 2050

2.3.1 Water Scarcity and the Apparel and Textiles Industry

Water scarcity refers to the physical abundance or lack of freshwater resources, which can significantly impact business and typically manifest through **production/supply chain disruption**, **higher operating costs**, and **growth constraints**. Water scarcity is human-driven and can be aggravated by natural conditions (e.g., aridity, droughts), and it is generally calculated as a function of the volume of water use/demand relative to the volume of water available in a given area.

In 2020, a total of 26 clusters (14,699 sites, comprising 15% of all OS Hub listed facility locations) were already facing above medium water scarcity risk, and this number is projected to increase to 38 clusters by 2050 (21,993 sites, 23% of OS Hub listed facility locations). Clusters currently facing very high water scarcity risk include:

- Ludhiana (India),
- Alicante (Spain),
- Madrid (Spain),
- Ahmedabad (India),
- Delhi (India) and
- Lahore(Pakistan)

It is worth noting that all of these clusters (with the exception of Alicante and Madrid) are projected to face even higher water scarcity by 2050. Additionally, 9 other clusters are projected to change from high risk to extreme risk, namely:

- Chennai (India),
- Casablanca (Morocco),
- Bangalore (India),
- Tanger (Morocco),
- Los Angeles-Long Beach-Santa Ana (USA),
- Karachi (Pakistan),
- Shijiazhuang (China),
- Jaipur (India) and
- Beijing (China).

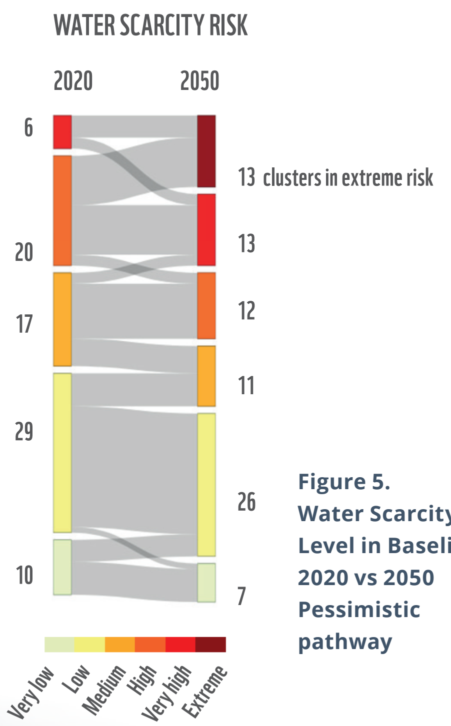


Figure 5. Water Scarcity Risk Level in Baseline 2020 vs 2050 Pessimistic pathway

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IN CONCLUSION

13 clusters, comprised of more than 7 thousand apparel and textiles sites, are projected to face extreme risk of water scarcity by 2050. The situation is also concerning in the clusters of Qingdao (Huai'an) and Shanghai, both on the East China coast, given their large concentration of textile sites and the projections that water scarcity will increase by approximately 20 percentage points.

2.3.2 Flooding and the Apparel and Textiles Industry

Flooding is when there is an overflowing of water onto land that is normally dry. Floods can happen due to overflowing rivers, lakes, or oceans, and are often caused by heavy rainfall, rapid snowmelt, when dams or levees break, or a storm surge from a tropical cyclone, hurricane or tsunami in coastal areas. Flood events can interrupt businesses' operations across their value chain by causing **closure of operations**, **supply chain disruptions**, **limitations to logistics/transportation** and **damaging assets**.

In 2020, a total of 53 clusters (62,350 sites, comprising 64% of all OS Hub listed facility locations) faced above medium flooding risk. This number is projected to slightly decrease to 51 clusters (62,983 sites) by 2050, albeit with a higher risk for more than half of these sites.

A total of 8 clusters faced very high flooding risk in 2020:

- Guangzhou (China),
- Nanchang (China),
- Colombo (Sri Lanka),
- Dhaka (Bangladesh),
- Lahore (Pakistan),
- Jakarta (Indonesia),
- Shantou (China),
- Xiamen (China).

For 6 out of these 8 clusters, flooding risks are projected to increase from very high risk to extreme risk by 2050 (exceptions are Lahore and Xiamen). Additionally, 7 other clusters are projected to increase from high risk to extreme risk:

- Bangkok (Thailand),
- Ahmedabad (India),
- Chennai (India),
- Bangalore (India),
- Yangon (Myanmar),
- Lima (Peru), and
- Surat (India)

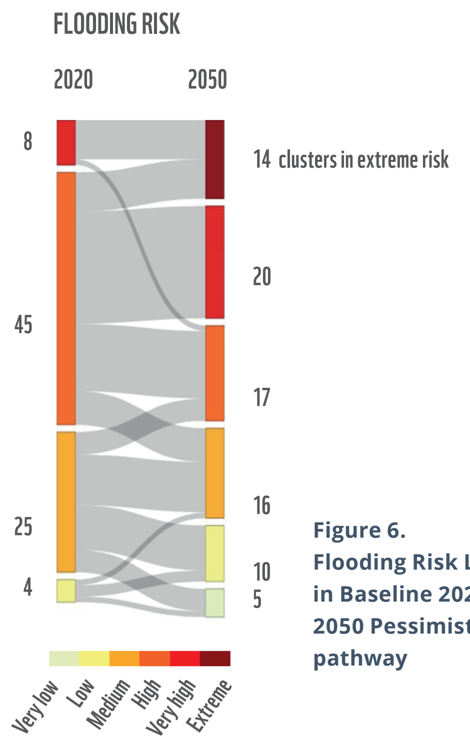

Figure 6. Flooding Risk Level in Baseline 2020 vs 2050 Pessimistic pathway

IN CONCLUSION

More than 20 thousand apparel and textiles sites, comprising roughly 1/5 of all listed OS Hub facility locations, are projected to face floods approximately four times more frequently than in past decades. It is worth noting that all very high-risk clusters in 2020 and almost all projected extreme-risk clusters in 2050 lie in the South and Southeast Asian regions. Sites located in, and brands sourcing from, those regions must act vigilantly to mitigate and/or adapt through stronger resilience efforts their high, and growing, flooding risk.

53 clusters, comprising 64% of all apparel and textiles sites, face above medium flooding risk

By 2050, three out of every four apparel and textile industry suppliers may face high water quality risk

2.3.3 Water Quality and the Apparel and Textiles Industry

Water quality indicates whether water resources are fit for human use and ecosystems alike. Poor water quality – water pollution – can impact businesses* indirectly by causing ecosystems destabilization or serious health issues (which in turn can affect **worker productivity**) as well as directly through **increased operating costs** of water treatment and **limiting production or growth** (not only physically, but also regulatorily and reputationally).

In 2020, a total of 56 clusters (49,896 sites, comprising 52% of all OS Hub listed facility locations) were already facing above medium water quality risk. By 2050, this number is projected to increase to 74 clusters (72,047 sites), meaning 74% of all OS Hub listed facility sites will be facing high water quality risk.

WATER QUALITY RISK

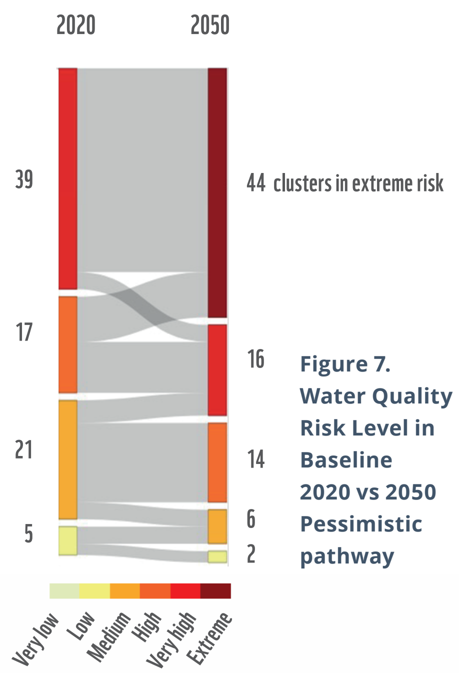

Figure 7. Water Quality Risk Level in Baseline 2020 vs 2050 Pessimistic pathway

Out of the 39 very high risk clusters in 2020, all of them (with exception for Padova, Milan and Thessaloniki) are projected to face extreme risk by 2050. Additionally, 8 other clusters are projected to increase from high risk directly to extreme risk, namely:

- Kolkata (India),
- Bangalore (India),
- Dhaka (Bangladesh),
- Karachi (Pakistan),
- San Salvador (El Salvador),
- Nagpur (India),
- Bangkok (Thailand) and
- Chennai (India)

IN CONCLUSION

With nearly 3/4 of the apparel and textiles sites projected to face high to extreme risk by 2050, it makes water quality a critical issue for the industry in the future. Even now, with 52% of all sites facing high risk in 2020, water quality is an issue upon which the industry must scale up its efforts. Furthermore, a total of 44 clusters are projected to face extreme risk by 2050. In short, water quality is by far the most prominent water risk facing the industry and is projected to worsen in the coming years.

2.3.4 Ecosystem Services Status and the Apparel and Textiles Industry

Ecosystems provide business, people and communities with a wide range of goods and services such as climate and streamflow regulation, water purification, maintenance of species' habitats, and balance of soil biodiversity, pests and diseases, among many others. Therefore, the degradation of ecosystems typically leads to greater instability in water systems and can result in businesses having restricted access in the long-term to the quantity and quality of water needed for their activities as well as other ecosystem services they rely on. This in turn drives many of the financial impacts already noted: **increased operational costs**, **reduced productivity**, and potential **impacts to assets**.

In 2020, a total of 29 clusters (20,005 sites, comprising 21% of all OS Hub listed facility locations) were already facing above medium ecosystem services risk, and this number is projected to increase to 41 clusters (29,955 sites, 31% of all OS Hub listed facility locations) by 2050.

Out of the 29 high risk clusters in 2020:

5 clusters are projected to face extreme risk by 2050:

- Sao Paulo (Brazil),
- Denizli (Turkey),
- Kayseri (Turkey),
- Taguai (Brazil) and
- Gaziantep (Turkey)

5 clusters are projected to face very high risk by 2050:

- Buzau (Romania),
- Nova Serrana (Brazil),
- Porto (Portugal),
- Madrid (Spain),
- Shantou (China)

In addition, 6 clusters facing medium risk in 2020 are projected to face very high risk:

- Adana (Turkey),
- Izmir (Turkey),
- Thessaloniki (Greece),
- Mersin (Turkey),
- Joinville (Brazil) and
- Sao Joao Nepomuceno (Brazil).

IN CONCLUSION

The data suggest that this issue is particularly noteworthy for clusters in both Turkey and Brazil. With between 21% of current and 31% of future apparel and textiles sites facing high ecosystem degradation risk, and given its links to water scarcity, flooding and water quality, ensuring freshwater ecosystems are functioning properly is also a material issue to the industry.

ECOSYSTEM SERVICES RISK

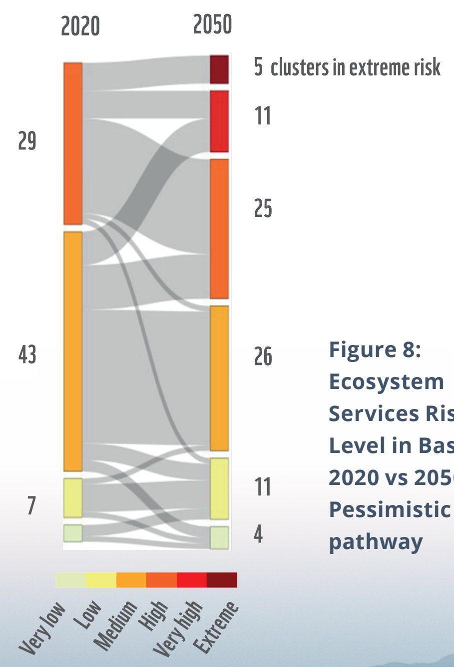

Figure 8: Ecosystem Services Risk Level in Baseline 2020 vs 2050 Pessimistic pathway

By 2050, half of the apparel and textiles industry's clusters are projected to face high ecosystem degradation. But there is still time to bend the curve

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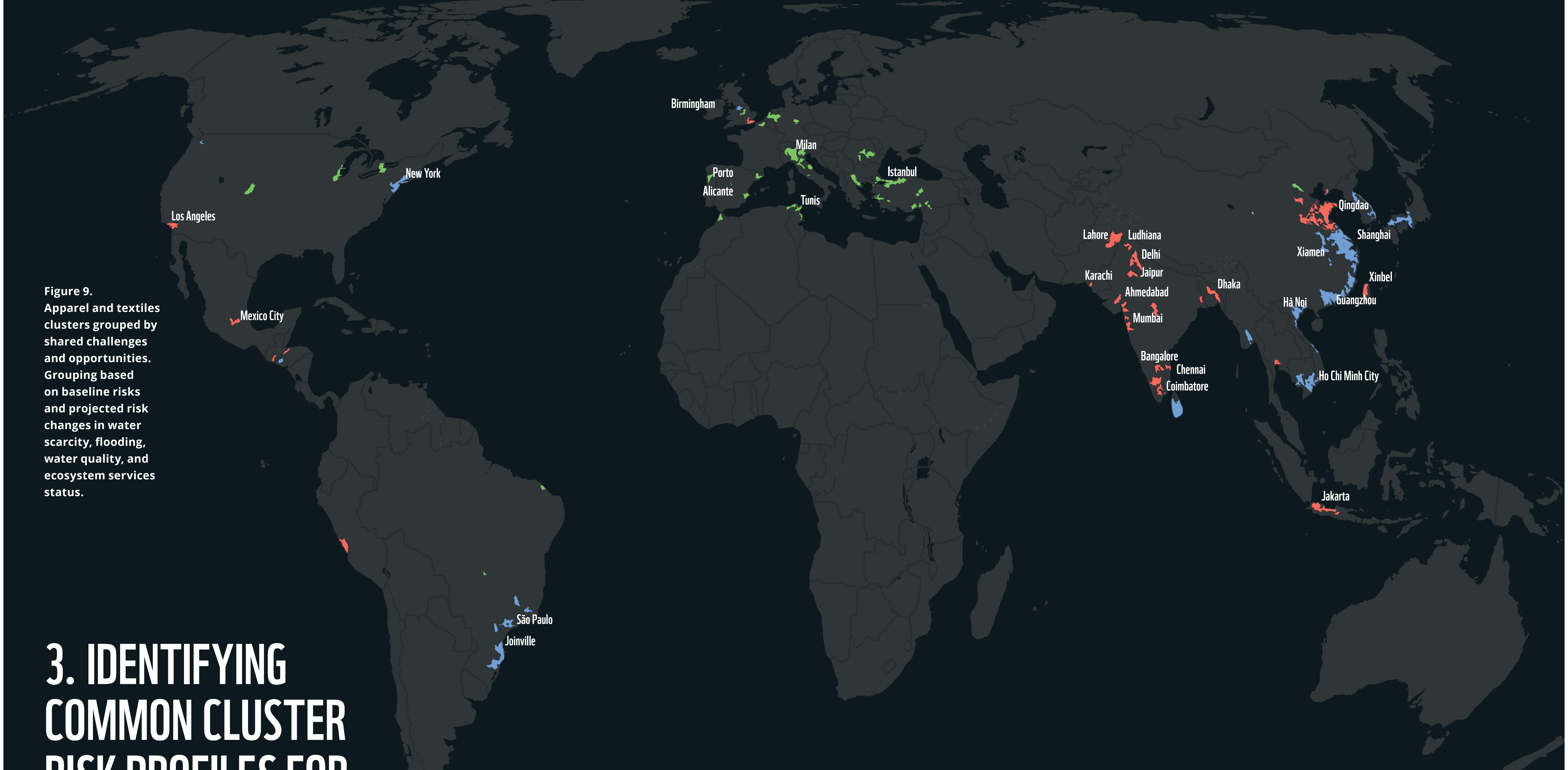


Figure 9. Apparel and textiles clusters grouped by shared challenges and opportunities. Grouping based on baseline risks and projected risk changes in water scarcity, flooding, water quality, and ecosystem services status.

3. IDENTIFYING COMMON CLUSTER RISK PROFILES FOR SHARED CHALLENGES AND OPPORTUNITIES

We have seen that there is not a singular angle to define which cluster faces or will face highest water risks.

Depending on the water risk category, from water scarcity to ecosystem degradation, different clusters rise to the top. Each site and each cluster faces unique issues on the ground - as they say, water is local and context always matters.

Nevertheless, the exercise of mapping the water risks of clusters does also identify some shared challenges. That in turn creates opportunities to learn about potentially shared solutions. For example, while Qingdao (China) and Los Angeles-Long Beach-Santa Ana (USA) are separated by thousands of kilometers, they share some of the same challenges when it comes to water risks. By organizing clusters by their most pressing water risks, we can help to identify opportunities to exchange knowledge on which solutions are best to address which combination of risks.

Harnessing a machine learning group analysis (See Appendix for more details) we identified that the global clusters of the apparel and textiles industry can be organized into 3 groups:

1. Group 1 are the clusters facing the greatest combined set of high water risks. They are the clusters with the highest water scarcity risk, and are also projected to face the highest increase in risk, not only in water scarcity, but also in flooding and water quality risk.
2. Group 2 are the clusters where flooding is the most pronounced water risk, both today and in the future.
3. Group 3 are the clusters with the highest risks in water quality and ecosystem services.

Figure 10

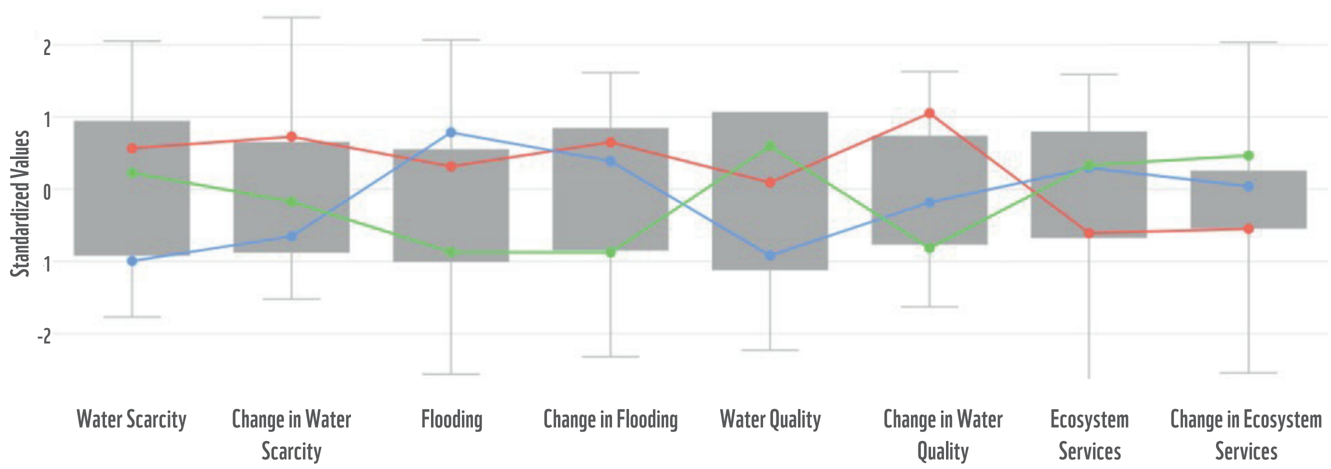


TABLE 1

Group 1	Group 2	Group 3
Ahmedabad (India)	Boston (USA)	Adana (Turkey)
Bangalore (India)	Colombo (Sri Lanka)	Alicante (Spain)
Bangkok (Thailand)	Da Nang (Viet Nam)	Amsterdam (Netherlands)
Casablanca (Morocco)	Guangzhou (China)	Barcelona (Spain)
Chennai (India)	Ha Noi (Viet Nam)	Beijing (China)
Coimbatore (India)	Ho Chi Minh City (Viet Nam)	Birmingham (UK)
Dalian (China)	Joinville (Brazil)	Bologna (Italy)
Delhi (India)	Liuan (China)	Buzau (Romania)
Dhaka (Bangladesh)	Manchester (UK)	Chicago (USA)
Guatemala City (Guatemala)	Nanchang (China)	Denizli (Turkey)
Jaipur (India)	New York-Newark (USA)	Denver-Aurora (USA)
Jakarta (China)	Nova Serrana (Brazil)	Erfurt (Germany)
Karachi (Pakistan)	Osaka (Japan)	Fermo (Italy)
Kolkata (India)	San Salvador (El Salvador)	Fortaleza (Brazil)
Lahore (Pakistan)	Sao Joao Nepomuceno (Brazil)	Gaziantep (Turkey)
Lima (Peru)	Sao Paulo (Brazil)	Guidonia Montecelio (Italy)
London (UK)	Seattle (USA)	Istanbul (Turkey)
Los Angeles-Long Beach-Santa Ana (USA)	Seoul (Republic of Korea)	Izmir (Turkey)
Ludhiana (India)	Shanghai (China)	Kayseri (Turkey)
Mexico City (Mexico)	Shantou (China)	Lille (France)
Mumbai (India)	Taguai (Brazil)	Madrid (Spain)
Nagpur (India)	Xiamen (China)	Mersin (Turkey)
Qingdao (China)	Yangon (Myanmar)	Milan (Italy)
Rio de Janeiro (Brazil)		Padova (Italy)
San Pedro Sula (Honduras)		Porto (Portugal)
Shijiazhuang (China)		Sanclerlandia (Brazil)
Surat (India)		Tanger (Morocco)
Xinbei (China Taiwan Province)		Thessaloniki (Greece)
		Toronto (Canada)
		Tunis (Tunisia)
		Yuzhong (China)

Table 1:
(Left) List of apparel and textiles clusters within the three groups of shared challenges and opportunities.

Figure 10.
(Above)
Box plot: Grouping of apparel and textiles clusters based on 2020 (baseline) risks and projected risk changes (by 2050 pessimistic pathway) in water scarcity, flooding, water quality, and ecosystem services status.

There are a few key takeaways by organizing the data in this manner:

Group 1

There are significant opportunities to **share lessons learned between India and Pakistan** (perhaps unsurprisingly given their general proximity), but also between **South Asia with several apparel hubs in the Americas** (Guatemala City, Lima, Greater LA, Mexico City, Rio de Janeiro and San Pedro Sula). Organizations that bridge these geographies, such as the Alliance for Water Stewardship (see Box C) offer a pathway to help translate lessons and solutions.

Group 2

There is a general **grouping of clusters in Southeast Asia facing the common challenge of flood risk**. This is supplemented by potential solutions outside of this region ranging from the Americas (New York, Boston, Seattle, Sao Paulo, San Salvador) to Eastern Asia (Osaka, Shanghai, Seoul). **Development agencies** with links to Japan and Korea, but also to China (e.g., JAICA, AIIB, ADB, KOICA) and even those in the Americas (e.g., IFC, IADB, USAID) have an opportunity to foster linkages between cities in their respective countries/ regions and those in Southeast Asia.

Group 3

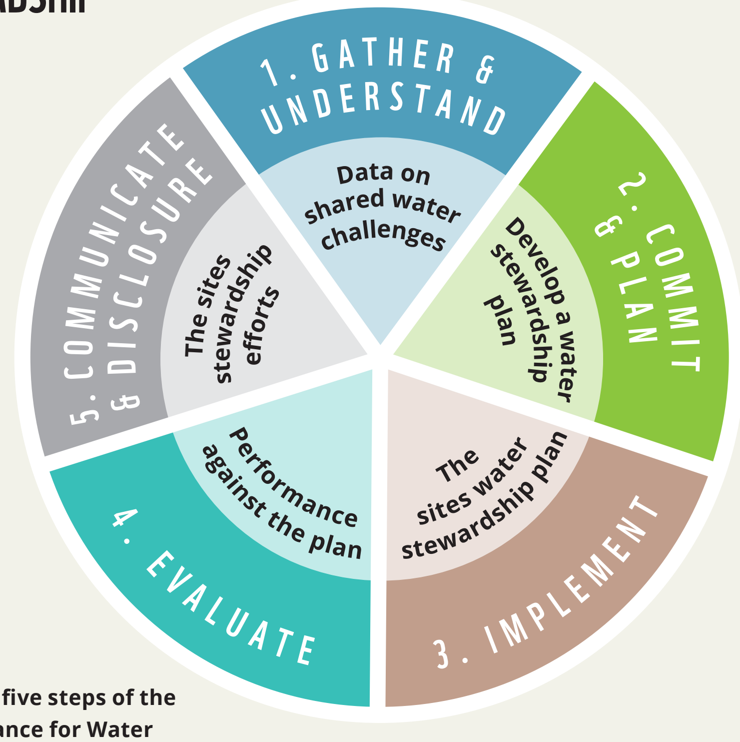
Lastly, this group includes a predominance of European countries. There are real opportunities to **learn from the growing efforts in Europe to implement nature-based solutions to address water quality issues** (e.g., the Dutch Room for Rivers work, efforts in the Danube to restore wetlands, etc.) and share these not only within Europe, but also with those clusters outside of Europe that share these common challenges.

BOX C

ALLIANCE FOR WATER STEWARDSHIP

The **Alliance for Water Stewardship (AWS)** is a global network with over 160 members. Its mission is to ignite and nurture global and local leadership in credible water stewardship that recognises and secures freshwater's social, cultural, environmental and economic value.

The AWS Standard provides a mechanism through which sites (for example, a manufacturing facility) can follow a defined approach to assess and understand both the site's water context (internal and external) and material water risks. Site-level insights from across a supply chain can then be aggregated to identify corporate-level water-related risks. The five steps of the Standard enable implementers to understand their site's reliance upon and impact on water resources and, crucially, it steers the site through a process to identify other risks and opportunities that might exist outside the site itself within the wider catchment (or watershed) and in its supply chain. It is through this comprehensive approach, moving beyond water management to stewardship, that implementers contribute towards the five AWS Standard outcomes.



The five steps of the Alliance for Water Stewardship Standard

Implementation of the AWS Standard takes a site through a process of data collection, to understand operational and external risk, before embarking on engagement with local stakeholders and the development of a water stewardship plan. Implementing the AWS Standard across a supply chain can help inform target and strategy development for brands and suppliers alike. For the Textile & Apparel sector, the AWS Standard can be used as a common language throughout the supply chain, reducing competing demands on suppliers and defining an agreed approach in responding to water challenges across the sector. Significant value can be created by embedding globally recognised best water stewardship practices within existing sustainability-focused initiatives – and by rolling out an aligned approach in the supply chain. Therefore, AWS has developed the Implementation Accelerator Programme, which aims to help brands and their suppliers use the AWS Standard System at scale. By identifying priority locations for AWS Standard implementation and facilitating a collective, a place-based approach, common objectives and benefits can be achieved more effectively. To find out more information, visit **a4ws.org/priority-sectors/textiles/**.

Opportunity for cross-sectoral collaboration

It is also worth noting that since the physical water risk of basins is shared with other actors in these cluster groupings, it is worth considering cross-sectoral learnings as well. Looking at Figure 11, we see that there is considerable overlap between apparel and textiles facility locations and Information and Communications Technology (ICT) facility locations. On top of this, we can see that oftentimes both of these sectors are located near (or formerly within) wetlands and deltas (see Figure 12), providing a reason for cross-sectoral collaboration on wetland restoration to help alleviate water scarcity, flooding and water quality risks. These sectors not only happen to have considerable overlap spatially, but also share many characteristics when it comes to supply chain management and lessons learned on how to drive efforts with shared suppliers. In that sense, this analysis can offer insights (and opportunities) not only to the Apparel and Textiles industry, but to the ICT sector as well.

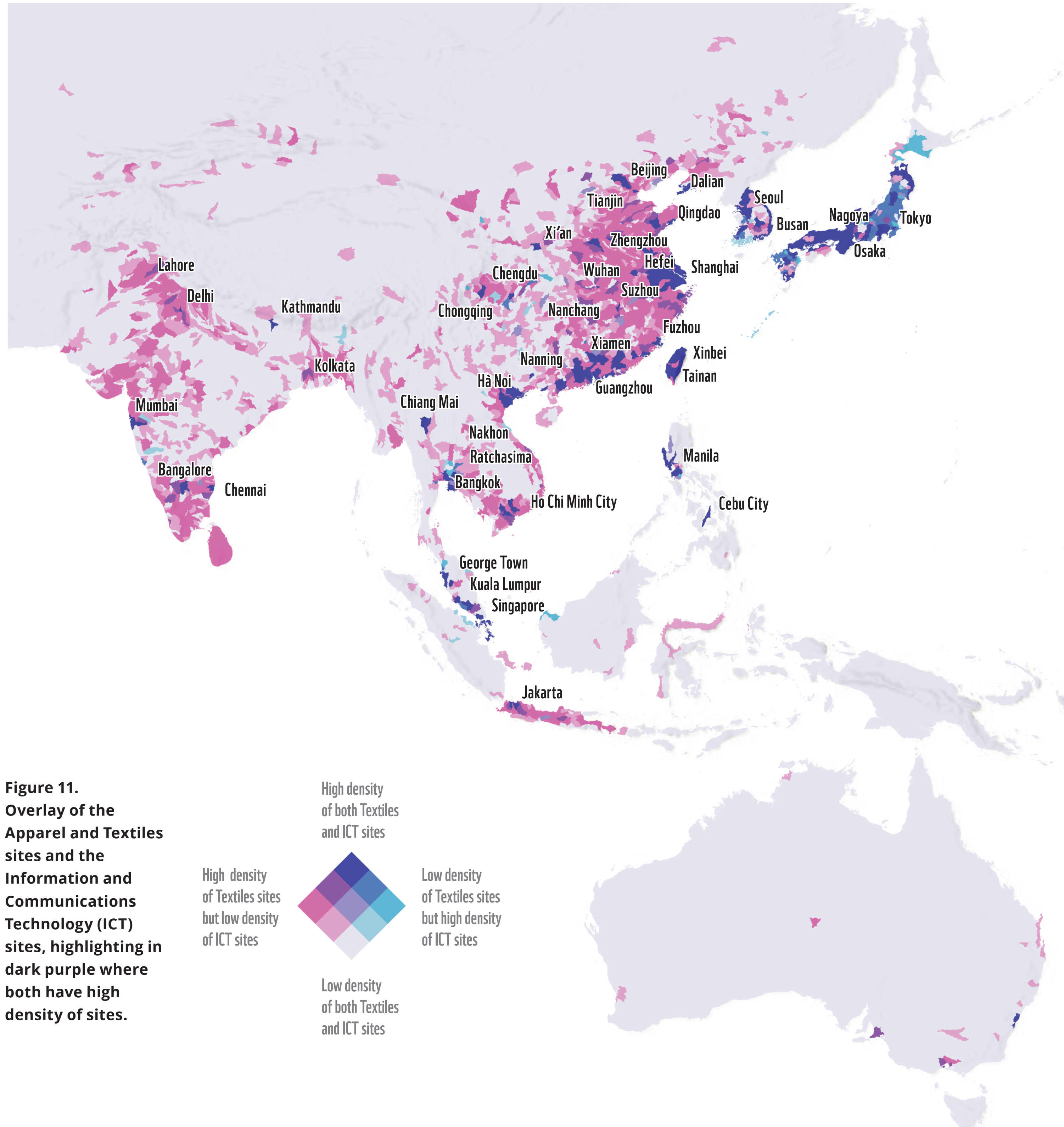


Figure 11. Overlay of the Apparel and Textiles sites and the Information and Communications Technology (ICT) sites, highlighting in dark purple where both have high density of sites.

Figure 12. Wetlands along East and Southeast Asia.

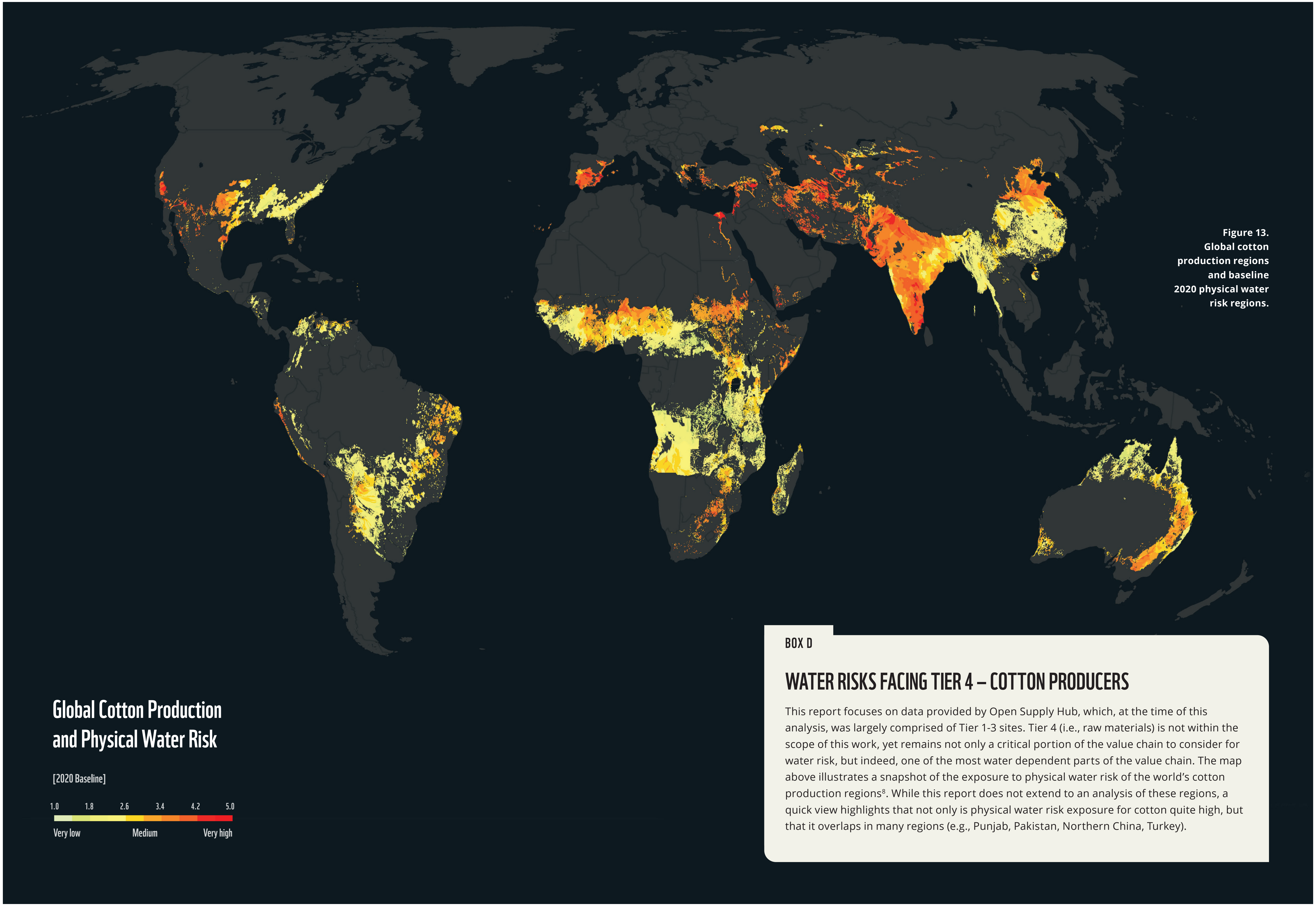


Figure 13. Global cotton production regions and baseline 2020 physical water risk regions.

BOX D

WATER RISKS FACING TIER 4 – COTTON PRODUCERS

This report focuses on data provided by Open Supply Hub, which, at the time of this analysis, was largely comprised of Tier 1-3 sites. Tier 4 (i.e., raw materials) is not within the scope of this work, yet remains not only a critical portion of the value chain to consider for water risk, but indeed, one of the most water dependent parts of the value chain. The map above illustrates a snapshot of the exposure to physical water risk of the world's cotton production regions[8]. While this report does not extend to an analysis of these regions, a quick view highlights that not only is physical water risk exposure for cotton quite high, but that it overlaps in many regions (e.g., Punjab, Pakistan, Northern China, Turkey).

4. CLUSTER DEEP DIVES: LAHORE AND HO CHI MINH CITY

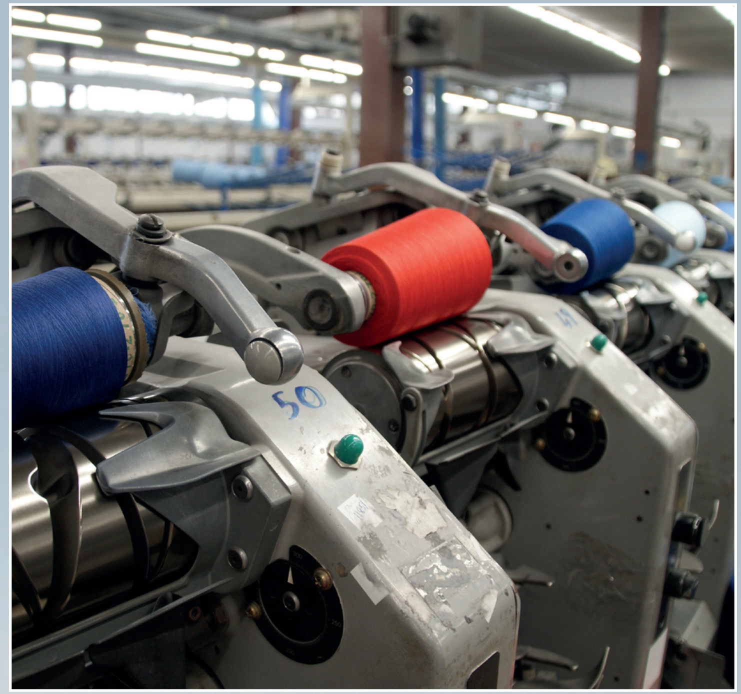
While a comprehensive breakdown of the different risks facing each cluster is theoretically possible, it would be impossible to cover in such a report. Nevertheless, we felt it worthwhile to unpack how such results could be harnessed by a given cluster to help inform their collective efforts to tackle shared water challenges.

We have opted to select two clusters: (1) Lahore, Pakistan and (2) Ho Chi Minh City, Viet Nam, for several reasons:

- They represent two of the groupings (#1 and #2);
- They are both amongst the larger clusters (~750 sites/20th and ~2500 sites/8th respectively; and
- They are both clusters where WWF has extensive experience of working both on the ground and in the basins, giving us the ability to ground truth the analysis generated in this report.

Figures 15 and 18 offer a breakdown of the risk categories associated with these two clusters, and extends this to several other dimensions covered by the WWF Water Risk Filter (notably reputational and regulatory risk). Furthermore, Figures 16 and 19 provide a breakdown of the brands that have suppliers in these clusters.

The picture that emerges is one that requires some interpretation.



Main: Ho Chi Minh City, Viet Nam

HO CHI MINH CITY CLUSTER

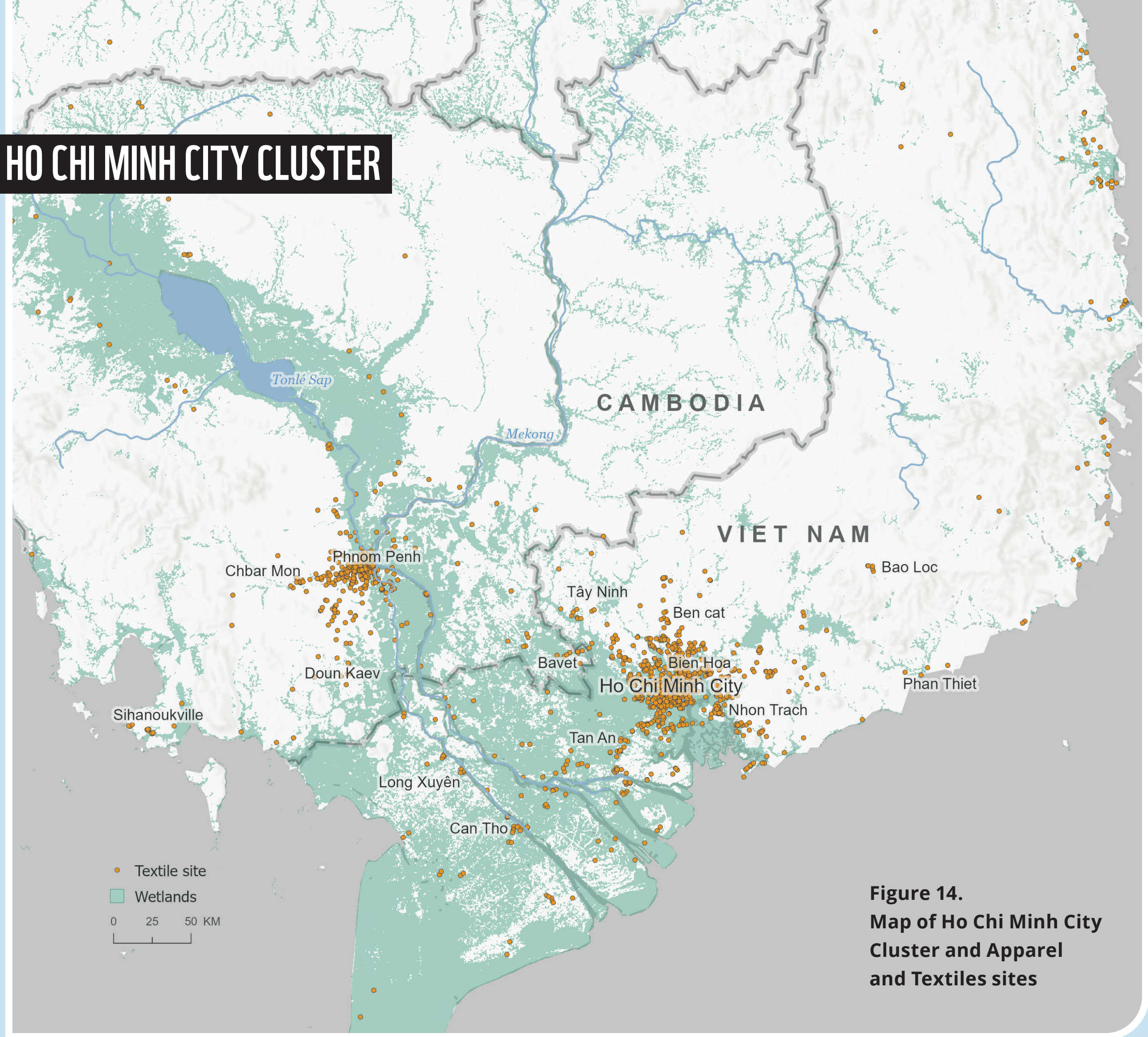


Figure 14. Map of Ho Chi Minh City Cluster and Apparel and Textiles sites

- As previously mentioned, **flooding risk** is not only high presently, but projected to increase by 2050. When we combine that with some of the regulatory risks faced by the cluster, it suggests the strong need to rally on **shared flood resilience**.
- Furthermore, noting that **ecosystem service status risk** is already reasonably high and **water quality risk** is slated to increase significantly, it is a cluster that would be well served by considering how **restoring floodplains and wetlands could help to mitigate the impact of flood pulses**.
- Working with public and private stakeholders to **collectively facilitate and strengthen flood resilience and water resources management capacity** through nature-based solutions may also benefit such sites, given that this is an area in need of strengthening.
- Ensuring that on site water treatment (especially hazardous chemicals in the event of a flood) and stormwater management are properly addressed would make sense.
- Given the reasonably high density of sites in this cluster, combined training in this cluster on all of the above issues would be logical.
- Based on the disclosures of their sourcing activities between 2019 and 2022 (see Figure 16), the following brands appear to be best positioned to support this cluster: Adidas, Anonymous, Columbia, Gap Inc. and Fast Retailing, along with, to a lesser extent, VF and Target. This sourcing data would need to be confirmed, but this is a strong starting point and highlights the importance of maintaining timely, up-to-date data. The brands sourcing from this region have a shared interest in the stability and resilience of the Ho Chi Minh City cluster and should consider supporting not only suppliers at the facility level, but also broader basin efforts to tackle flooding risks in particular. For a full list of the suppliers in this cluster, please visit **Open Supply Hub**.

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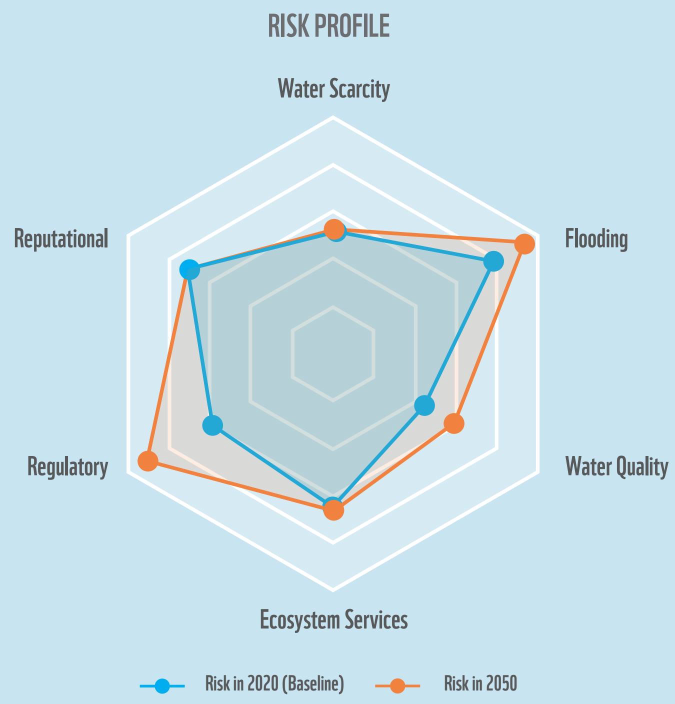


Figure 15. (Above): Spider diagram showing risk profile for Ho Chi Minh City

Figure 16. (Left): Number of listed suppliers, based on 2019-2022 data, by brand for the Ho Chi Minh cluster

DRIVING COLLECTIVE ACTION IN THE GREATER MEKONG DELTA (HO CHI MINH CITY CLUSTER)

"Especially in the Central region, floods and storms are frequent disasters. The company has experienced a number of losses at manufacturing sites, such as damage to roofs of buildings during storms, and machinery and garment goods inundated in sudden floods. So far, the company sees the most impact in the disruption of the labor force… work productivity during floods is low and unstable. This is so far the most detrimental effect to business continuity."

Mrs. Nguyen Thi Lien, Vice Chairman, Phong Phu International Joint Stock Corporation (PPJ)

Hydropower development along the Mekong river has caused significant challenges in terms of reduced sediment load and habitat fragmentation, which has brought upstream basin challenges to the forefront of the Ho Chi Minh City cluster's challenges. Large parts of the Mekong Delta are sinking due to depletion of river sediments and groundwater extraction. Even though the delta sinks naturally, increasing land subsidence caused by unsustainable groundwater extraction, and a loss of sediment, has hastened the process[9]. Water pollution due to industries, over-exploitation of groundwater around Ho Chi Minh City, and decreasing aquifer water levels are also affecting water availability in the basin. Other water risks include floods, saline intrusion, and drought, all of which are likely to worsen with climate change, unsustainable sand mining and upstream hydropower development.

WWF-Viet Nam piloted a water stewardship approach for the textile sector in 2019 with the initial aim to promote water efficiency in the sector. The project works to reduce resource impacts and engage with stakeholders to find solutions to water challenges in the basin. So far, the project has succeeded in engaging textile businesses, facilitating technical support to manufacturers to enhance water effectiveness at the factory-level, promoting green credit amongst financial institutions, driving collective commitment for sustainable transformation of the sector, and advocating for green production and industrial parks with local industrial authorities. Building on these successes, the work will continue to aim to mobilize solutions throughout the basin to tackle shared water challenges.

"WWF- Viet Nam initiated the Water Stewardship project because there was a need to have an entity that could put out a call for collective action. One of the drivers of behaviour change in businesses is pressure from peers and to improve their public image – so WWF, in association with VITAS, is using a public platform to drive collective action for the green transformation of the sector."

Mrs. Hoang Thi Thanh Nga, Water Stewardship Programme Manager, WWF-Viet Nam

LAHORE CLUSTER

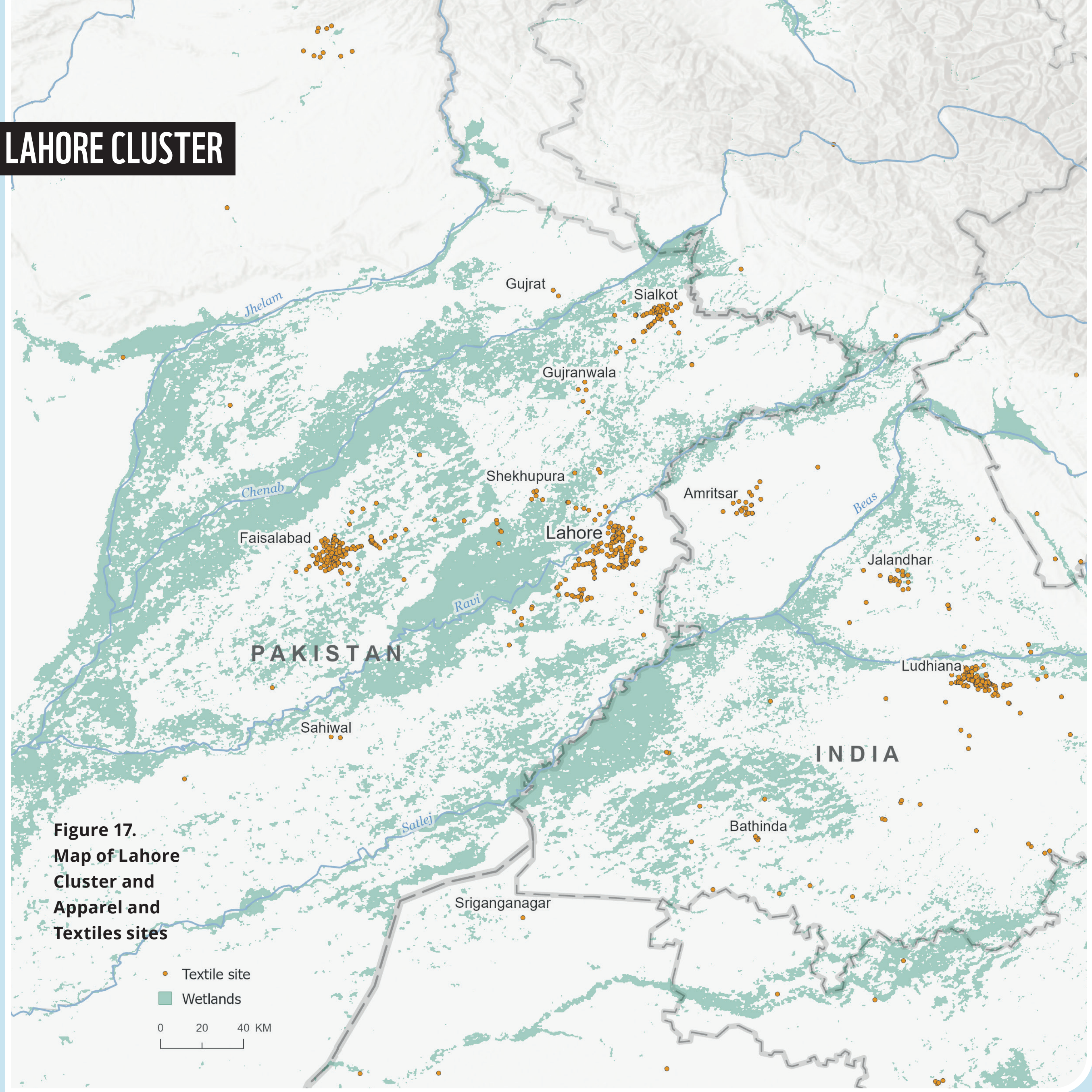
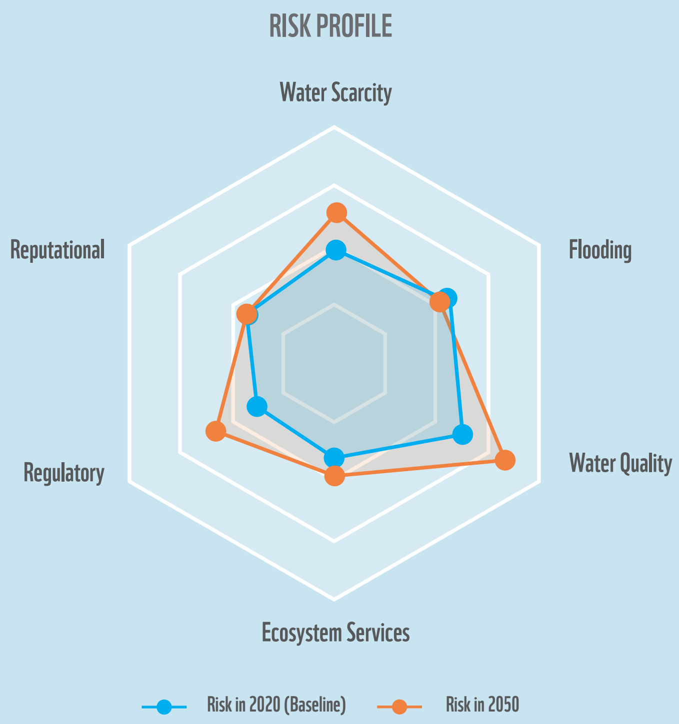


Figure 17. Map of Lahore Cluster and Apparel and Textiles sites

- As previously mentioned, Lahore faces a mix of challenges, with **water scarcity, water quality,** and **flooding risk** all being notable. When we combine that with some of the regulatory risks faced by the cluster, it suggests the strong need to rally around shared resilience, but in this case to consider not only conditions of too much water, but also of too little. Efforts to dampen "flashy" water systems and ensure water moves more slowly through the basin are critical to this cluster.
- With **water quality risk** slated to increase significantly, it is a cluster that would be well served by considering efforts to improve water quality both inside and outside sites.
- With water scarcity being of particular concern, efforts to **improve water use efficiency should be considered along with contingency plans for water shortages**. This also extends to considering water with respect to energy sources (since water scarcity could also drive brown/black outs of any water-intensive energy sources).
- Based on the disclosures of their sourcing activities between 2019 and 2022 (see Figure 19), which would need to be confirmed with up-to-date data, the following brands appear to be best positioned to support this cluster: particularly Adidas, Boohoo, Missguided, the Very Group, and Arcadia, along with, to a lesser extent, Lidl, Tchibo and Levi Strauss & Co.. All of these brands with high levels of sourcing from this region have solid dependencies on the status of water linked to the Lahore cluster, and should consider working with suppliers at the facility level, but and also supporting broader basin efforts to tackle combined water scarcity, water quality, and flooding challenges. For a full list of the suppliers in this cluster, please visit **Open Supply Hub**.



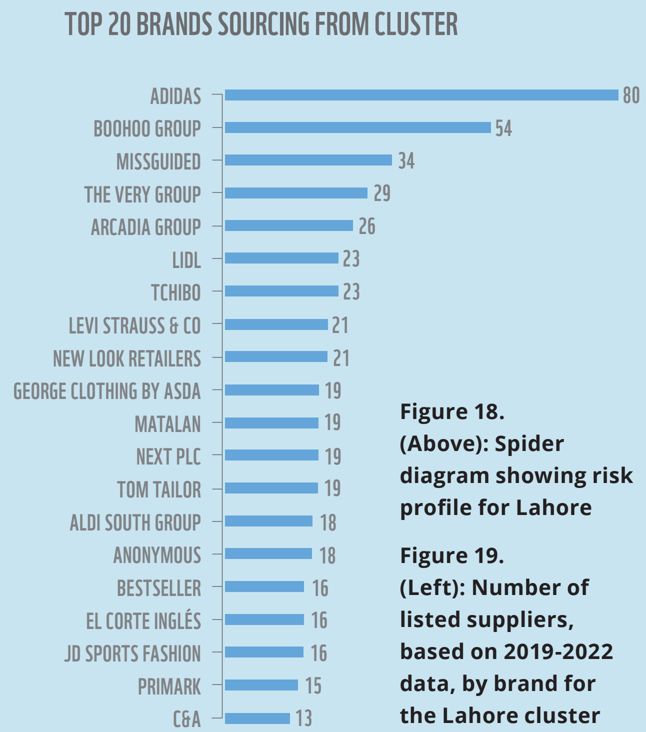


Figure 18. (Above): Spider diagram showing risk profile for Lahore

Figure 19. (Left): Number of listed suppliers, based on 2019-2022 data, by brand for the Lahore cluster

DRIVING COLLECTIVE ACTION IN THE INDUS RIVER BASIN (LAHORE CLUSTER)

"I have seen that the push from brands has a trickle-down effect on suppliers, which drives them to focus on reducing their water use and wastewater volumes."

Sohail Ali Naqvi, Director Freshwater Programme, Lead Stewardship and Sustainability, WWF-Pakistan

The Apparel and Textiles industry are one of the key sectors in Pakistan, which banks on the Indus Basin for the production of cotton, as well as the manufacturing of textile products. Industrial sectors have caused the water quality of the basin to deteriorate significantly, with all major tributaries of the basin carrying both sewage and industrial effluents.

Despite the government's commitment to prioritize integrated water resources management (IWRM), Pakistan lags in the implementation of water conservation and nature-based solutions. Recognizing the gaps that exist in local water resources management and the textile sector's large water footprint, WWF-Pakistan has been engaging businesses and the public sector to drive collective action in the basin.

The International Labour and Environmental Standards (ILES) in Pakistan's SMEs' project has helped textile companies reduce their energy and water footprint, and implement international standards such as the Alliance for Water Stewardship (AWS). WWF-Pakistan initiated a city-wide partnership on sustainable water use in the city of Lahore in 2015, and helped to develop a common understanding of the water issues facing the city. The partnership helped one of WWF's multinational corporate partners to install rainwater harvesting systems and construct wetlands to replenish water, which is now used for both agricultural and aquaculture purposes.

5. KEY MESSAGES & CONCLUSION

The Apparel and Textiles industry was founded on water and remains intimately connected to this key resource. The clusters that have formed in the industry are heavily influenced by river systems, wetlands and deltas where some of the world's largest cities have emerged.

While water has fuelled the growth and success of the industry, it also is an issue which, due to human activities, now poses a risk to these same clusters.

Part I in this series outlined the key issues facing the industry. Part II has sought to unpack how water risk affects the largest clusters in the industry. By grouping sites, not only can we begin to better understand the shared physical water risks facing sites (and even co-located sites in other sectors, such as the Information and Communications Technology), but we can also begin to better understand the opportunities to jointly de-risk key production clusters.

Several key messages emerge from this report:

- Much of the **industry is concentrated in a few large clusters and many of these large clusters are highly exposed to physical water risks**. Some clusters are particularly dense (e.g., Dhaka) ensuring they are at greater risk but also affording them a greater opportunity to collaborate.
- While the industry often focuses on water scarcity and efficiency, broadly speaking, **flooding risks and water quality are the key risks for the industry to prioritize** (both in terms of severity and prevalence). As climate instability increases, the industry must **equip suppliers to enhance their resilience** to avoid supply chain disruptions that are likely to emerge – as evidenced by recent flooding in India and Pakistan.
- Given the dual challenges of flooding risk and water quality risk, focusing on **protecting, managing and restoring wetlands offers a logical pathway for the industry**. Not only do healthy wetlands help to mitigate floods, but they also purify water and can even help to tackle water scarcity, while enhancing degraded ecosystems. Enhancing the health of wetlands represents a multi-pronged way to address the array of risks facing sites across most clusters.
- There are considerable opportunities to **share learnings between sites and clusters** around the world. This also extends to **sharing challenges and solutions with other, co-located sectors** such as the ICT sector and other sectors, which can be explored via the **Open Supply Hub**.

Understanding water risks is critical throughout the value chain. While this work focused on Tiers 1-3 for the most part, understanding water risk facing Tier 4 sourcing regions (e.g., raw material clusters, such as cotton which was briefly highlighted in this report) is important, as is understanding how stores and customers can also be impacted by water risks. After all, shoppers who have had their homes flooded are not focused on next season's clothing trends! Moreover, thinking about the exposure of customers also enables brands to empower their customers to also take action through innovative product, service, and marketing/awareness efforts.

Water is local and responding to its challenges will vary from place to place, and company to company. However, as we explore the shared water challenges we face in common basins, we have the opportunity to enhance collaboration and work together to face these challenges. Many hands make for light work, and water will indeed require many hands.

With transparent data, brave brand leaders, supportive governments and passionate civil society organizations, we have many of the building blocks required to not only mitigate water risks for the apparel and textiles industry but for nature and communities as well.

Stay tuned for more in Part III, the third, and final, report in this series, which will further outline how WWF is taking action and how we are working to mobilize others to scale solutions.

6. APPENDIX A – DATA AND METHODS

The Open Supply Hub dataset

Open Supply Hub (formerly the Open Apparel Registry) is an accessible, collaborative, supply chain mapping platform, used and populated by stakeholders across sectors and supply chains. By September 2022, the platform had records for 96,866 textile and apparel sites worldwide, including their location and organizations connected to them (like brands whom they supply to). This data was the base for this report.

The WWF Water Risk Filter Scenarios dataset

The **Water Risk Filter** scenarios dataset builds on the framework of the tool's current basin risk assessment, but integrates 2030 and 2050 quantitative projections of water risks (see the **Water Risk Filter Methodology** for more details). This dataset is based on a combination of the most relevant climate scenarios (**IPCC CMIP5 Representative Concentration Pathways – RCP**) and socio-economic scenarios (**IIASA Shared Socioeconomic Pathways – SSP**), and it is in line with the Task Force on Climate-related Financial Disclosure (TCFD) recommendations. More specifically, the risk scores of the year 2020 (baseline) are added with projected changes based on climate impact ensemble projections that account for climate (e.g., temperature, precipitation, wind) and socio-economic variables (e.g., population, GDP, technological developments), and represent the consequences and effects of climate and socio-economic changes on water resources by 2030 and 2050. Accordingly, the pathways for the Water Risk Filter scenarios follow the respective three narratives described in table 2 on the right.

For this report, we presented the results focused primarily on how physical water risks in the cluster regions will evolve by 2050 under a pessimistic scenario. Whilst it is important to understand exposure to water risk under different scenarios, being aware of and prepared for the 'worst case' pessimistic pathway is imperative.

For this report, we presented the results focused primarily on how physical water risks in the cluster regions will evolve by 2050 under a pessimistic scenario.

Table 2. (Right): Overview of the narratives of the Water Risk Filter Scenarios pathways

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	OPTIMISTIC	CURRENT TREND	PESSIMISTIC
CLIMATE ASPECTS [1]	Moderate emissions RCP2.6 / RCP4.5	Intermediate emissions RCP4.5 / RCP6.0	High emissions RCP6.0 / RCP8.5
	· Moderate mitigation measures so that GHG emissions are halved by 2050 · Increase of global mean surface temperature is unlikely to exceed 2°C by the end of the 21st century	· Intermediate mitigation measures so that GHG emissions peak around mid-century, then start declining · Increase of global mean surface temperature is likely to exceed 2°C by the end of the 21st century	· Business-as-usual so that GHG emissions continue to rise throughout the 21st century · Increase of global mean surface temperature is likely to exceed 4°C by the end of the 21st century
SOCIO-ECONOMIC ASPECTS, [2] EXTENDED TOWARDS WATER AVAILABILITY AND USE [3]	Sustainability SSP1	Middle of the road SSP2	Regional rivalry SSP3
	· Emphasis on human and nature well-being · Effective and persistent cooperation and collaboration across the local, national, regional international scales and between public organizations, private sector and civil society within and across all scales of governance · Rapid technological change · Improved resource efficiency · Sustainability concerns; more stringent environmental regulation implemented · Research and technology development reduce the challenges of access to safe water and improved sanitation	· Current social and economic trends continue · Relatively weak coordination and cooperation among national and international institutions, the private sector, and civil society for achieving sustainable development goals · Technological progress but no major breakthroughs · Modest decline in resource use intensity · Moderate awareness of the environmental consequences of choices when using natural resources. Environmental systems experience degradation · Access to safe water and improved sanitation in low-income countries makes unsteady progress	· Emphasis on national issues due to regional conflicts and nationalism · Societies are becoming more skeptical about globalization. Global governance, institutions and leadership are relatively weak · Low investment in technology development · Increase in resource use intensity · Environmental policies have very little importance. Serious degradation of environmental systems in some regions · Growing population and limited access to safe water and improved sanitation challenge human and natural systems

[1] IPCC (2014). Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp. **https://www.ipcc.ch/report/ar5/syr/**

[2] O'Neill, B., Kriegler, E., & Ebi, K. L. (2017). Supporting information. Supplementary content to: the roads ahead: narratives for shared socioeconomic pathways describing world futures in the 21st century. Glob Environ Chang, 42, 169-180. **https://doi.org/10.1016/j.gloenvcha.2015.01.004**

[3] Wada, Y., Flörke, M., Hanasaki, N., Eisner, S., Fischer, G., Tramberend, S., ... & Wiberg, D. (2016). Modeling global water use for the 21st century: The Water Futures and Solutions (WFaS) initiative and its approaches. Geoscientific Model Development, 9(1), 175-222. **https://doi.org/10.5194/gmd-9-175-2016**

Clustering the apparel and textile sites

Identifying specific sites of highest risk is definitely of great importance for companies, however, it does not help the industry as a whole as much as identifying where there are the largest concentrations of sites under high risk. That is especially the case for Apparel and Textiles as the industry has a high concentration of sites in a few regions. The rationale for this clustering is that 1) sites within a same basin (catchment) share very similar challenges and opportunities; and 2) results are easier to manage, which makes it easier to translate into action on the ground. Therefore we focused this analysis on the clusters of highest density of sites, where collective action can make a great impact.

To delineate clusters we firstly did a spatial join to count the number of apparel and textile sites in each HydroSHEDS[10] HydroBASINs Level 7, which are basically river basins (catchments) of approximately 1,500 km^2, the same watershed division used for the WWF Water Risk Filter indicators. Secondly, we used an iterative approach to select only spatially contiguous basins encompassing significantly high numbers of textile sites. The first iteration selected basins that contained >50 textiles sites in a basin (2.5 times the average, excluding the basins with no site). The second iteration added basins with at least the average number of sites, and that were contiguous to any basin selected in the first iteration. The third iteration, once again, added basins with at least the average number of sites, and were contiguous to any basin selected in the previous iterations. By the fourth iteration no additional basin was selected given the criteria. Thirdly, we used only the selected basins and merged the spatially contiguous ones into clusters. This process resulted in 82 clusters of various sizes, ranging from 275 to 167,745 km^2. Lastly, we used the WWF Water Risk Filter Scenarios data to compute the cluster's risk scores in the year 2020 (as the baseline) and in 2050 (Pessimistic pathway), based on the area-weighted average.

Grouping clusters of common risk profile

Looking at the risk profile of the 82 clusters it was evident that many clusters share certain risk profiles. With a different perspective, it also represents many clusters sharing opportunities to exchange knowledge on which solutions are best to address which combination of risks, and thus learning from each other. With this in mind, we used **machine learning group analysis** to identify groups of clusters where all the clusters within each group are as similar as possible, and all the groups themselves are as different as possible. Similarity was based on the clusters' risk profile, i.e., their baseline risk scores as well as their projected risk change between 2020 and 2050 in the physical risk categories of water scarcity, flooding, water quality, and ecosystems services status.

Identifying specific sites of highest risk is definitely of great importance for companies, however, it does not help the industry as a whole as much as identifying where there are the largest concentrations of sites under high risk.

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World Wide Fund for Nature (WWF) is one of the world's largest and most experienced independent conservation organizations, with over 5 million supporters and a global network active in more than 100 countries.

WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by conserving the world's biological diversity, ensuring that the use of renewable natural resources is sustainable, and promoting the reduction of pollution and wasteful consumption.

As a part of its efforts to achieve this mission, WWF has partnered with many fashion companies (e.g., H&M Group, PVH Corp and Tommy Hilfiger, Levi Strauss & Co, Gap Inc., and others) and peer organisations on an approach called 'Water Stewardship'.

Adopting Water Stewardship requires not only impact reduction activities with manufacturers and materials (i.e., water management), but also asks companies to address shared water challenges and governance in basins through collective action with other businesses, governments, NGOs and communities. These key water users work together to create shared solutions to shared water risks, with a focus on collective solutions to underlying problems and with the goal to ultimately strengthen water governance in partnership with policymakers.

You can find out more about WWF's work on water stewardship **here**. You can find out more about WWF's on-ground work with the apparel and textiles industry **here**.

Publisher: WWF Germany & WWF Sweden

November 2022

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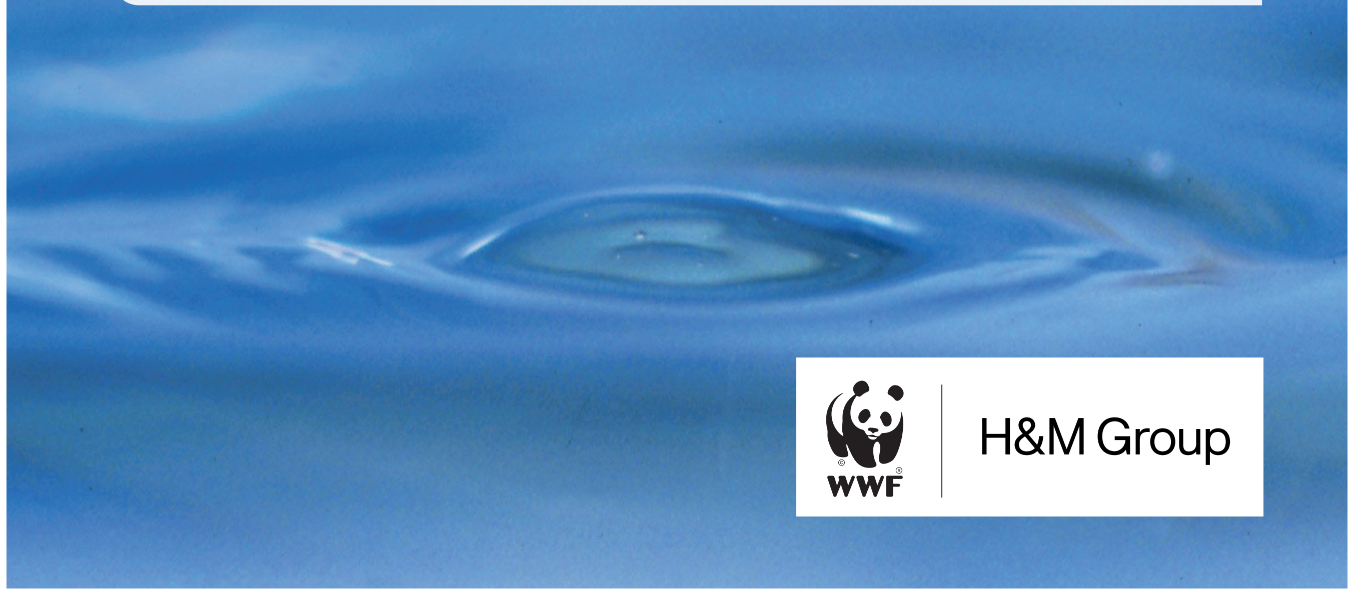
Please cite this report as:
Morgan, A.J., Camargo, R., Luthra, P., Baig, A., Laporte-Bisquit, A., Dar, S. (2022) Avant-garde: the water risks and opportunities facing apparel and textiles clusters – Part II, Water risk facing the Industry's value chain. WWF Germany / WWF-Sweden.



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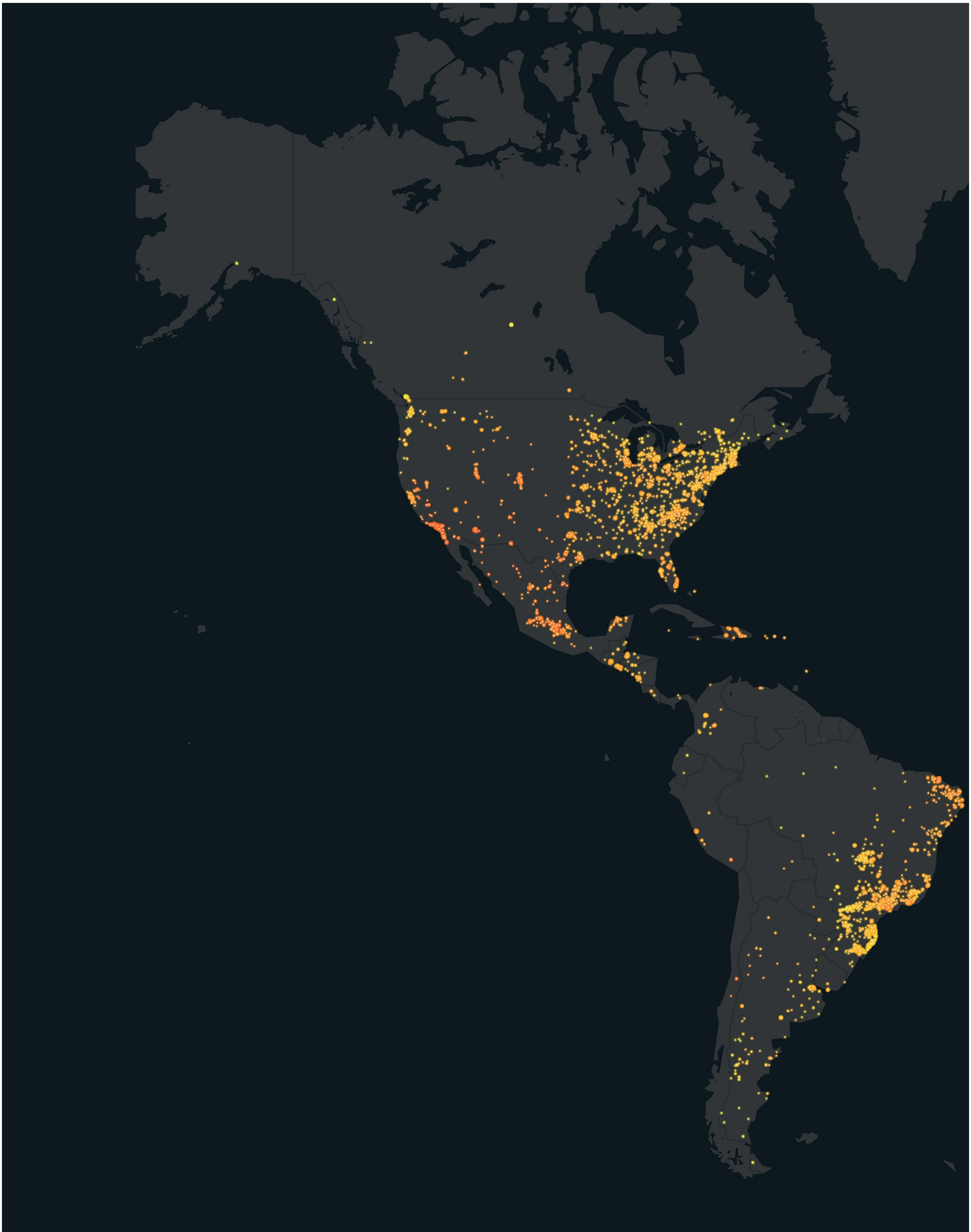

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