From global to local: enhancing ESG data on water

Recommendations in support of responsible investment

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Deltares is an independent institute for applied research in the field of water, subsurface and infrastructure with its base in the Netherlands. Throughout the world, Deltares works on smart solutions, innovations and applications for people, environment and society. Main focus is on deltas, coastal regions and river basins. Managing these densely populated and vulnerable areas is complex, which is why Deltares experts work closely with governments, businesses, NGO's, other research institutes and universities at home and abroad.

ABOUT WWF

WWF is the world's leading conservation organization. Founded in 1961, WWF is active in nearly 100 countries and has over 5 million supporters. WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which people live in harmony with nature. WWF has worked with the finance sector for more than a decade via innovative collaborations that seek to integrate ESG risks and opportunities into mainstream finance, to redirect financial flows in support of the global sustainable development agenda.

ABOUT ACHMEA IM

Achmea Investment Management is a leading player in the Dutch fiduciary and asset management market. Via robust portfolio construction, effective asset management, responsible investing and thoughtful risk management our goal is to create more capital for our pension fund clients to meet their obligations. We operate with a professional and dedicated team of 350 professionals. Achmea Investment Management is an independent division of Achmea, a solid, non-listed Dutch insurance group with a cooperative tradition. We have supported pension funds in the Netherlands with tailored solutions for over 60 years. We manage assets of over € 190 billion for customers including our parent balance sheet.

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NN Group is an international financial services company, active in 11 countries and with a strong presence in a number of European countries and Japan. NN Group provides retirement services, pensions, insurance, banking and investment services to approximately 19 million customers. The Group includes Nationale-Nederlanden, NN, ABN AMRO Insurance, Movir, AZL, BeFrank, OHRA and Woonnu, and is listed on Euronext Amsterdam (NN). As a long-term global institutional investor with an ambition to accelerate the transition to a more sustainable economy, NN Group has a duty to act in the best interest of its policyholders, clients, shareholders and other stakeholders. To fulfil this duty, we acknowledge the importance of systematically incorporating Environmental, Social, and Governance (ESG) factors into our investment policies, decision-making and related processes.

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As a leading global reinsurer, SCOR offers its clients a diversified and innovative range of reinsurance and insurance solutions and services to control and manage risk. Applying "The Art & Science of Risk", SCOR uses its industry-recognized expertise and cutting-edge financial solutions to serve its clients and contribute to the welfare and resilience of society.

ABOUT the TKI BRIDGE project

This publication is the main deliverable of the BRIDGE project, a project focusing on novel approaches to bridge ESG data gaps and focusing on institutional investors. It is co-funded by Top consortium for Knowledge and Innovation Delta Technology from the PPS innovation programme grant from the Ministry of Economic Affairs of the Netherlands.

Executive Summary

Environmental, Social and Governance reporting has become increasingly important over the last years as it enhances companies and investors understanding of risks not captured by traditional financial reports. However, there are significant shortcomings in current ESG reporting and ESG data on water risks, including a one-dimensional view of water risk exposure, lack of standardised reporting frameworks, insufficient contextual detail, and unaddressed cascading risks. This was identified in a previous study conducted in 2022 focused on addressing gaps in ESG water data in support of responsible investments.

Building on these findings and the recommendations of the previous report, this report analyses water risk management and reporting with a particular focus on localised risks. In order to compare water risks in a local context, the report conducts a scenario analysis focused on two economic zones: the Chennai (India) and São Paulo (Brazil). These zones were chosen because of their existing and future water risks as well as the importance of these zones for investment portfolios. Through this scenario analysis the report seeks to evaluate the actual and potential future water risks in each region, and the reporting practices under differing regulatory and climatic contexts, while addressing the benefits and limitations of these practices. By doing so, we provide a pathway for improving water reporting and ESG data on water.

A key aspect of the analysis undertaken is the use of two complementary water risk assessments tools: WaterLOUPE and WWF Water Risk Filter (WRF). These tools offer detailed, region-specific insights that can improve the accuracy and relevance of water risk management strategies. By integrating these localised assessments, companies can develop more targeted strategies, enhance transparency, and improve communication with stakeholders, ensuring that water management practices are aligned with local conditions and promoting sustainable use.

Our analysis leads to the following conclusions:

- In both watersheds the **economic activities are concentrated in the areas most at risk**. This emphasizes the need to look beyond the average risks in a watershed for companies, investors and ESG data providers.
- We find that the risks profiles of both watersheds are different (from seasonality to economic activity), and different topics (from water safety to water quality) have a different materiality in each. **This underscores the importance of incorporating localised water risk assessments into ESG reporting frameworks.**
- **Forward-looking data is crucia**l to assess the risks various stakeholders encounter in the long term. Especially relevant for long-term economic decision making – both at the private/company level, or at the (sub)government policy level – such as identifying alternative locations for operations, agreements on collaborative water use, or the limitations on licenses granted.
- Findings show that **companies are making significant efforts** to comply with local water regulations and implement effective water management practices, such as zero-liquid discharge (ZLD) in Chennai and detailed water management plans in Alto Tietê river basin (São Paulo).
- However, based on our assessment, **current corporate reporting does not sufficiently capture localised water risks and future risks**, leaving a gap that has to be addressed to map and assess water risks in a standardized way.

What does this mean for companies, investors and ESG data providers?

- Need for more current and consistent location-specific data and corporate reporting
- Use scenarios to get a better grasp of forward-looking risks and integrate the outcomes in strategic decision making.
- Understand the risk-profiles of the key watersheds in which a company is active to contextualize its activities, its geo-specific impacts and reporting.
- More data is needed on the supply chains of companies to contextualize risks to the company and risks to the regions in which it operates.
- Our findings support the need for companies to apply the recommendations and guidance of The Taskforce on Nature-related Financial Disclosures (TNFD) and the LEAP approach (Locate, Evaluate, Assess, Prepare).
- Investor engagement with companies is important to develop risks and impacts dependency assessments that take into account both own operations and critically, their supply chains, in a timely manner.
- The need for investors to practice engagement on geo-specific water risks to ensure companies are well positioned to assess and mitigate risks in corporate policies, strategies and implementation.

In conclusion, this report highlights a) the need for improved data and reporting on corporate water risks, especially regarding contextual, localised and forward-looking water risks and b) provides the tools with which forward-looking and localised risks can be identified. By doing so, localised and forward-looking data will enable companies, investors, and data providers to better manage water-related risks and strengthen sustainability efforts, leading to improved corporate performance and improved environmental stewardship.

Note: For the purpose of this report, the authors selected two readily available tools developed by their own organisations to illustrate and make more concrete what type of data and information these type of tools can produce in support of responsible investment. There are however more water risks assessment tools available for free or on the market with different focus, strengths and weaknesses that could provide the necessary data and information.

Reader's guide

This report builds on a previous discussion paper focusing on bridging the gaps in ESG[1] water data to create opportunities. The paper identified gaps in ESG reporting[2], such as the **one-dimensional approach to water risk exposure, lack of standardised basis for reporting, insufficient nuance in water context and cascading risks**. It also provided recommendations for ESG reporting improvements. This report aims to bridge some of the challenges identified in the previous report by underscoring the **advantages of integrating scenario analysis considerations** into ESG reporting, going beyond the one-dimensional approach to water risk exposure and understanding the nuances in local water contexts by showcasing the **added value of tools to assess local water risks**. Scenario and industry sector-specific analyses are developed focusing in two economic zones: Chennai (India) and São Paulo (Brazil) economic zones.

The collaborative effort behind the report involves key stakeholders from various sectors, underlining the importance of collective action in addressing environmental challenges and improving ESG reporting standards.

The report covers the following:
Chapter 1 introduces the report objectives and scope, setting the stage for the detailed exploration of water risks, ESG data gaps, and scenario and sector-specific analysis that follow. **Chapter 2** explores the implications of water-related risks and opportunities for investment portfolios, highlighting how investors can manage and capitalize on these factors for better decision-making. **Chapter 3** discusses emerging regulatory and voluntary frameworks and their connection to ESG reporting, anchored by the Task Force on Nature Related Financial Disclosures (TNFD) framework. The TNFD framework offers a structured approach to integrating nature-related risks and opportunities into financial decision-making, setting the standard for how organizations disclose their impact on and dependencies upon nature. Through the lens of the TNFD framework, **Chapter 3** explores the interplay between various regulatory and voluntary initiatives, highlighting their contributions to more comprehensive and transparent ESG reporting.

Chapter 4 introduces two selected scenario analysis tools used as showcase for this report, the WaterLOUPE and WWF Water Risk Filter, how they can address the reported ESG data gaps, and explains their synergies with TNFD recommendations. To demonstrate the advantages of scenario analysis for ESG, **Chapter 5** presents case studies from India and Brazil, focusing on the Chennai and São Paulo economic zones. It details scenario and sectoral analyses, sector-specific impacts, and water risk management strategies in these regions. **Chapter 6** examines ESG reporting practices, focusing on corporate and CDP reporting. It assesses ESG reporting from selected companies in the studied regions and discusses how integrating scenario analysis can enhance these reports.

Chapter 7 provides insights into leveraging case studies analyses' results for investors to develop engagement strategies. It includes findings from localised water risk assessments and case studies. **Chapter 8** explores strategies for utilizing the results of water risk assessments to drive positive impact. It includes actionable steps for investors and companies to enhance water management and resilience.

[1] ESG stands for Environment, Social and Governance.
[2] ESG reporting is the disclosure of measurable information covering an organisation's operations and risks in three areas: environmental stewardship, social responsibility and corporate governance.

1 Scope and Objective

Key messages

- ESG reporting is essential for sustainable investments decision-making process, but traditional methods usually do not capture the complexity of nature-relates risks, particularly water-related issues.
- Localised water risks, their link to biodiversity and the lack of standardized metrics and methodologies create challenges in evaluating and reporting water-related impacts.
- Enhanced nuance in water risk evaluation, the establishment of consistent reporting standards and adopting site-specific approaches are necessary for accurate ESG reporting and decision-making.
- The TNFD framework and its LEAP approach offers a structured method do understand and manage nature-related financial risks by focusing on location-specific aspects and incorporating scenario analysis in its guidance.
- Case studies from Brazil and India in this report illustrate the practical challenges and opportunities in translating water-related impacts into actionable insights, emphasizing the importance of localized approaches and scenario analysis.
- Scenario analysis provides a forward-looking perspective that is essential for adapting to uncertainties in climate change and evolving regulations, equipping businesses and investors with tools to build resilient strategies.

Environmental, Social, and Governance (ESG) reporting has become integral to sustainable investment decision-making. Our previous discussion paper showcased many challenges traditional ESG reporting faces in effectively capturing the complex interdependencies of nature-related risks, particularly water-related. These challenges stem from the **localised nature of water risks**, their **interlinkages with biodiversity** and the **lack of standardised measurement methodologies.**

The paper illuminated several key areas for improvement, including the need for greater nuance in water risk evaluation, the establishment of consistent reporting standards, a more profound understanding of the cascading nature of water risks and the value of collective actions and corporate responses beyond surface-level engagement.

The **localised nature of water risks** emphasizes the importance of adopting a site-specific approach in corporate ESG reporting to ensure a better understanding of a company's sustainability performance. For instance, according to the World Bank Country Climate and Development Report, extreme weather events in Brazil, such as droughts, flash floods, and riverine floods in cities, cause losses averaging $2.6 billion annually. São Paulo city alone experienced a $22 million loss due to floods in 2020, which had implications for companies' financial performance and resilience.[3] This information is particularly critical for investors because localised water risks can impact companies' and whole sectors' financial stability and operational efficiency.

This report aims to go beyond identifying risks and proposes solutions with multifaceted objectives. Firstly, it aims to propose scenario analysis as a risk analysis methodology for enhancing ESG reporting, focusing on two expert-developed tools used to assess localised water-related risks. Secondly, it seeks to demonstrate the importance of scenario analysis in providing localised and sector-specific insights.

[3] For more information, visit: G1 - São Paulo

Lastly, the report aims to provide actionable insights for investors and companies to enhance their understanding of water-related risks and opportunities, facilitating informed decision-making and the development of corporate sustainability strategies.

The report uses the TNFD framework as a foundation for ESG reporting. It highlights the benefits of incorporating a subset of risk analysis (scenario analysis) to enhance understanding of water risks. Real-world case studies from Brazil and India provide concrete examples of the challenges and opportunities of translating water-related impacts into actionable insights for investors. It highlights the need for **enhanced nuance in water risk evaluation** and consistent reporting standards. The case studies underscore the **importance of adopting a site-specific approach** to improve understanding of companies' and sectors' sustainability performance, particularly considering extreme weather events and localised water risks.

As discussed in greater detail in Chapter 3, the TNFD takes a location-first approach, emphasising the importance of location-specific aspects and introducing additional guidelines to enhance the understanding and management of nature-related financial risks. One of these innovative approaches is the LEAP (Locate, Evaluate, Assess, and Prepare) methodology. The LEAP approach encourages organisations to locate their interactions with nature, evaluate their dependencies and impacts, assess the risks and opportunities these interactions present, and prepare management strategies and disclosures accordingly. Figure 1 showcases the application of the TNFD's LEAP approach to the report.

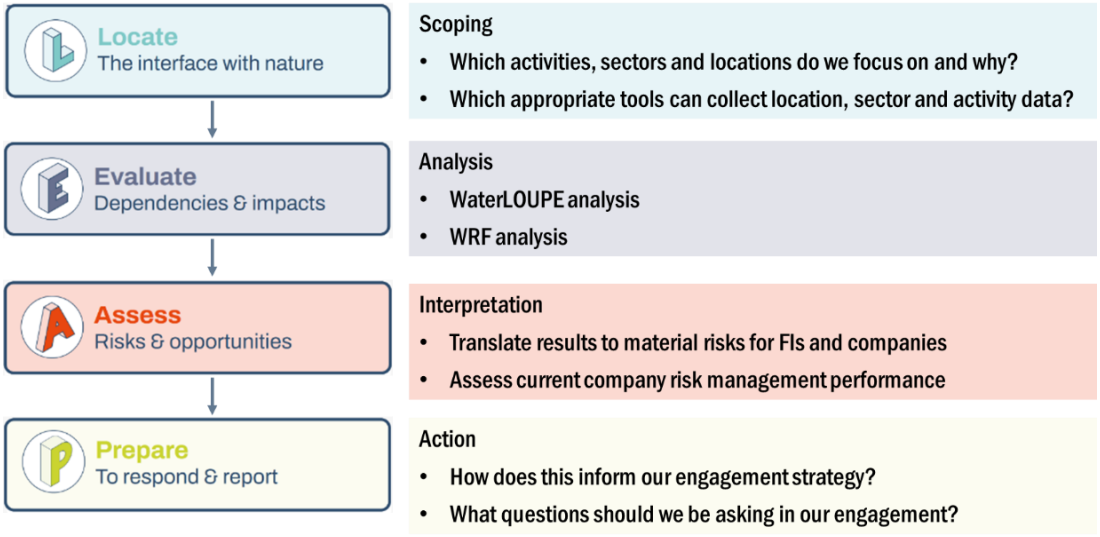

Figure 1. TNFD LEAP application to the report.

Adopting a scenario-analysis approach is crucial as it offers a forward-looking perspective that considers potential futures and their implications. Scenario analysis can provide innovative insights into understanding, adapting and mitigating water-related risks in a landscape characterized by uncertainty and complexity, especially considering climate change and evolving regulatory landscapes. By leveraging this approach, the report aims to equip businesses and investors with the tools to develop robust, resilient investment strategies that account for water-related risks.

While site-specific approaches and detailed scenario analysis can significantly improve the accuracy of ESG reporting, it is essential to recognize that they also come with higher data requirements and complexity. Generic approaches, though easier to apply across different regions or sectors, may not fully capture localized risks, especially those tied to water and biodiversity.

2 Navigating water risks and opportunities within an investment portfolio

Key messages

- Water scarcity, quality, and regulatory pressures are increasingly affecting investment performance. Incorporating water risk considerations into investment strategies can enhance portfolio resilience and unlock sustainable growth opportunities.
- Water is a crucial resource for various economic activities, including agriculture, industry, and real estate. It plays a vital role in supply chains and is integral to the functioning of many investees.
- Water is essential for ecosystems and human rights, especially in communities near business operations. Climate change will exacerbate risks, with too much or too little water impacting different sectors and scales.
- ESG data on water often lacks local context and forward-looking insights, making it difficult to assess risks accurately. Enhancing data on water use, quality, and availability is critical for informed investment decisions.
- Different sectors face varying levels of water dependency and risk. Understanding these nuances and considering local watershed conditions are key to managing water risks effectively.
- Current corporate reporting on water risks is inadequate. Frameworks like TNFD, SFDR, and CSRD are essential for improving transparency and guiding investors in assessing water-related financial risks.

This chapter delves into the critical aspects of identifying and managing water risks and opportunities within an investment portfolio. It explores how water scarcity, quality, and regulatory pressures affect investment performance. **By integrating water risk considerations into investment strategies, investors can enhance portfolio resilience and capitalize on opportunities for sustainable growth.** The chapter provides frameworks and best practices for evaluating water risks and incorporating them into investment decision-making processes.

Water is undeniably an important topic in investment management, from a purely financial and economic point of view, as well as from different sustainability perspectives.

From a purely financial and economic point of view, water is a vital resource and driver for a range of economic activities and investees:

- Without water, agriculture and its supply chains cannot function.
- Water is used in a wide range of industrial processes for cleaning, cooling and production purposes.
- Water serves as a way of transport through rivers and canals.
- Drinking water and sanitation are crucial for residential, commercial and industrial activities.
- The presence of water can have a value-added influence on real estate.

Water is also relevant from several sustainability perspectives. It serves as an important foundation for local ecosystems, and the continued access to water for drinking and sanitation, particularly for communities surrounding corporate/business activities, remains an essential human right that companies are expected to observe and protect. From a risk perspective, too much or too little water is a critical way climate change will materialize at different scales and for different sectors, including the environment.

Given these interconnections, it makes sense to understand both a company's negative impacts and dependencies. Taking this ‘inside out’ and ‘outside in’ approach with their specific operating contexts will allow us to better understand water's relevance for their businesses. For example, how are companies a) dependent on water for their economic activities and b) impacting their environment and stakeholders by using and influencing water? Although the importance of water for investment decisions is clear, it does not translate to data on water or be up to par with other themes and topics. This can be explained partly due to the traditional approach to ESG data in which:

- ESG data and numbers are often collated to the investee (domicile) level or even the portfolio level, making it more complex to consider the local contexts. **The local context is vital for understanding water risks and developing appropriate management strategies**.
- ESG data often describes the current state, and forward-looking data is more difficult to obtain. **Forward-looking data is crucial to understand if water will also be available in a region's short and longer term and if water availability is further aggravated by quickly changing weather patterns**, including more frequent droughts or changes in rainfall patterns.
- The interconnected nature of global supply chains often results in disjointed data on water use, availability and impact, even within companies. **Irrespective of the compounding effect, local water issues can impact global commodities and businesses.**
- ESG data on water is more focused on assessing quantitative data on water use. However, **water can only be understood fully when taking multiple perspectives**, including water quantity (too much or too little), water quality (used or released) and temporal variability in availability, use and quality. It is important to stress that the perspective(s) to be taken depends on the analysed economic sector. Water temperature is relevant for the utility sector, while drought and reduced water flows are key to understanding the risks to the transport sector.

To gain a better understanding of water risks and opportunities, it is therefore important to evolve ESG data on water through the following means:

- Understanding **water risk as a function of place** (the location of assets) and their exposure to different climate scenarios is essential for investors looking to mitigate risk and capitalize on opportunities. Certain regions are more prone to droughts and water shortages, which can significantly impact sectors reliant on water, such as agriculture, textile and beverage industries. Other areas may face the opposite problem, with an increased risk of flooding due to rising sea levels or more intense and frequent storm events, affecting real estate, infrastructure, and any physical assets in flood-prone areas.
- Introduce forward-looking tools. For example, climate models can project different scenarios and provide a **comprehensive risk assessment** considering various water-related risks. These scenarios can help investors understand potential future risks related to water in specific locations[4]. Some areas might become drier, affecting water availability, while others might see an increase in precipitation, affecting flood risk. Besides a climate perspective, social developments are key to understanding the context for water use, as increased urbanization or more intensive agriculture can drive water use independently from climate change.
- Understand that specific investments and economic sectors need a different approach and perspective. Different sectors have varying levels of water dependency and risk.

[4] Ortec. (2023) Unlocking the true values of climate scenarios. Link for download: Unlocking the true value of climate scenarios (ortecfinance.com)

Comprehending **sector-specific risks and insights,** understanding the water use intensity of various industries, and understanding how climate might impact water availability are crucial.
- Consider the watershed level and relevant other water users in the watershed. Understanding the health of the local watershed where investees operate is key to gaining a deeper, locally nuanced understanding of water-related risks to inform more effective management strategies and investments. Secondly, water has the unique feature that it can be used multiple times if (jointly) managed well by water users. That makes cooperation between investees and local authorities key in managing water risks.

Is corporate (ESG-) reporting addressing these challenges?
To truly integrate water into ESG data and ESG integration, corporate reporting is key in providing the necessary information and datapoints. Is corporate reporting indeed up to par with the needs, and which developments are taking place with regard to best practices and regulatory requirements? To address this question, we explore two reports and reflect on the evolving corporate reporting standards on water. The first report is from the investor network organization CERES, and the second report is from the World Benchmarking Alliance.

The **CERES Valuing Water Finance Initiative Benchmark report** highlights the varying degrees to which some of the largest companies address water risks within their operations and supply chains in line with the six Corporate Expectations for Valuing Water. The report:

- Integrates insights and leading practices on corporate water stewardship, emphasizing efforts to assess and report localised water risks. **It highlights the importance of bridging water data gaps and underscores the critical need for context-specific water-related targets.**
- Findings reveal a widespread lack of **localised context in water risk assessments**, with only 35% of companies considering contextual factors for water availability and 14% for water quality risks. Furthermore, just 42% of companies have developed contextual or risk-differentiated water targets for direct operations and/or supply chains, especially focusing on high-risk watersheds.
- **Insights also emphasize the need for holistic strategies that address water quantity, water quality, water access and ecosystem issues.**
- Points to the potential of collective action in watershed management, with 51% of companies participating in such initiatives to address water availability and quality issues. However, **it emphasized the need for more transparent reporting on the outcomes and impacts of these efforts**. Report transparency supports the achievement of collective goals in addressing shared basin challenges.
- Underlines the critical need for industries to adopt more ambitious, context-specific, and comprehensive approaches to water stewardship. From a climate research perspective, climate scenario tools are essential to bridging the gaps in local water data and management practices.

On the same note, the World Benchmarking Alliance has released a Nature Benchmark publication assessing how food and agriculture companies respond to rising water insecurity. It reports that around 30% of companies in this category disclose water use reductions or water usage from water-stressed areas. However, only 12% disclose pollutant discharge information. On the bright side, it states that 63% of food companies assign sustainability oversight to their boards. However, only 1% of the boards demonstrate relevant biodiversity, water or climate expertise.

Reporting standards

Assessing the relationship between nature and financial risk can be challenging, but investors can build upon frameworks developed for assessing financial risk related to climate change. Regulatory and voluntary Frameworks such as the TNFD, SFDR, and CSRD are critical in driving transparency and enabling investors to assess how companies manage their water risk. These frameworks and reporting standards are instrumental in driving improvements in water stewardship and sustainability practices across industries, thereby contributing to more sustainable water management on a global scale. **Understanding and addressing water risks facilitates better management practices and resilience to water-related challenges and opens avenues for innovation in data analysis**.

The TNFD, among others, categorizes nature-related financial risks into two main types[5]:

- **Physical risks** are related to the extent to which businesses depend on nature ('outside in') and can be characterised as risks arising from the deterioration of natural environments and the loss of ecosystem services.
- **Transition risks** stem from economic actors' failure to align with initiatives designed to protect, restore, or minimize adverse effects on nature ('inside out').
- A subset of transition risk, **reputational risk**, is linked to stakeholders' and local communities' perceptions of whether companies conduct business sustainably or responsibly concerning water.

Industries with a high impact on biodiversity loss are most at risk of facing tighter regulatory or litigation pressures. In addition, these businesses are most vulnerable to changes in technology and consumer preferences because of efforts to reduce the impact of biodiversity loss. Nature-related risks can result in a multitude of effects on a company's balance sheet and a compounded effect on investors' portfolios or investments. These financial impacts range from increased underwriting losses to liquidity and credit risk. Understanding how we impact and depend on biodiversity is thus crucial not only from a social but also from an economic perspective. Reliable data can help investors strengthen their management and engagement strategies to better locate the highest-risk companies and regions, protect investment portfolios and present opportunities for investors to engage with companies and encourage better water management practices, reduce water usage, and improve resilience to water-related risks.

[5] De Nederlandsche Bank NV. (2024) Nature-related financial risk: A case study of own account investments: An exploratory case study and deep dive in electric utilities.

3 The rise of new regulations and link with ESG reporting

Key messages

- Water and biodiversity have gained prominence in disclosure frameworks and regulations, leading to more detailed guidance for companies and financial institutions to assess and disclose water-related risks.
- The regulatory landscape now includes both mandatory (e.g., SFDR, EU Taxonomy, CSRD) and voluntary (e.g., ISSB, TNFD, GRI) frameworks. These frameworks drive greater transparency, consistency, and comparability in ESG reporting, enabling more informed investment decisions.
- The TNFD framework emphasises the importance of scenario analysis for understanding the resilience of organizational strategies in the face of nature-related risks, helping organizations anticipate and mitigate environmental risks more effectively.
- The integration of new standards and frameworks enhances transparency, improves risk management, and promotes the adoption of double materiality assessments. This ensures comprehensive disclosure of both financial impacts and the effects of corporate activities on the environment, aiding in better sustainability practices.
- The evolving regulatory landscape underscores the increasing importance of water-related risks in corporate sustainability and highlights the need for investors to adapt their strategies to align with these new standards and disclosures.

Our previous discussion paper highlighted the weakness of water-related ESG data and corporate disclosures. Over the last two years, water and biodiversity have become more prominent in disclosure frameworks and regulations. Consequently, there is a growing body of detailed guidance available for companies and financial institutions to use when performing their water-related risk assessments and related disclosures. These include:

- The release of the Taskforce on Nature-related Financial Disclosures (TNFD) framework.
- The introduction of a new GRI Biodiversity standard.
- The enforcement of the European Corporate Sustainability Disclosure Regulation (CSRD).
- The inclusion of scenario analyses in both the TNFD and its sister framework, the Taskforce on Climate-Related Financial Disclosures (TCFD).

Figure 2 illustrates the timeline for launching some ESG-related regulatory landscape.

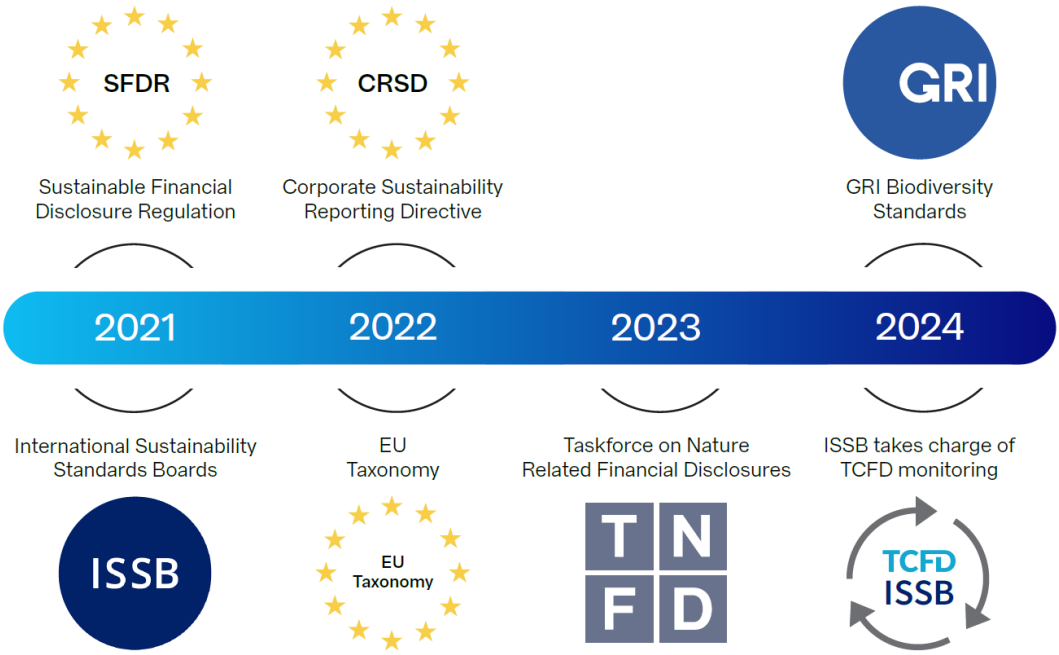

Figure 2. A timeline of the ESG-related regulatory landscape.

3.1 Regulatory developments

Without intending to cover all regulatory developments exhaustively, Table 1 briefly highlights and discusses some of the most relevant ones.

Table 1. Mandatory and Voluntary Regulatory Developments Explained.

Mandatory	
Regulation	**Background**
Sustainable Finance Disclosure Regulation (SFDR)	In 2021, the European Commission introduced the SFDR alongside the Taxonomy Regulation as part of an Action Plan on Sustainable Finance. The SFDR aims to bring sustainability risk transparency by considering adverse sustainability impacts in investment processes and sustainability-related information in financial products. These factors need to be integrated at the entity and product level.
EU Taxonomy	The Taxonomy Regulation mandates additional disclosures beyond those required by the SFDR. The Taxonomy Regulation is the EU Commission's main tool for tackling greenwashing. It establishes criteria to determine whether an activity is environmentally sustainable, assessing if it contributes to or does not significantly harm one or more specific environmental objectives.
Corporate Sustainability Reporting Directive (CSRD)	In the summer of 2023, the European Commission adopted the European Sustainability Reporting Standards (ESRS), which contain technical details on the reporting requirements for large and listed companies set out by the CSRD. The CSRD expands the existing requirements for sustainability reporting. The ESRS include topical standards for Water & Marine Resources (ESRS E3) and Biodiversity (ESRS E4), with around 170 underlying data points for these topics alone. While applying these topical standards is subject to a materiality assessment by companies,

Mandatory	
	the CSRD includes a double materiality standard, which encompasses both dependencies (financial materiality) and impacts.
Corporate Sustainability Due Diligence Directive (CSDDD)	In 2024, the CSDDD was adopted. This Directive aims for companies to identify and address adverse human rights and environmental impacts in their operations as well as their supply chains, inside and outside Europe.
Voluntary	
Regulation	**Background**
International Sustainability Standards Board (ISSB)	In 2021, during the COP26, the International Sustainability Standards Board (ISSB) was established as part of the IFRS Foundation, responding to the global demand for sustainable practices in finance and business. In 2024, as part of its mandate, the ISSB assumed responsibility for monitoring compliance with the Task Force on Climate-related Financial Disclosures (TCFD) recommendations. By taking charge of TCFD monitoring, the ISSB underscored the importance of climate-related disclosures and signalled a collective commitment towards fostering transparency and accountability in pursuing a more sustainable future. However, since it does not embrace impact materiality, it lacks the double-materiality lens.
Task-Force on Nature-Related Finance Disclosure (TNFD)	In September 2023, the Taskforce on Nature-related Financial Disclosures (TNFD) released its final recommendations for nature-related risk management and disclosure. This science-based framework takes a location-first, integrated approach to assessing, managing and disclosing nature-related impacts, dependencies, risks and opportunities. The framework includes disclosure recommendations and detailed guidance on locating, evaluating, assessing and preparing to respond (LEAP) to nature-related risks.
GRI Biodiversity Standard	The Global Reporting Initiative released a new Biodiversity Standard in early 2024, complementing its existing standards for corporate sustainability reporting. The standard includes disclosure guidance on location-specific impacts, including in areas of high-water risks (referencing TNFD), site-level reporting and collaboration with local stakeholders to manage impacts jointly.

3.2 TNFD and TCFD Scenarios

Both the TNFD and the TCFD include a disclosure recommendation on scenarios. This alignment underscores the critical role of scenario analysis in anticipating and mitigating nature-related and climate-related financial risks. By incorporating these guidelines, organizations can better navigate the complexities of ESG reporting and enhance their resilience to environmental changes. The relevance of these frameworks to this report discussion lies in their ability to provide a structured and comprehensive approach to ESG reporting, ensuring that organizations are well-equipped to disclose their environmental impacts and dependencies transparently and effectively.

Both the TNFD and the TCFD include a disclosure recommendation on scenarios:

Table 2. TNFD and TCFD scenarios

TCFD	TNFD
Disclosure Recommendation Strategy C	Disclosure Recommendation Strategy C
Describe the resilience of the organisation's strategy, considering different climate-related scenarios, including a 2°C or lower scenario.	Describe the resilience of the organisation's strategy to nature-related risks and opportunities, considering different scenarios.

The TNFD guidance states that organisations should use nature-related scenario analysis to assess their strategy resilience, using an approach commensurate with their circumstances. It also has released detailed guidance on scenario analysis, building on TCFD's scenario resources, including the TCFD Guidance on Scenario Analysis for Non-Financial Companies, to enable integrated considerations of climate and nature in scenario analysis and integrated disclosures.

The TNFD takes a location-first approach, emphasising the importance of location-specific aspects when trying to understand business interaction with nature. It has also introduced additional guidelines to enhance the understanding and management of nature-related financial risks, such as the innovative LEAP approach methodology and scenario analysis. The LEAP approach encourages organisations to locate their interactions with nature, evaluate their dependencies and impacts, assess the risks and opportunities these interactions present, and prepare management strategies and disclosures accordingly.

3.3 Implications for ESG Reporting

Overall, ESG-related regulatory developments have implications for ESG reporting and financial decision-making, such as:

- **Enhance transparency**: The TNFD and GRI Biodiversity Standard promote greater transparency by encouraging companies to disclose their environmental impacts and dependencies in a standardised manner. This transparency enables investors to make more informed decisions about sustainability risks and opportunities.

- **Improve risk management**: By incorporating location-specific considerations and scenario analysis, regulatory frameworks like the TNFD help companies better understand and manage water-related risks. This approach to risk management enhances resilience and reduces vulnerability to environmental shocks.

- **Foster consistency and comparability in ESG reporting:** The alignment of regulatory standards, such as the TNFD and CSRD, fosters consistency and comparability in ESG reporting practices. This alignment enables investors to assess companies' sustainability performance more accurately and facilitates capital allocation towards sustainable initiatives.

- **Develop double materiality assessments**: There is an increasing need for understanding and considering double materiality in ESG assessments. New ESG-related regulations, like the EU's CSRD, mandate companies to assess and report on both financial and impact materiality, ensuring comprehensive disclosure of how sustainability issues affect and are affected by the company, thereby promoting transparency and accountability.

The evolving regulatory landscape reflects a growing recognition of the importance of water-related risks in corporate sustainability.

4 Water Risk Analysis: Exploring Scenario Analysis Tools

Key messages

- Building on previous findings, there is a critical need for more granular, localized water risk data, to understand risks at the asset and supply chain levels to drive actionable insights for investors and companies.
- Scenario analysis is a key methodology for assessing potential climate-related impacts on investments. Endorsed by the TNFD, it allows stakeholders to anticipate and plan for various future environmental conditions, enhancing financial and operational resilience.
- Two risk assessment tools—WaterLOUPE and WWF Water Risk Filter— are introduced that present scenario and sector-specific analysis. These tools are complementary, offering distinct features that help address climate risk uncertainties by providing localized, sector-specific water risk assessments. They are used as examples to show what data and information is available. Other tools serving the same purpose are available but not presented in this report.
- Both tools align with the TNFD's LEAP (Locate, Evaluate, Assess, Prepare) approach, reinforcing the importance of scenario-based analysis in risk management.
- There are challenges in conducting industry-specific analyses due to data availability constraints. Enhancing data granularity to the asset level is identified as a key area for future improvement to better understand industry water dependencies and align with the TNFD framework.

This chapter builds on the findings of a previous discussion paper, which identified significant gaps in water risk data across various sectors. The earlier study highlighted the need for more granular and localised water risk data, emphasizing the importance of understanding water-related risks at the asset and supply chain levels. These foundational insights drive the current focus on integrating detailed scenario analyses and financial assessments to provide actionable insights for investors and companies.

Scenario analysis, a subset of risk analysis, emerged as a prominent methodology for assessing the potential climate-related impacts on investments by exploring different plausible future environmental conditions. Endorsed by the TNFD, scenario analysis enables stakeholders to envision and plan for possible future environmental conditions that might affect financial stability and operational resilience. This chapter introduces the application of two tools, the WaterLOUPE and WWF Water Risk Filter, in developing scenario and sector-specific analysis. Also, it emphasises their complementary features and relevance in addressing climate risk uncertainties. These tools are the foundation upon which this report draws its applied conclusions.

It is important to emphasize that other tools also exist that can support investors and business in assessing their water related risks by incorporating scenario analysis, such as WRI's Aqueduct tool.

4.1 WaterLOUPE

The WaterLOUPE is a water scarcity risk assessment dashboard available for 10 cases and freely available online. It enables local water scarcity risk analysis across different sectors, considering current and future conditions under various climatic and socio-economic scenarios. It combines data on hydrology, exposure and vulnerability at the local level[6].

[6] For more information about hydrology, exposure and vulnerability terms visit the glossary section in ANNEX III.

WaterLOUPE runs a risk assessment for each actor group separately instead of providing generic risk assessment indicators representing all water users in a basin. For example, it specifies the impacts of water scarcity on industry, domestic and agriculture sectors. The distinction in actor-level impacts is key in establishing the right adaptation strategies in a catchment. One of the key indicators WaterLOUPE generates is the 'water gap'—a concept that compares water demand across agriculture, industry, and domestic sectors to its availability in a given region. A water gap occurs when demand surpasses supply, a concept of critical importance in assessing water risks for companies operating in a basin and in assessing their impact.

The dashboard analyses current conditions and two possible future states influenced by both climate change (RCP8.5[7]) and Shared Socioeconomic Pathways (SSPs), conceived by the International Institute for Applied Systems Analysis (IIASA). These scenarios consider the impacts of climate change and socioeconomic dynamics, including water demand narratives and producing visual maps that depict water scarcity across various regions. The case studies presented in the next chapter of this report draw on two scenarios. The scenarios considered in the studies are plotted in Figure 3 and defined in the subsequent text.

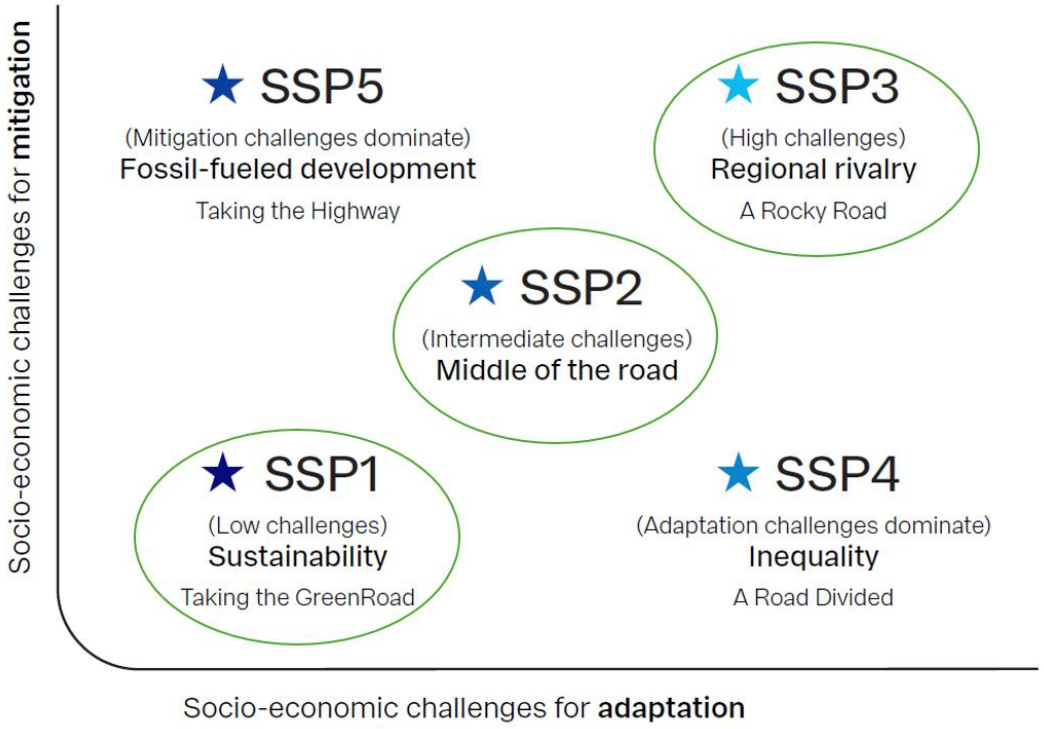

Figure 3. Shared Socioeconomic Pathways (WaterLOUPE, 2020)

- **SSP1 – Sustainability** envisages a world prioritizing sustainability, marked by equitable growth, technological advances, and high environmental consciousness, facilitating climate change mitigation and adaptation.

- **SSP2 – Middle of the Road** describes a continuation of current trends, with incremental advances in reducing resource and energy consumption.

[7] RCP: *Representative Concentration Pathways*.

- **SSP3 – Regional Rivalry** paints a bleaker scenario of fragmentation, where poverty, rapid population growth, and environmental degradation challenge climate change mitigation and adaptation efforts due to slow technological progress in energy and poor regional cooperation.

For more information on the climate scenario used (RCP8.5) and all the socio-economical scenarios presented in Figure 3, we refer to the papers and website mentioned above.

The analysis is enriched by examining multiple companies within each basin, categorized into economic sectors. This approach enables an assessment of water scarcity's impact on industrial activities. **The case study analysis faces limitations due to the unavailability of asset-level data across all sectors, leading to a potential overrepresentation of specific industries like textile or energy in the findings due to data accessibility constraints.**

This enhanced understanding of water scarcity risks empowers stakeholders to make informed decisions, ensuring sustainable water resource management and resilience against future challenges.

More information about the WaterLOUPE methodology is available in ANNEX II.

4.2 WWF Water Risk Filter

The WWF Water Risk Filter (WRF), part of the WWF Risk Filter Suite, together with the Biodiversity Risk Filter, is a free online water risk assessment tool. Designed to be used as a corporate and portfolio-level screening and prioritisation tool, the WRF enables companies and investors to identify water risks facing their operations, value chains and investments.

The WRF assessment framework includes two key factors which are needed for a comprehensive assessment of water risk:

1 the state of water surrounding a site – referred to as basin risk; and
2 how a site uses or needs water – referred to as operational risk.

Sites across a company's value chain face different physical, regulatory and reputational basin risks due to the nature and conditions of the basins in which they operate. By entering sites' geographical location and industry into the WRF, basin risks can be assessed. The WRF calculates basin risk scores for all sites using indicators and industry-specific weightings[8]. The WRF's global dataset contains 32 global basin indicators based on best available peer-reviewed spatial datasets to assess basin risk for all sites worldwide.

The tool's basin and operational risk assessment framework is composed of three levels:

1. Risk types

The WRF's risk assessment framework uses the well-recognized categorization of corporate water risks according to three risk types: physical, regulatory and reputational – as defined by the CEO Water Mandate. In TNFD terminology, regulatory and reputational risk are subsets of transition risk.

[8]For more information about the WRF methodology, see the data & methodology documentation: https://riskfilter.org/water/explore/data-and-methods

- **Physical risks** account for whether the water in the river basin is too little (scarcity), too much (flooding), unfit for use (quality), and/or the surrounding ecosystems are degraded, and in turn, negatively impacting water ecosystem services (ecosystem service status).

- **Regulatory risk** is linked to how water is managed (or governed) in the area or country. Thus, it is heavily tied to the concept of good governance and the fact that businesses thrive in a stable, effective and properly implemented regulatory environment.

- **Reputational risk** is linked to stakeholders' and local communities' perceptions of whether companies conduct business sustainably or responsibly with respect to water.

2. Risk categories

Each of the three risk types comprises multiple risk categories for a comprehensive coverage of different aspects within the broad risk types, as shown in Figure 4. A full definition of each of the 12 risk categories is included in ANNEX I.

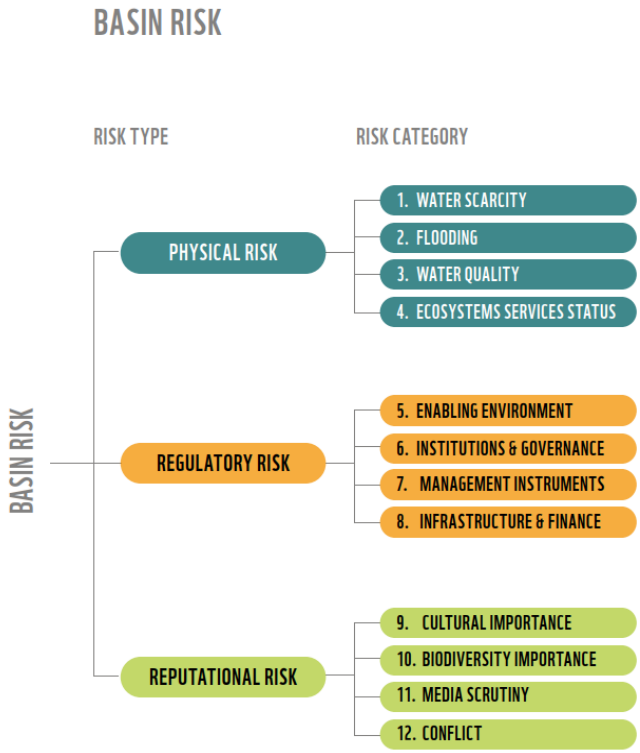

Figure 4. WWF Water Risk Filter risk types and categories

3. Indicators

Multiple indicators inform the risk categories.

By assessing their water risks using the WRF tool, companies and investors can identify what to prioritise and where it matters the most to mitigate their water risk. Furthermore, it enables them to better account for water within their corporate strategies and investment decisions to build resilience for their businesses and investments while supporting the river basins in which their business operate and upon which their investments depend.

It is important to note that the WRF evaluates typical risk conditions at basin or country level based on historical trends, recent data, and some level of projected future risk.

The WRF is, however, not intended to assess real-time water risk conditions at a specific site-level location.

For the case studies, we focused on the application of the WRF to determine the **basin risk**. The analysis is presented both at the risk type and risk category level. The WRF also includes a scenario function, however this function was not applied to the case studies in India and Brazil as it was already included in the WaterLOUPE tool scenario analysis. The WRF focus lies in its complementary nature, which covers a broader set of risk aspects beyond water scarcity. We used regularly available datasets to determine the site locations of companies operating in both basins.

As also stated in section 4.1, asset-level data is not readily available for all sectors meaning that some industrial sectors, like apparel or energy, may be overrepresented in the results due to data availability.

4.3 Synergy with TNFD recommendations

The alignment of WaterLOUPE, the WWF Water Risk Filter, and the TNFD framework, particularly through its LEAP (Locate, Evaluate, Assess, Prepare) approach, is rooted in their shared emphasis on scenario-based analysis, enhancing risk management practices.

The WaterLOUPE provides site-specific insights at a sub-basin or municipal level, a first step in the 'Locate' phase of the TNFD's LEAP approach. While its initial analysis may not directly display specific industry locations, integrating data points from open source data bridges this gap, offering a more nuanced understanding of water dependency per industry sector. This underscores the importance of granular, location-specific information in identifying and mitigating environmental and financial risks associated with water use and management.

Moving from 'Locate' to 'Evaluate' and 'Assess', both tools have unique strengths. The WWF Water Risk Filter's distinction between physical, transitional, and reputational risks complements WaterLOUPE's qualitative water risk assessment by interpreting future water risk scenarios. This dual approach allows for a risk evaluation that accounts for both direct and indirect water-related risks. These tools collectively facilitate a deeper understanding of how water risks intersect with broader natural and socioeconomic factors, aligning closely with the TNFD's emphasis on evaluating dependencies and impacts on nature.

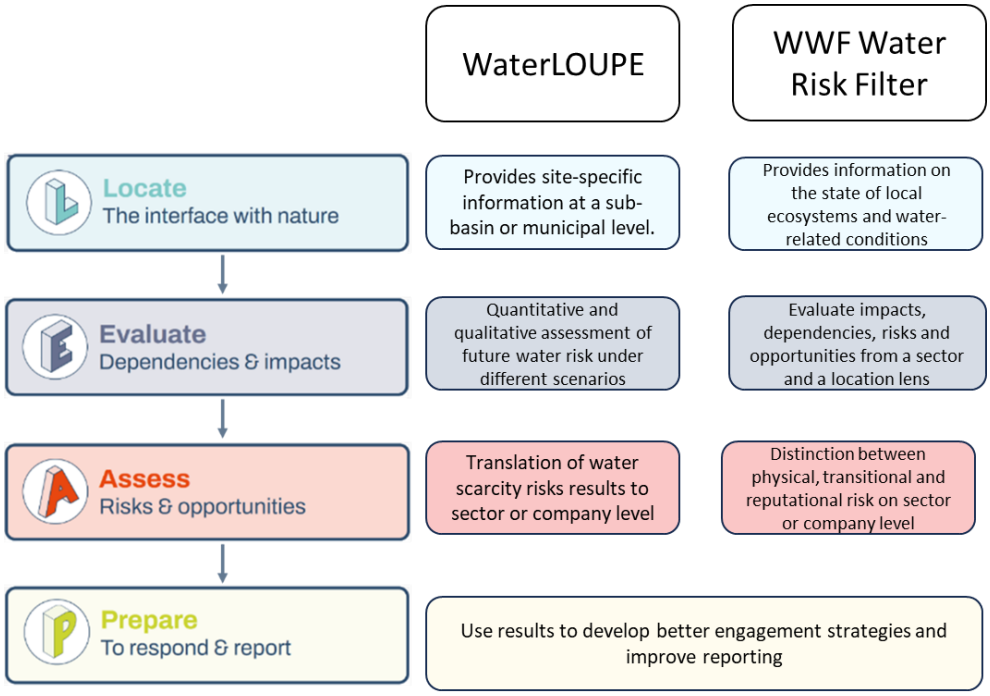

Figure 5. Synergies between WaterLOUPE, WWF Water Risk Filter and the LEAP approach.

One noted limitation is the challenge of conducting in-depth industry-specific analysis due to company-specific operations unavailability and overrepresentation of specific sectors. This highlights an area for future development, where enhancing the granularity of data to asset level could improve the understanding of industry water dependency and alignment with the 'Evaluate' and 'Assess' steps of the LEAP approach.

In the 'Prepare' phase, the integration of the tools supports the development of strategies that are responsive to current risks and resilient to future environmental changes.
The next chapter delves into two case studies, showcasing scenario and sector-specific analysis insights. The practical implications and benefits of integrating these types of tools into corporate and investment strategies for water risk management are also discussed.

5 Case studies

Key messages

- The chapter provides water risk assessments in the Chennai and São Paulo economic zones, each representing distinct socio-climatic environments.
- Both regions face significant water gaps under various scenarios. In Chennai, SSP2 and SSP3 scenarios show frequent water shortages, especially in Araniyar, Gummidipundi, and Adyar. Peak months are December, March, and April. In the São Paulo economic zone, SSP1 and SSP3 scenarios forecast prolonged water gaps from June to November, with important industrial cities such as São Paulo and Guarulhos being vulnerable. These gaps lead to operational disruptions, increased costs, and the need for strategic adjustments across both regions.
- High water-dependent industries, such as textiles and energy, are concentrated in the most water-stressed areas of both river basins. However, data limitations may have led to an overrepresentation of these sectors, potentially skewing the analysis.
- Analysis using WaterLOUPE indicates a medium to high water gap index for both basins, while the Water Risk Filter analysis highlights high reputational and physical risks associated with water scarcity.
- The chapter outlines general response strategies tailored to each basin. These strategies focus on mitigating operational disruptions, managing increased costs, addressing supply chain vulnerabilities, and adapting to evolving regulatory landscapes.

This report aims to expand on previous study findings that identified gaps in ESG reporting, such as the lack of localised context in water-related risk analysis. This chapter explores the benefits of integrating scenario analysis considerations and the importance of local contexts into ESG reporting for better investment-making by exploring the added value of two tools – WaterLOUPE and Water Risk Filter, in two economic zones: Chennai in India and São Paulo in Brazil.

These case studies provide insights into the complexities of water risk assessment and the benefits of scenario analysis tools aligned with TNFD (Task Force on Nature-related Financial Disclosures) recommendations. The Chennai (India) and the São Paulo (Brazil) economic zones were chosen to showcase the diverse challenges and opportunities in water resource management in different socio-climatic environments. The analysis focused on several key components:

- **Socio-climatic diversity**: Chennai and São Paulo represent distinct socio-climatic regions. Chennai, characterised by a tropical wet and dry climate, faces intense seasonal water availability variations, often leading to shortages. São Paulo is characterised by a temperate climate, deals with seasonal variability and issues with compounded urban and industrial demands.

- **Economic significance**: Both areas are vital to their regional economies. The Chennai economic zone supports agriculture, industry, and millions of livelihoods. The São Paulo economic zone is crucial for São Paulo city, Brazil's economic hub. Insights from these basins are valuable for investors and businesses.

- **Data availability**: Comprehensive data availability and the applicability of tools like WaterLOUPE and WWF Water Risk Filter were critical. These basins had sufficient data for a detailed analysis, making them ideal for this report.

- **Investor relevance**: Both regions host water-dependent industries, from manufacturing to energy production. Therefore, insights can help investors understand vulnerabilities

and opportunities within their portfolios, especially in sectors where water scarcity could impact operations.

The findings from these case studies are discussed in the following sections, highlighting the practical implications and benefits of integrating scenario analysis tools into water risk management strategies.

5.1 Case study: India - Chennai economic zone

The Chennai Basin, situated in the southeastern state of Tamil Nadu, India, is essential for the region's economy, supporting various sectors, including agriculture, industry, and energy production. Despite having one of the lowest per capita water availabilities in India, it provides water for the megacity of Chennai, which has a population of over 10 million. The basin has an intense concentration of industrial activity, particularly in the automotive, information technology (IT), and manufacturing sectors.

The Chennai River basin is segmented into 10 sub-basins: Gummidipundi, Araniyar, Kotta Chennai, Cooum Chennai, Adyar Chennai, Cooum, Kotta/Aiyair R, Nandhi Ar, Nagari, and Adyar. These sub-basins are essential to the city's water system, influencing the supply and management of water resources for industrial, agricultural, and domestic use. Historically, agriculture was the primary consumer of water; however, recent trends indicate a shift, with the industrial and domestic sectors now leading in water demand. The unit of analysis chosen for Chennai are its sub-basins, which was defined in collaboration with local stakeholders.

The basin is home to key industrial and business municipalities and economic zones, including:

1. Chennai: As the capital city of Tamil Nadu region, Chennai is the central hub within the basin, depending extensively on its water system. The city's economy comprises a mix of traditional and modern industries, with significant contributions from the automotive and IT sectors.
2. Siruseri and Sriperumbudur: These areas are recognized as major industrial zones, hosting a variety of Indian and international manufacturing plants.
3. Muttukadu-Kovalam: Located south of Chennai, this area is emerging as a key business district, adding to the region's diverse economic landscape.

Challenges such as pollution, over-exploitation of water resources, and the impacts of urbanization and climate change are prevalent, echoing the issues other critical basins face worldwide.

The Chennai Metropolitan Water Supply & Sewage Board (CMWSSB) manages water supply and sewage treatment. Innovative solutions, including building desalination plants and extracting surface water from lakes such as Red Hills Lake and Chembarambakkam Lake, are part of the strategies employed to meet the growing water demand.

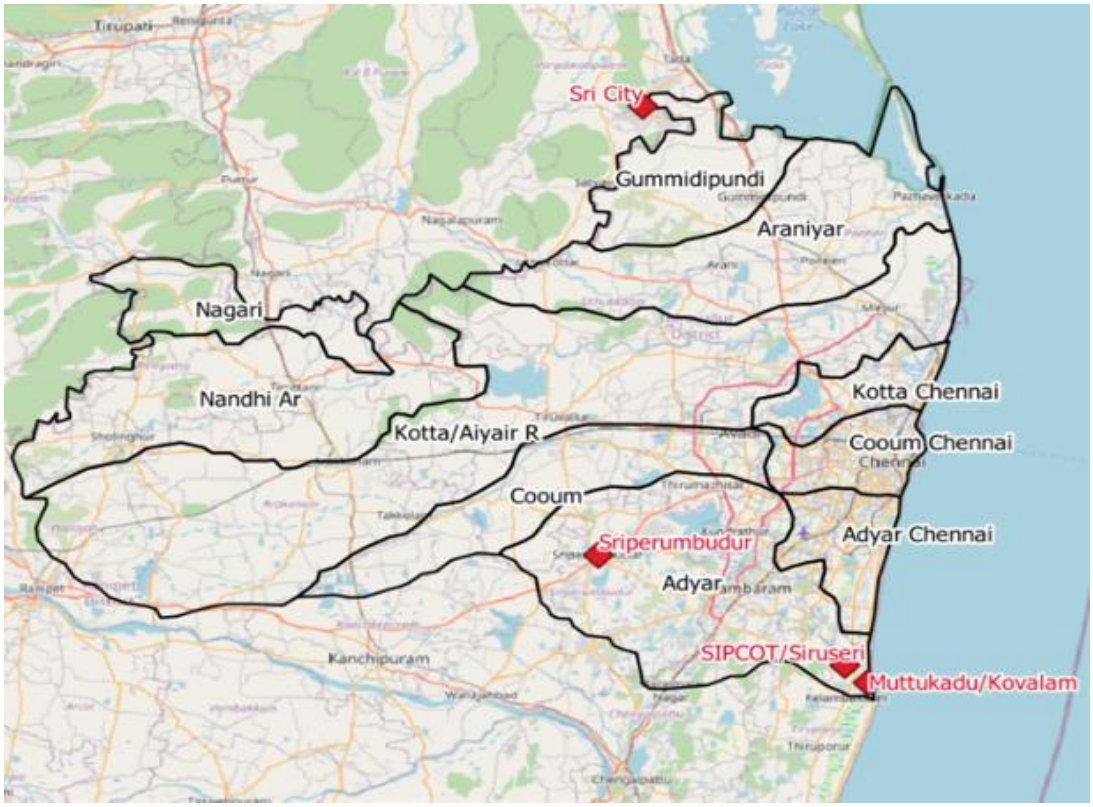

Figure 6. Chennai river basin and sub-basins

In the basin, water is distributed to the users through three main methods: piped networks, private groundwater wells, and private tankers. Piped water is primarily sourced from rain-fed reservoirs and well fields outside the city. However, the piped network's coverage is limited beyond the metropolitan zone. About 70% of Chennai's population relies on private groundwater wells as an additional water source, which are also heavily relied upon for agricultural production. Private tankers supply a smaller fraction of household water and are generally a more expensive option.

5.1.1 Scenario analysis in the Chennai economic zone

The unit of analysis used for Chennai are the sub-basins, with water deficit trends calculated historically (2010-2020) and projected over future periods (2020-2060) under two scenarios, SSP2 and SSP3[9]. As mentioned in section 4.1, SSP2, known as the "Middle of the Road", assumes moderate socioeconomic challenges to mitigation and adaptation, with trends consistent with historical patterns.

SSP3 scenario, "A Rocky Road," envisions a fragmented world with heightened regional rivalry and slower economic growth, leading to substantial challenges for mitigation and adaptation efforts. The assessment does not consider SSP1, SSP4, and SSP5 to avoid overcomplicating messages.

It's important to emphasize that the choice of SSPs can significantly influence the outcomes of an analysis. While SSP2 and SSP3 do not differ drastically in this analysis, SSP4 or SSP5 could have led to more pronounced water gaps outcomes due to higher economic growth projections. The selection of SSP2 and SSP3 was made based on specific objectives of this project, but it is crucial to check the requirements of the analysis before choosing an SSP.

[9] For more information about the Shared Socioeconomic Pathways Scenarios, visit: Database (SSP) | IIASA

Sometimes it is valuable to demonstrate the "bandwidths" or extremes of outcomes, especially to address uncertainties.

A summary of SSP scenarios information is described in Table 3Table 3:

Table 3. Key characteristics Shared Socio-Economic Pathways 2 and 3 explained.

Characteristics	★ SSP2	★ SSP3
Name	Middle of the Road	Regional Rivalry Rocky Road
Description	Describes a continuation of current trends, with incremental advances in reducing resource and energy consumption	Paints a bleaker scenario of fragmentation, where poverty, rapid population growth, and environmental degradation challenge climate change mitigation and adaptation efforts due to slow technological progress in energy and poor regional cooperation
Population	Continuation of current developments	Low population growth in rich countries and high population growth in other countries
Economic growth	Continuation of current developments	Slow
International cooperation and trade	Continuation of current developments	Barriers
Policy types	Focused on reduced resources and energy consumption	Focused on security

Figure 7 illustrates the frequency of water gaps occurring in specific months throughout the analysis period (2000-2060). Red cells mean a high frequency of water gaps during those months, whereas green cells denote a lower frequency or absence of water gaps.

Both SSP2 and SSP3 scenarios indicate frequent water gaps in Araniyar, Gummidipundi, and Adyar, the most affected regions, particularly from December to April, which follows the monsoon season. The incidence of water gaps peaks in December, March, and April, likely due to increased water demands following the monsoon period.

Water gaps can cause operational interruptions, escalate costs, and necessitate strategic realignments within affected industries.
Figure 7. Frequency of monthly water gaps per sub-basin between 2000-2060 for SSP2 and SSP3.
Table 4 summarises key findings of this analysis.

Figure 7. Frequency of monthly water gaps per sub-basin between 2000-2060 for SSP2 and SSP3.

Table 4. Chennai - Water gaps analysis explained.

What do the figures tell you?
About the Water Gap Analysis • Figure 7 displays the frequency of occuring monthly water gaps for a certain month during the analysis period (2000-2060). The number '40' for example means that, between 2000 and 2060, 40 months of January have experience a water gap. Red indicates a large frequency of water gaps for that month, while green indicates a smaller frequency (or no water gaps in that month between 2000 and 2060). • Left figure shows the results of the SSP2 scenario analysis. Right figure shows the results of the SSP3 scenario analysis.
Most Impacted Areas are: • Araniyar, Gummidipundi and Adyar.
Key Findings are: • Water Gap Trends: Both SSP2 and SSP3 show frequent water gaps in Araniyar, Gummidipundi, and Adyar, especially from December to April, post-monsoon. • Impact on Industries: These water gaps can lead to operational disruptions, increased costs, and the need for strategic adjustments. • Peak Months: Water gaps peak in December, March, and April, likely due to post-monsoon water demands. • Scenario Comparison: SSP3 shows slightly worse conditions with more frequent and severe water gaps, indicated by darker red and orange shades.

The analysis suggests growing disparities between water demand and availability, posing significant industry challenges. Detailed sector impacts are discussed in the following section.

5.1.2 Sector-specific analysis in the Chennai economic zone

Water gaps significantly impact industries in the Chennai economic zone, particularly in Adyar, where industry concentration is highest. Araniyar and Gummidipundi also face severe water gaps, but these areas have less industrial activity.

Figure 8 displays the number of companies per sub-basin and includes a matrix with industry categories. **It reveals a notable overrepresentation of water-intensive industries in specific sub-basins. This overrepresentation is partly due to data constraints**; the sector data available is disproportionally larger for textiles and electric energy production than other sectors, potentially skewing the findings. **This limitation implies that the case studies might illustrate the challenges and risks more than provide a comprehensive view of all sectors**. The results are, therefore, more illustrative of the water stress faced by these overrepresented industries rather than fully actionable across all sectors. Table 5Table 5 shows a summary of key findings.

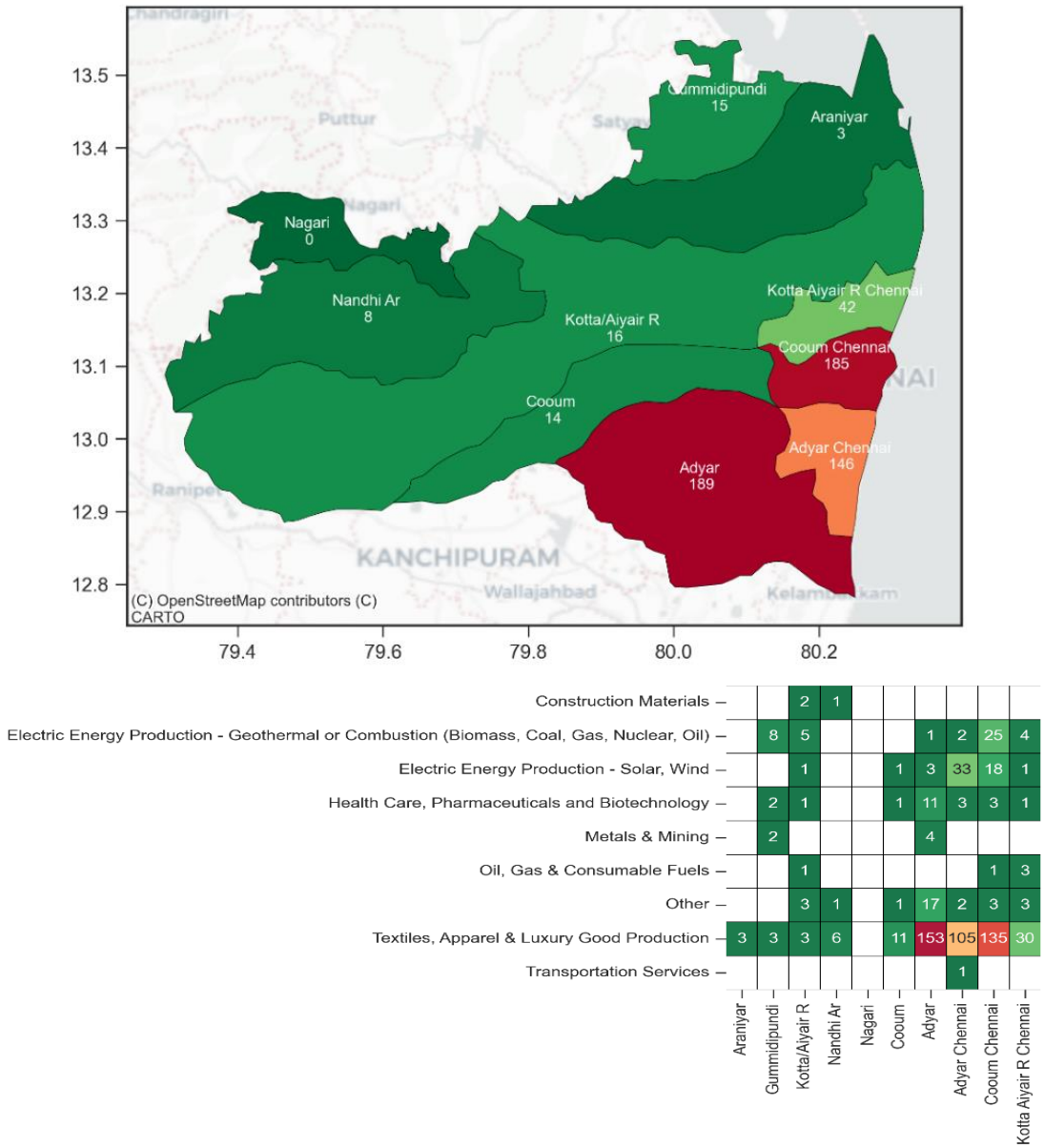

Figure 8. Chennai – Number of industries per sector in each sub-basin

Table 5. Chennai – Analysis of industry type distribution per sub-basin explained

What do the figures tell you?
About the Industry-type Distribution Analysis • Figure 8 indicates the number of industries per sector in each sub-basin. • Red colours in the figure indicate many industries, while green indicates fewer industries. • The matrix shows how many industries from different sectors are listed in each sub-basin.
Most Impacted Areas are: • Adyar, Adyar Chennai and Cooum Chennai.
Key Findings are: • Data Limitation: Overrepresentation of textiles and electric energy sectors highlights a critical limitation for understanding water risks. • Industry Concentration: Textile, apparel and luxury good industries are disproportionally concentrated in Adyar (153), Adyar Chennai (105) and Cooum Chennai (135) sub-basins. Electric energy production (solar, wind) and electric energy production geothermal or combustion follow in numbers, concentrated in Adyar Chennai (33) and Cooum Chennai (25), respectively. • Industry Dependence: High water demand industries concentrated in Adyar, Adyar Chennai and Cooum Chennai are at significant risk.

The analysis indicates that Adyar, Adyar Chennai, and Cooum Chennai sub-basins face the highest water gap risks, which are heavily influenced by the high concentration of water-intensive industries such as textiles. These industries, dependent on substantial water volumes for processes like dyeing and finishing, face heightened vulnerability to water scarcity. Adyar sub-basin is home to 153 industries in the textile sector alone, which is significantly higher than in other sub-basins. This disproportionate concentration exacerbates the strain on already limited water resources.

Electric energy production industries, including those using solar, wind, geothermal, and combustion methods, follow in high numbers. In Adyar Chennai, there are 33 electric energy production industries, and in Cooum Chennai, 25. While renewable energy sources like solar and wind are less water-intensive, combustion-based energy production requires substantial amounts of water for cooling and steam generation, exacerbating the water stress in these areas. **Overrepresentation of textiles and electric energy sectors highlights a critical limitation to data analysis. This skew could lead to an incomplete understanding of the water risks other industry sectors face, which may be vulnerable but less represented in the data.**

Industries in Chennai depend on a mix of surface and groundwater, managed by the Chennai Metropolitan Water Supply and Sewerage Board (CMWSSB). During the 2019 water crisis, Chennai declared "Day Zero," depleting its main reservoirs and resorting to costly, unregulated water sources[10]. Since then, CMWSSB has implemented a corporate water reuse plan and mandated zero liquid discharge for industries, emphasizing water treatment and reuse[11].

[10] For more information about Chennai's 2019 water crisis, access: Chennai water crisis.
[11] For more information about Chennai's water and wastewater recycling, access: Chennai, India – EBRD.

Figure 9 shows an average water gap index (WGI) between 2000-2060 per sub-basin[12]. It also shows the locations of different industries in the basin. The first figure considers SSP2 scenario conditions, and the second SSP3 scenario conditions. Under the SSP3 scenario, WGI is slightly larger than in the SSP2, but hazards are similarly medium to high due to increasing industrial water demand. Table 6 summarises the sector-specific water gap index (WGI) analysis. It is though expected that under the SSP5 scenario, the risks would be even worse. Scenario SSP5 was however not the one chosen by the stakeholders in the basin at the time of the WaterLOUPE assessment.

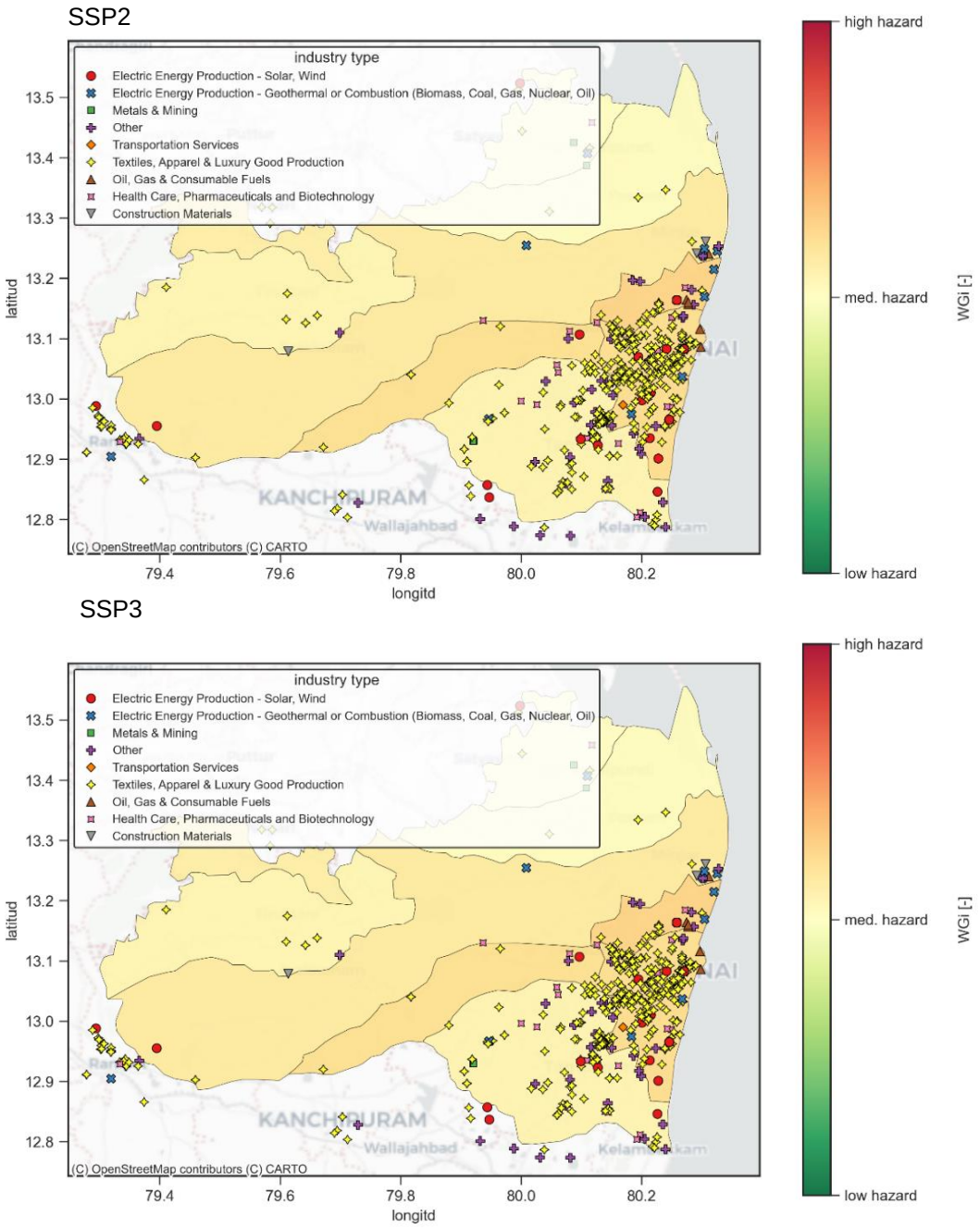

Figure 9. Chennai – Water Gap Index and Industry type distribution within the basin under SSP2 and SSP3 scenarios

[12] For more information about the Water Gap Index visit ANNEX III.

Table 6. Chennai - Sector-specific analysis explained

What do the figures tell you?
About the Sector-Specific Analysis • Figure 9 displays the concentration of industries per sector within the basin and the water gap index (WGI) for each sub-basin until 2060 under SSP2 and SSP3 scenarios. • Red colours indicate a larger WGI (high hazard), and green colours indicate a small WGI (small hazard) over the analysis period (2000-2060).
Most Impacted Industry-types are: • Textile apparel and luxury goods and Electric energy production (solar and wind, followed by geothermal and combustion. • These industries are located in the orange-coloured areas within the map
Key Findings are: • Most Affected Sub-basins: Adyar, Adyar Chennai, and Cooum Chennai face the highest water gap risks, especially impacting water-intensive industries like textiles. • Water Demand: Textile and apparel industries, concentrated in Adyar, Adyar Chennai and Cooum Chennai sub-basins, are highly water-dependent, particularly for dyeing and washing processes.

Overall, the basin experiences medium to high water gap hazards. With the significant water demand for processes like dyeing, finishing, and washing, the textile industry sector can be highly affected by water gaps. As previously mentioned, industries within the basin are mandated to implement water-efficient technologies, effective wastewater treatment solutions, and sustainable water management practices. These measures are crucial for mitigating the adverse effects on the region's water resources and aligning with broader environmental conservation efforts.

The energy sector's water demand in the basin varies depending on the energy source. Combustion-based energy production, including coal and gas, requires significant water for cooling and steam generation. In Chennai, the focus is gradually shifting towards more sustainable and less water-intensive energy sources, with national policies promoting renewable energy production, which is reflected in the number of solar and wind energy producers within the basin (57). Currently, combustion-based energy production is concentrated in Cooum Chennai, adding to the overall water demand and increasing competition for limited water resources.

Figure 10 displays projected water demand for three economic sectors until 2060 - agriculture, domestic and industry - considering SSP2 (full line) and SSP3 (dotted line). It further breaks down the domestic sector into four categories – domestic rural population above poverty levels[13], domestic rural population below poverty levels, domestic urban population above poverty levels, and domestic urban population below poverty levels.

Table 7 shows a summary of key the analysis key findings.

[13] By above poverty levels one means the minimum level of income deemed adequate in a particular country to cover basic needs of an average adult.

When comparing socioeconomic sectors' projected water demand, the industry sector is still below the domestic urban population above poverty levels and very close to the agriculture sector. **After 2030, the industry sector is expected to become the water user champion, surpassing the domestic and agriculture sectors' water demand.**

Under the SSP2 scenario (full line), water demand for the industrial, agricultural, and domestic urban population above the poverty level and domestic rural population below the poverty level are higher than those estimated under the SSP3 scenario (dotted line). This is an interesting finding in line with SSP2 considerations of current social and economic trends. It means that rural and urban populations below poverty levels will increase if current trends continue to unfold. If a more unsustainable scenario, such as SSP5, was used in this analysis, difference in water gaps would consider uncontrolled growth versus a more sustainable growth.

Interestingly, the water demand for domestic rural population above poverty levels decreases with time. Potentially because the number of people also decreases. Overall, these trends might happen due to the differences in levels of inequality presented in both scenarios.

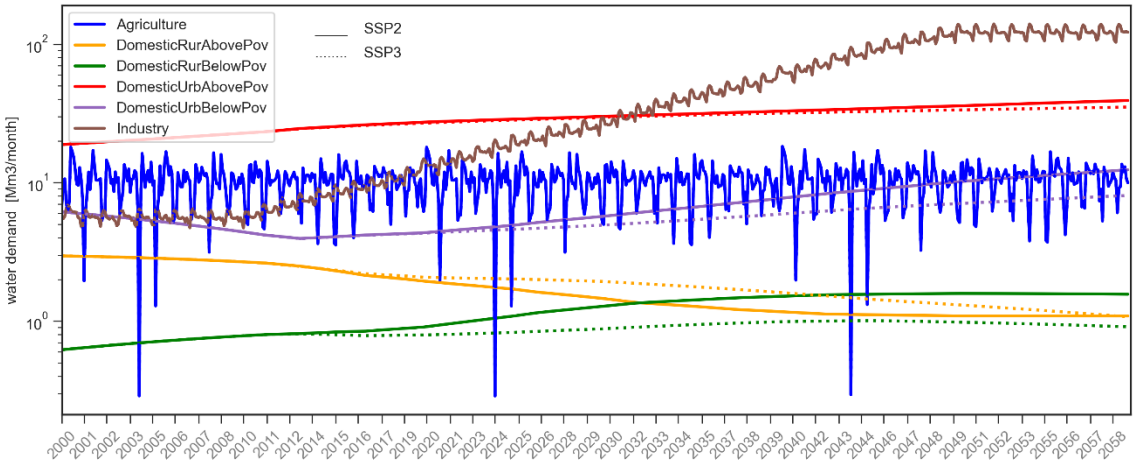

Figure 10. Chennai - Projected Water Demand by Socioeconomic Sector

Table 7. Chennai - Evolution of socioeconomic sectors water demand explained

What do the figures tell you?
About the Socioeconomic Sectors Water Demand Analysis • Figure 10 shows the evolution of water demand per sector under two different SSP scenarios (SSP2: full line and SSP3: dotted line). • The domestic sector is divided into four subsectors: i) domestic rural population above the poverty line, ii) domestic rural population below the poverty line, iii) domestic urban population above the poverty line and iv) domestic urban population below the poverty line. Agriculture and Industry are also considered.
Highest Sectoral Water Demand is: • Industry sector – surpassing all other sectors from 2030 onwards.
Key Findings are: • Projected Demand: The industrial sector's water demand will surpass all other sectors by 2030 under both SSP2 and SSP3 scenarios. Domestic and agricultural water demands show a lower increase. It's essential to note that domestic water

What do the figures tell you?

demand also plays a considerable role in the overall water consumption pattern in the Chennai economic zone.

- Seasonal variability: There is a clear seasonal variation in the water demand from the agricultural sector, showcased by the graph's drops.
- Comparative Analysis: Under SSP2 and SSP3, industrial water demand remains high, with more notable differences in demand growth for the domestic sector. In addition, a decrease in water demand is expected for the domestic rural population above the poverty level. Industrial water demand increases under both scenarios with no expressed differences. This could be because the basin is already highly water-stressed, with limited possibilities for industrial growth. Although water conservation measures can be implemented by industries to decrease the water demand, the sub-basins will still have higher water gaps.

To complement the findings of the scenario analysis conducted by the WaterLOUPE tool, the Water Risk Filter is used to assess the overall basin risk.

The Water Risk Filter is a tool developed by the World Wide Fund for Nature (WWF) as part of their Risk Filter Suite. It is designed to help companies and investors to assess and respond to water-related risks in their operations and supply chains. The results from the WRF show a broader category of risk types, with a distinction between physical, regulatory and reputational risk for companies located in the Chennai economic zone, complementing the scenarios and sector-specific analysis provided by the WaterLOUPE, which focus on water scarcity related risk.

The results of the analysis are displayed in Figure 11, which summarises average scores from the 724 sites under study within the Chennai River basin. The Water Risk Filter scores run from 1 to 5, being 5 the highest score, i.e. the worst-case scenario.

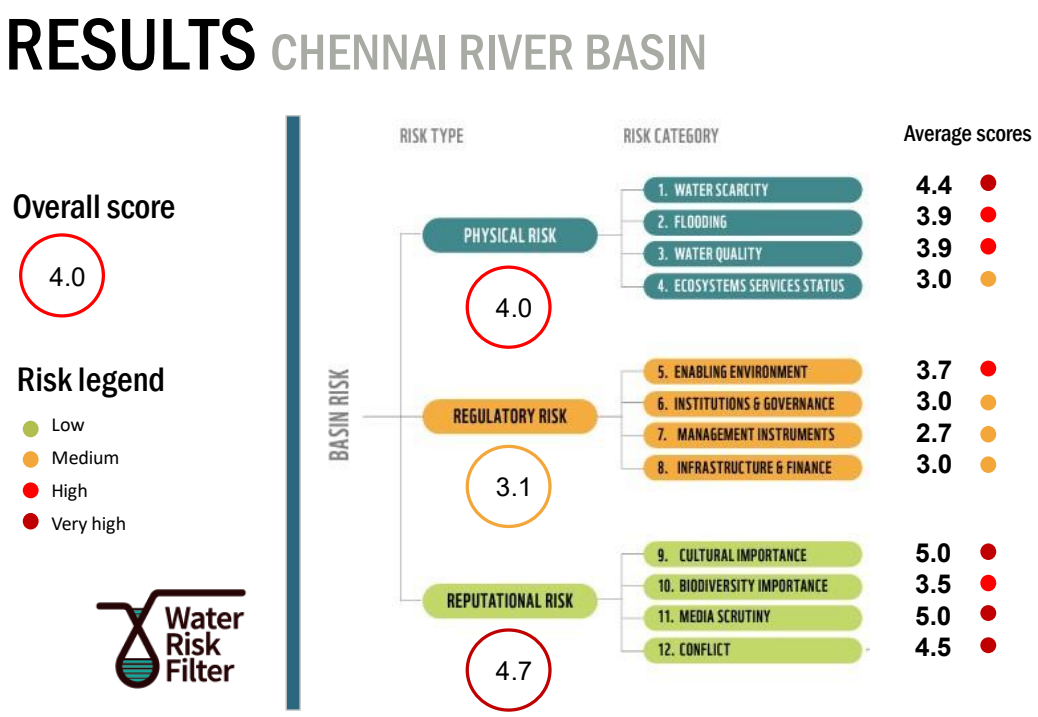

Figure 11. Water Risk Filter average risk score to companies located in the Chennai economic zone.

The sectoral classification of the analysed sites in Figure 12 shows that companies in the textiles, apparel & luxury goods production sector represent 73% of the analysed sites. Next are companies within the solar and wind electricity and geothermal or combustion electricity sectors, representing 8% and 7% of the analysed sites, respectively. As highlighted above, due to the varying availability of open-source data across different sectors, some sectors, like textiles, may be overrepresented in this dataset. These findings are aligned with WaterLOUPE sectoral results.

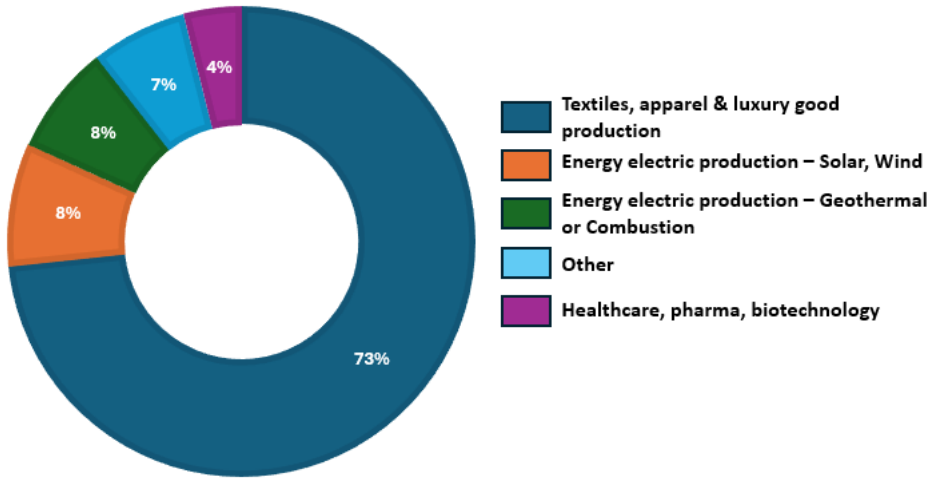

Figure 12 Sites included in the Chennai dataset per sector, showing a bias to sectors with better data-availability.

Very high scores (Score of 4.2 and above)

The reputational risk type has a very high average score (4.7). This significant rating represents a high stakeholder and local community perception of whether companies conduct business sustainably or responsibly concerning water. To reduce reputational risks, businesses should prioritize actions to mitigate any negative impact or violation of water resources. A more detailed water risk assessment and possible response strategies are discussed in the next section.

The reputational risk score results from the aggregation of 4 risk categories (cultural importance, biodiversity importance, media scrutiny and conflict risk). Very high scores influence the very high reputational risk score for the Chennai economic zone in three of these categories:

1 First, water as a social and cultural good is sensed as **very important for local communities**. The highest possible risk score (5) is based on the number of ethnolinguistic groups by country as a proxy of cultural diversity. The rationale is that a high-risk score indicates that cultural diversity leads to a strong valuation of water in communities' daily life, religion and culture.
2 Second, the actions affecting the status of the river basin are **highly scrutinized**. Stakeholders and local communities are strongly aware of any business water-related actions. The highest possible risk score (5) results from frequent thresholds on national and international media coverage.
3 Third, documented **water-related negative incidents**, criticism, and controversies affect the high-risk score in the conflict category (4.5). For instance, frequent historical cross-border water interactions as indicators of the magnitude of corresponding water joint-management issues determine the high-risk score.

Water scarcity, defined in the WRF as the volume of water use/demand relative to the available volume, also has a very high-risk score (4.4). Consequently, companies and investors should act to mitigate any physical risk affecting the lack of freshwater resources. This score aggregates high-risk physical conditions (such as aridity index, projected drought occurrence, water depletion or blue water availability) and human activities, such as total surface water withdrawal. Business action is needed to control an efficient balance between the volume of water used and water available in the basin.

High scores (Score of 3.4 to 4.2)
Physical risks account for natural and human-induced conditions of water resources and their surroundings: quantity, quality and ecosystem degradation. The high physical risk score is a result of the aggregation of 4 risk categories (water scarcity, flooding, water quality and ecosystem service status). Consequently, it is influenced by very high scores in three of them:

- The first is the aforementioned very high score on **water scarcity**.
- The second high score indicates a **high flooding occurrence risk** (3.9). High water overflowing can cause business operations closure, supply chain and transportation disruption, or increased capital costs.
- Last, the third high score indicates a high risk of qualitative fit of water resources for human use (3.9), in other words, **water quality**. Again, business operations can be affected by poor water security.

Existing policies, laws, and plans to support water management (i.e., enabling the environment risk category) compare the freshwater policy and law status in a list of countries. Its high score (3.7) indicates significant pressure on existing policies, laws and plans to support water stewardship implementation.

Medium scores (Score of 2.6 to 3.4)
The regulatory risk aggregated score measures good governance and an effective regulatory environment. The medium regulatory risk score is a result of the aggregation of 4 risk categories (enabling environment, institutions & governance, management instruments and infrastructure & finance). Consequently, it is influenced by medium scores in three of them: stakeholders' engagement in water stewardship implementation (3.0), data and management instruments availability (2.7) and finance of water infrastructure development (3.0). Figure 13 summarises the score distributions of each risk category, classified by the three risk types in different colours. As we can see, the 12 risk categories are above 2.6, representing either a medium, high or very high risk. Three reputational risks (conflict, cultural importance and media scrutiny) represent the risks with higher scores.

Figure 13 gives a prioritised overview of the full list of all 12 Chennai economic zone risk categories, from high to low scores.

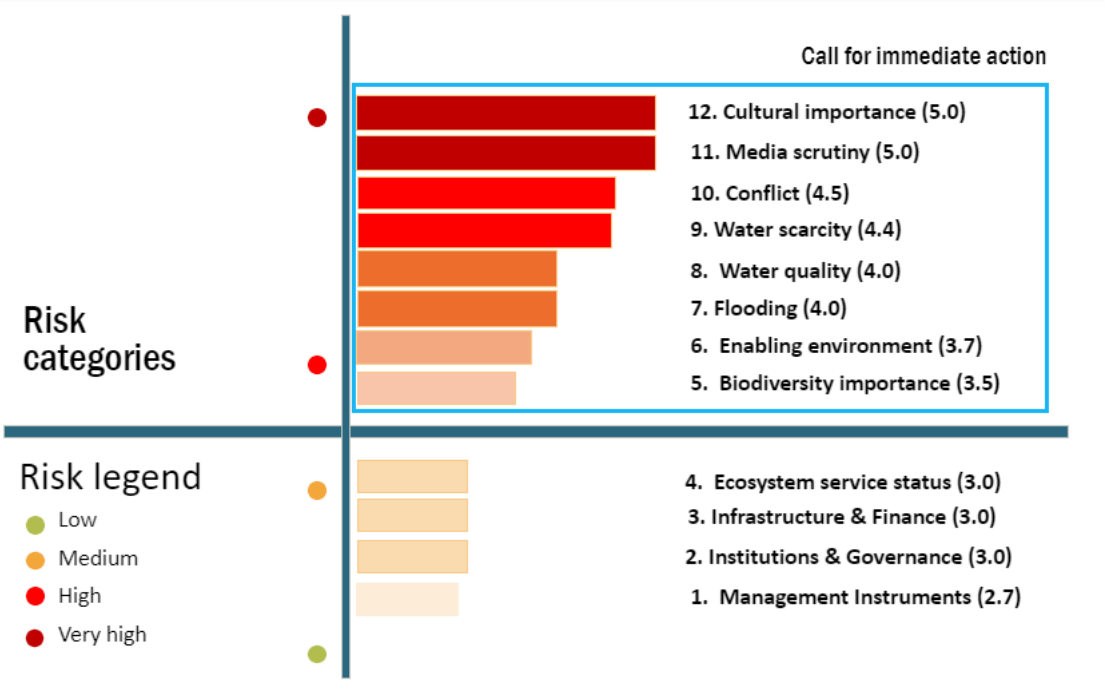

Figure 13 Prioritisation of risk categories for Chennai economic zone, with highest scores shown on top.

With these results, companies can prioritize actions based on the categories that got a higher average score.

5.1.3 Water risk assessment and response strategies in the Chennai economic zone

Following a comprehensive scenario and sector-specific analysis conducted for various economic actors, this section delves into the water risk assessment and outlines potential response strategies within the Chennai economic zone.

The current dataset predominantly represents the textile and electric energy sectors, revealing an analysis limitation. This disproportionate focus may hamper the ability to conduct an analysis that reveals the full spectrum of water risks, particularly for vulnerable and underrepresented sectors. **Sector-specific data collection enhancement is imperative to construct a more precise profile of water risks affecting diverse industries**. Improved data availability is crucial for informed risk management, enabling precise interventions and formulating effective response strategies.

The analyses concluded that the Chennai economic zone, a key industrial hub in India, faces significant challenges considering water scarcity. These issues threaten the basin's industrial sustainability and community livelihoods. In response to these multifaceted risks, this section delineates general risks and response strategies for companies in the Chennai economic zone.

Given that the analysis identifies the Chennai economic zone areas of concern for future water gaps under both SSP2 and SSP3 scenarios, **industries in the most affected areas must strategize and adapt accordingly**. The textile, apparel, luxury goods industries, and electric energy production sectors are identified as particularly vulnerable due to their high number in the region and dependence on water.

Table 8 lists general risks and response strategies for companies in the Chennai economic zone based on desk research, and the scenario and sectoral analyses conducted.

Risks are categorized into physical, transitional, and reputational categories. Then, strategic response strategies are drafted based on desk research. Responses focus on mitigating impacts, capitalising on emerging opportunities, and fostering resilience. Specific company-level strategy cannot be drafted unless tailored company-level analysis is conducted.

Table 8. Chennai water risk assessment and response strategies.

Risk type	Risk	Responses
Physical	**Operational Disruptions & Increased costs**	**Alternative Water Sources:** Explore alternative water sources, such as rainwater harvesting, providing additional buffer against shortages. **Increase Environmental Resilience:** Improving wetlands, aquifer functionality, and generally "slowing water" in the landscape can help ensure improved flow during dry seasons through nature-based solutions, for example.
		Water Efficiency and Recycling: Invest in technologies to reduce water usage and implement recycling systems to lower freshwater demand. While there are robust regulatory frameworks and incentives in Chennai promoting water efficiency and recycling, making these practices mandatory varies depending on specific industrial sectors and regulatory guidelines. Both state and central governments offer incentives for industries that adopt water-saving technologies and practices. These can include subsidies, tax benefits, and recognition awards.
	Water Quality Degradation	**Efficient Wastewater Treatment:** Industries in Chennai must install and operate wastewater treatment plants to treat effluents before discharge. They must monitor their effluent quality and report to the Tamil Nadu Pollution Control Board. In addition, industries in water-intensive sectors, such as textile, must comply with zero liquid discharge (ZLD) mandates to ensure all wastewater is treated and reused.
	Supply Chain Vulnerabilities	**Innovation and Diversification:** Invest in research to develop less water-intensive products and processes. Diversifying water sources and exploring new business models can also mitigate risks associated with water scarcity.
		Fostering Resilient Suppliers: Given the industrial water demand increase over time, it's valuable to assess the resilience of supply chains to water scarcity and explore ways of equipping suppliers with the necessary information regarding climate, water and biodiversity challenges projected in the future, enabling supply chains to become more resilient.
	Lack of Resources	**Collaborative Water Management:** Due to the increase in water demand under both scenarios, competition with the domestic sector might prove a competitive disadvantage, especially in areas with high population, such as Cooum (6,516 persons/m²) and Adyar (4,003 persons/m²)[14]. Engaging in collective action initiatives with local governments, communities,

[14] For more information about population density in Chennai, please visit: Chennai Report. (nwm.gov.in).

Risk type	Risk	Responses
		and other businesses can lead to shared solutions for water management, such as developing shared water infrastructure or watershed protection programs. Industries can collaborate with the State Water Resources Management Agency (TNSWRMA) to plan and manage water resources. This includes participating in consultations and contributing to developing sustainable water management strategies.
Transition	**Regulatory Compliance and Risks**	**Risk Management and Planning:** Conducting thorough risk assessments, knowing seasonal variabilities and developing business continuity plans that account for water scarcity scenarios can help industries prepare for and quickly respond to water-related challenges better, enabling companies to respond or adapt to regulatory requirements In Chennai, industrial water risk management and planning are governed by a robust set of regulations and policies at the national, state, and local levels. These frameworks mandate industries to adopt sustainable water use practices and prepare for water-related risks through a water management plan.
		Evidence-based Transparent Performance: Sourcing and seeking independent standards and certifications, such as the Alliance for Water Stewardship Standard, and robust site-level reporting are key for implementing a regulatory risk mitigation strategy.
Reputational	**Lack of Communication**	**Transparent Communication:** Companies that proactively manage their water use, follow standards, seek water stewardship certifications and contribute to sustainable water management in active regions can enhance their reputation and strengthen relationships with stakeholders, including customers, employees, and regulators.
	Lack of Stakeholder Acceptance	**Collaborative Engagements:** Engage in community projects to meet local water needs, such as WASH, and increase efforts to improve the state of water resources (quality, quantity, and ecosystems).

5.2 Case Study: Brazil - São Paulo economic zone

The São Paulo Economic Zone, Brazil, is crucial for the country's economy, supporting various activities, including agriculture, industry, and energy production. The region faces severe water scarcity, with the lowest per capita availability in Brazil, yet it supplies water to more than 4 million people. The basin holds only 6% of Brazil's water resources but is a key economic area with the highest concentration of industrial activity and contributes 1% to national hydropower generation[15]. The Alto Tietê river basin covers an area of about 6000km² and includes 40 municipalities. The unit of analysis is the municipalities within the basin. Some of the key cities and municipalities within the Alto Tietê river basin include:

[15] Travassos, L.; Momm, S. (2022) Urban River Interventions in São Paulo Municipality (Brazil): The Challenge of Ensuring Justice in Sociotechnical Transitions. Frontiers in Sustainable Cities 3

1. São Paulo - As the largest city in Brazil, São Paulo is the central urban area of the country and heavily relies on the Alto Tietê river system for its water supply.
2. Guarulhos - Located northeast of São Paulo, Guarulhos is an essential city in the basin, known for hosting São Paulo's main international airport.
3. São Bernardo do Campo - This city is part of the São Paulo Metropolitan Region, situated southeast of São Paulo city. It's an industrial hub for the automotive industry and many metallurgical and chemical companies.
4. Santo André - Adjacent to São Bernardo do Campo, Santo André is another important municipality within the basin. Santo André stands out as a commercial and cultural centre in the Greater ABC Region (an industrial region in Greater São Paulo) and the entire state of São Paulo.
5. Osasco - Located west of São Paulo, Osasco is a densely populated municipality and a key industrial and commercial hub. It has the 2nd highest GDP of the State of São Paulo.

These areas rely heavily on the Alto Tietê river system for industrial, agricultural, and domestic water supply. The basin faces challenges such as pollution, overuse of water, and the impacts of urbanization and climate change. According to São Paulo's Environmental Company (CETESB), approximately 80% of whole São Paulo State are partially supplied by groundwater, serving a population of more than 5.5 million inhabitants. Although this is not the case for the Alto Tietê River Basin. SABESP (Water supply and sanitation company for the state of São Paulo) is the primary provider of water and sanitation services in the São Paulo Metropolitan Area.

SABESP relies on both surface water and groundwater sources. This includes a network of reservoirs and rivers that are part of the Alto Tietê and nearby water systems. The use of groundwater varies across different municipalities within the basin, depending on local aquifer conditions, the availability of surface water, and the infrastructure for groundwater extraction and treatment. The exact proportions of groundwater and surface water usage can vary over time due to rainfall patterns, changes in water demand, and infrastructure developments.

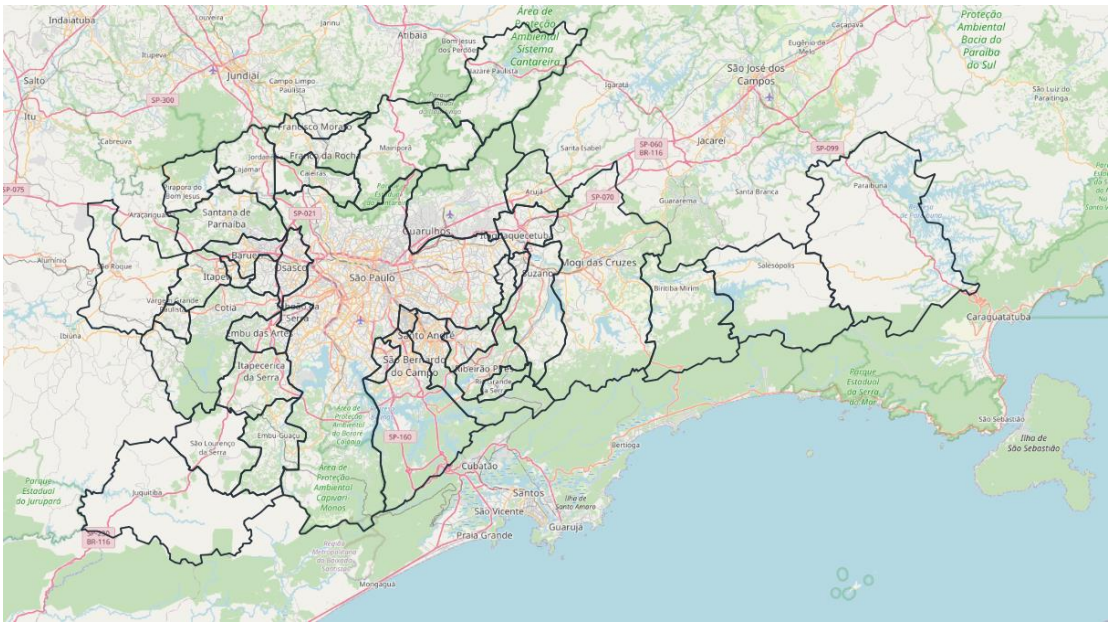

Figure 14. Alto Tietê River basin, São Paulo and 40 municipalities.

5.2.1 Scenario analysis in the São Paulo economic zone

The units of analysis in the Alto Tietê River basin are the 40 municipalities, with water deficit trends calculated historically (2010-2020) and projected over future periods (2020-2040) under two scenarios, SSP1 and SSP3[16]. As mentioned in section 4.1, SSP1 is known as “Sustainability” and SSP3 as “Rocky Road”. The SSP1 scenario envisions a greener and more sustainable future with low population growth. SSP3 scenario, "A Rocky Road," envisions a fragmented world with heightened regional rivalry and slower economic growth, leading to substantial challenges for mitigation and adaptation efforts. The assessment does not consider SSP2, SSP4, and SSP5 to avoid overcomplicating messages.

While this analysis operates at a detailed spatial scale, it is important to acknowledge the inherent trade-offs between data availability, resource constraints, and the desired level of granularity in scenario analyses. Achieving fine spatial or temporal resolutions often requires extensive datasets, which may not always be accessible. In such cases, the level of detail in the analysis must be adjusted, potentially impacting the precision of the outcomes. Therefore, decisions about the level of granularity should carefully weigh the availability of reliable data and the project's objectives, recognizing that a balance between precision and practicality is often necessary.

It’s important to emphasize that the choice of SSPs can significantly influence the outcomes of an analysis. While SSP2 and SSP3 do not differ drastically in this analysis, SSP4 or SSP5 could have led to more pronounced water gaps outcomes due to higher economic growth projections. The selection of SSP2 and SSP3 was made based on specific objectives of this project, but it is crucial to check the requirements of the analysis before choosing an SSP. Sometimes it is valuable to demonstrate the "bandwidths" or extremes of outcomes, especially to address uncertainties.

A summary of both scenarios is shown Table 9 below.

Table 9. Key characteristics of Shared Socio-Economic Pathways 1 and 3 explained.

Characteristics	★ SSP1	★ SSP3
Name	Sustainability Taking the Green Road	Regional Rivalry Rocky Road
Description	The SSP1 scenario depicts a world that aims for green growth (sustainable development). For instance, the assumed rapid technology development and concerns about environmental impacts lead to high energy efficiency and high shares of renewable energy	Paints a bleaker scenario of fragmentation, where poverty, rapid population growth, and environmental degradation challenge climate change mitigation and adaptation efforts due to slow technological progress in energy and poor regional cooperation
Population	Low population growth	Low population growth in rich countries and high population growth in other countries
Economic growth	Low	Slow
International cooperation and trade	Effective	Barriers
Policy types	Focused on sustainable development	Focused on security

[16] For more information about the Shared Socioeconomic Pathways Scenarios, access: Database (SSP) | IIASA

Figure 15 displays the frequency of water gaps occurring each month during the period of analysis (2000-2040) for each municipality within the Alto Tietê Basin. The total monthly water gaps over the 40 years are displayed in each quadrant. Red cells indicate a high frequency of water gaps during those months, while green cells denote a lower frequency or absence of water gaps.

Several municipalities stand out due to their higher occurrence of water gaps, such as São Paulo, São Roque, Carapicuíba, and Diadema. Other relevant cities such as Osasco, São Bernardo do Campo, Santo André, and Guarulhos also experience elevated water gap occurrences, primarily concentrated between May and November.

Both scenarios predict water deficits in the Alto Tietê Basin (SSP1 and SSP3), particularly during the winter months from June to October. However, the SSP3 scenario indicates more frequent and prolonged water gaps than SSP1.

For example, under the SSP1 scenario, water gaps mainly occur between June and November (about six months) in the municipality of Barueri. Under the SSP3 scenario, water gaps are significantly longer, occuring almost yearly. Although the summer period in the region is rainy, drier springs and autumns contribute to gaps all year. Similar changes and trends are observed for most municipalities in the area. **The analysis also reveals that water gaps will always occur regardless of the SSP scenario for some locations, such as São Paulo, implying regular scarcity and consequences and the imminent need for improved integrated water management and interventions**.

Recurring water gaps pose significant challenges for the industrial sector, including operational disruptions, cost escalation, and the necessity for strategic adjustments. Table 10 summarises the analysis key findings.

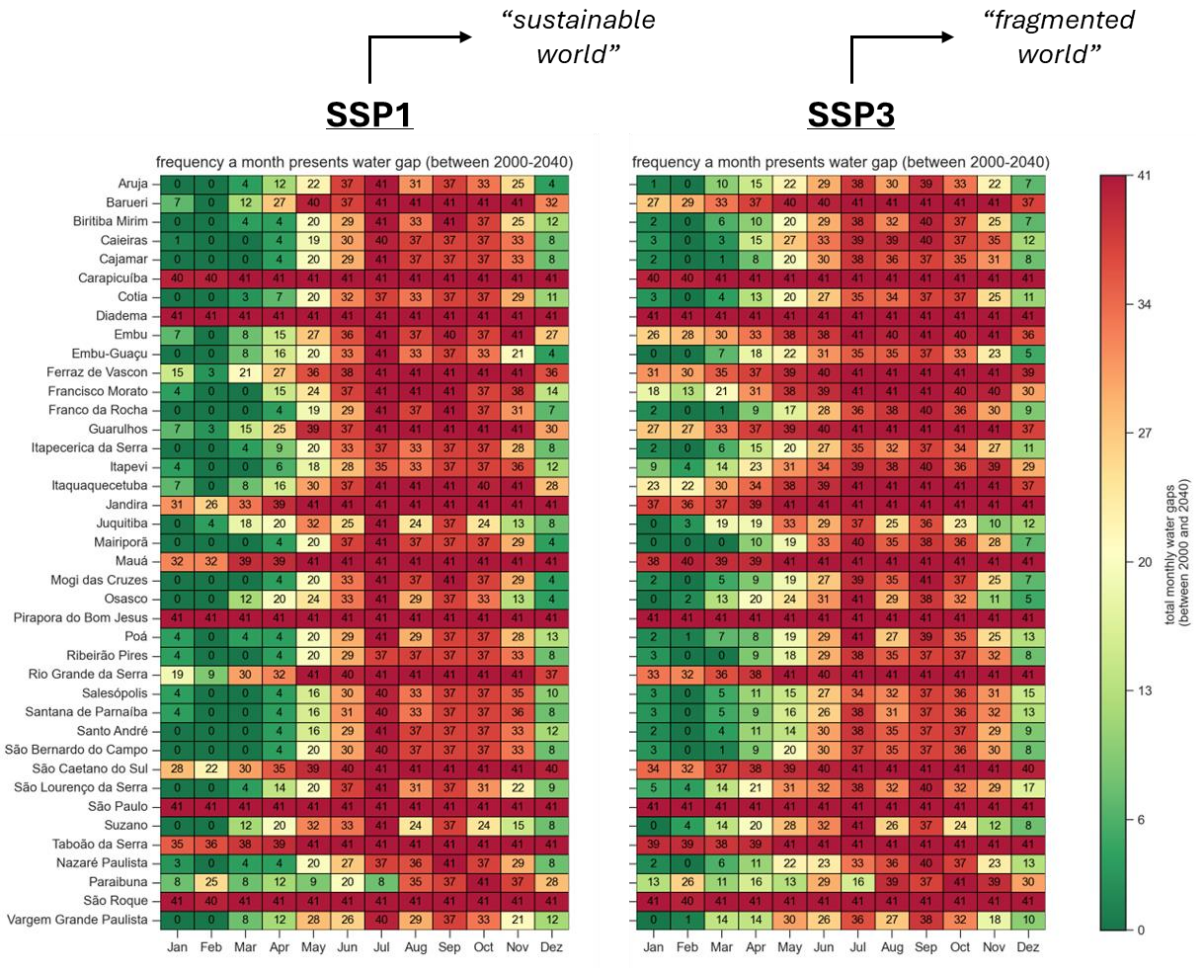

Figure 15. Alto Tietê Basin, São Paulo Economic Zone - Frequency of monthly water gaps per municipality between 2000-2040

Table 10. Alto Tietê Basin, São Paulo Economic Zone - Water gap analysis explained.

What do the figures tell you?
About Water Gap Analysis • Left figure shows the results of the SSP1 scenario analysis. Right future shows the result of the SSP3 scenario analysis. • Figure 15 displays the frequency a specific month presented a water gap during the analysis period (2000-2040) for each municipality. The number of total monthly water gaps under 40 years is displayed in the quadrants. • Red colours indicate a large frequency of water gaps in that month, while green colours indicate a smaller frequency (or no water gap).
Most Impacted Areas are: • São Paulo, São Roque, Carapicuíba, Diadema, Pirapora do Bom Jesus. These municipalities presented more months with a high number of water gaps. • Other relevant cities such as Osasco, São Bernardo do Campo, Santo André, and Guarulhos also presented more water gaps, concentrated between May and November.

What do the figures tell you?

Key Findings are:

- Water Gaps Trends: Both SSP1 and SSP3 scenarios indicate that the São Paulo ecoonomic zone will experience water deficits, particularly during the winter months of June to October.
- Impact on Industries: The water gaps contribute to challenges for the industrial sector, including operational disruptions, increased costs, and the need for strategic realignments.
- Peak Months: Water gaps peak in July and September, likely due to previous dry season consequences.
- Scenario Comparison: SSP3 shows slightly worse conditions with more frequent and prolonged gaps.

A more in-depth analysis of the industry sectors impacted is provided below.

5.2.2 Sector specific analysis in the São Paulo economic zone

Water gaps significantly impact industries, particularly in São Paulo municipality and its vicinities, the most industry-concentrated and densely populated areas in the basin. **Companies operating in the city of São Paulo and its vicinities are more exposed to the most severe, frequent, and persistent water gaps annually.**

Figure 16 displays the number of companies per municipality and a matrix with number of companies per industry type breakdown. It shows that São Paulo is home to a disproportionally high number of companies, compared to other municipalities within the basin, which face the highest water gap risks, significantly impacting water-intensive industries such as textiles. In São Paulo city alone, there are 684 companies in the textile industry. These companies depend highly on water for processes like dyeing, finishing, and washing, making them highly vulnerable to water gaps.

However, similar to Chennai, **the São Paulo analysis reveals an overrepresentation of textiles and energy sectors due to data limitations**. São Paulo, with its high concentration of textile companies, shows a disproportionate impact on water resources. However, this may not fully reflect the water risks other sectors face that are not as well-documented in the available data. **This limitation suggests that the case studies offer valuable insights but may not be fully actionable without a more complete dataset.**

Besides textiles, electric energy production companies, including those using biomass, coal, gas nuclear and oil, follow in numbers (55). While renewable energy sources like solar and wind are less water-intensive, combustion-based energy production requires substantial amounts of water for cooling and steam generation, exacerbating the water stress in this area.

The next municipality with the highest concentration of industries is Diadema. It has 55 companies in the textile, apparel, and luxury goods production industry. In addition, Diadema is the second municipality with the highest number of projected water gaps. Table 11 presents a summary of key findings.

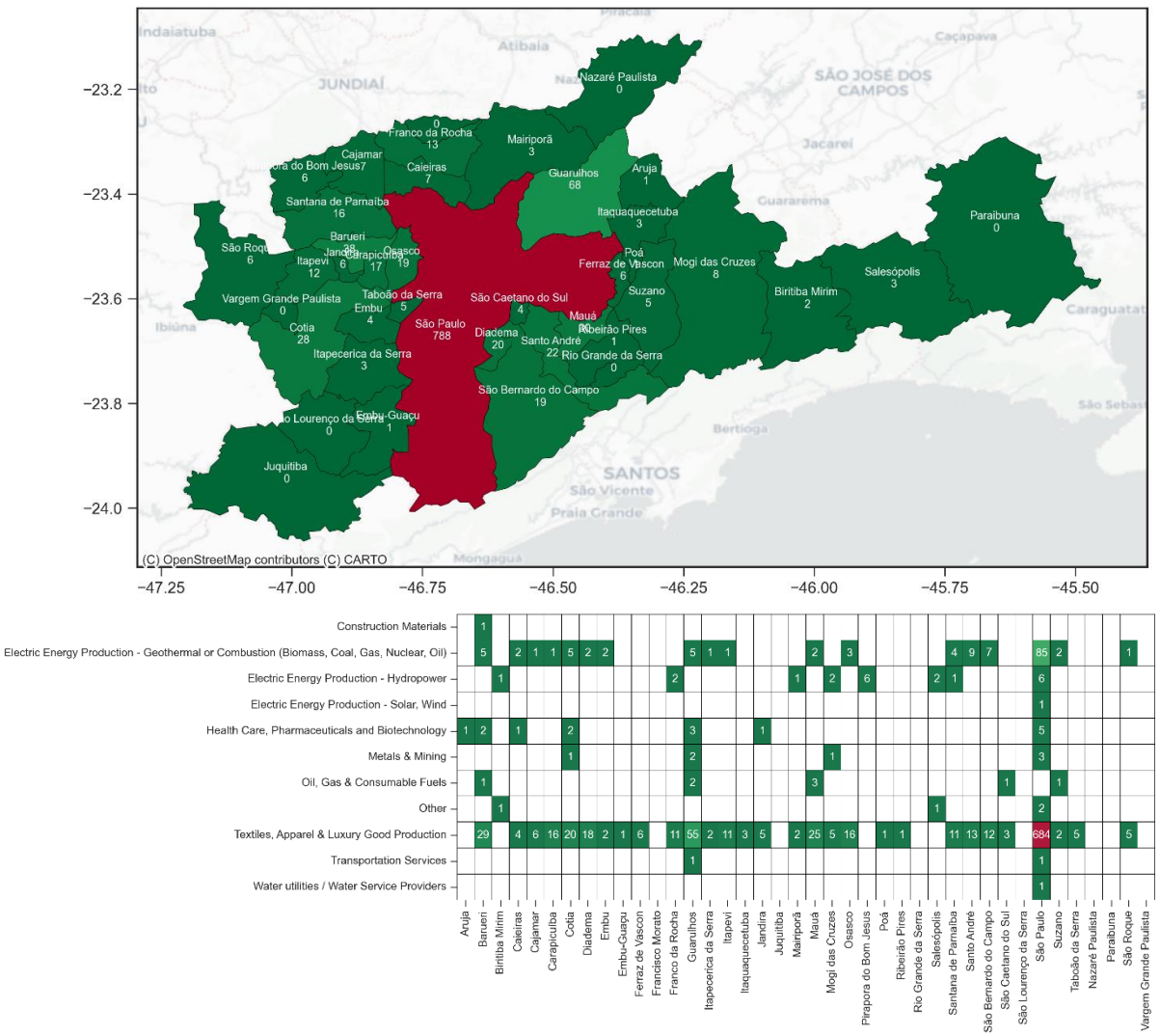

Figure 16. Alto Tietê Basin, São Paulo Economic Zone - Number and type of industries per municipality

Table 11. Alto Tietê Basin, São Paulo Economic Zone – Analysis of industry type distribution explained

What do the figures tell you?
Abou the Industry-type Distribution Analysis • Figure 16 indicates the number of companies and industry type in each sub-basin. • Red colours indicate a large number of industries, while green colours indicate fewer industries. • The matrix shows how many industries from different sectors are listed in each municipality.
Most Impacted Areas are: • São Paulo (red), Guarulhos, Barueri (light green).

What do the figures tell you?

Key Findings are:

- Data Limitation: Overrepresentation of textiles and energy sectors due to data limitations hinder the ability to conduct a more comprehensive water risk assessment faced by other sectors.
- Industry Concentration: Textile, apparel and luxury goods companies are disproportionally concentrated in São Paulo (684). Electric energy from geothermal or combustion sources follows in numbers, especially in São Paulo (85).
- Industry Dependence: The textile industry requires significant water demand for dyeing, finishing, and washing processes. This sector's concentration in the basin increases pressure on local water supplies.

Companies operating in the Alto Tietê River basin in São Paulo, Brazil, utilise water supplied by the Basic Sanitation Company of the State of São Paulo (SABESP), responsible for water and sewage services provision in São Paulo state. Many companies and almost all urban residential customers receive their water from SABESP, which mostly treats surface water in the basin and rely on reservoirs.

SABESP has faced challenges in meeting the demand for water during droughts. This has led to stricter regulations on water use, including for industrial purposes. Historically, the reliance of the socioeconomic sectors in the basin, such as agriculture, domestic and industry, has been primarily on surface water, with groundwater serving as a supplemental source[17]. **This reliance on surface water is very relevant because it highlights the vulnerability of these sectors to changes in surface water availability.**

During dry periods, when the water levels are lower, water withdrawal from rivers increases because there is no rain to supply the basin reservoirs. When surface water is scarce during these periods, groundwater withdrawal is also significant[18]. Although it is mandatory to register a well for groundwater subtraction and apply for a permit for water extraction, there is no data regarding the number of wells dug in the country used for extracting groundwater.

In the upper part of the basin, the landscape is predominantly characterized by agricultural activity, although with significant urban centres such as Mogi das Cruzes and Suzano, alongside numerous large-scale industrial operations. The Alto Tietê River basin Committee, in 2019, painted a concerning picture, revealing that over 50% of its sub-basin surface and groundwater resources are in a critical or near-critical state regarding water quality and pollution control[19].

Figure 17 provides an overview of industry distribution in the basin per category while Table 12 provides sector specific insights from the analysis.

[17] Cavalcanti, V. (2020). Differentiating the impacts of water shortages on different social classes: A case study of Sao Paulo Metropolitan Region. Vrije Universiteit.
[18] UNESP. (2023) Jornal da UNESP. Accessible at: Jornal da Unesp
[19] ANA. (2019). Conjuntura dos recursos hídricos no Brasil 2019: Informe Anual. Accessible at: informe_anual_2019 (snirh.gov.br)

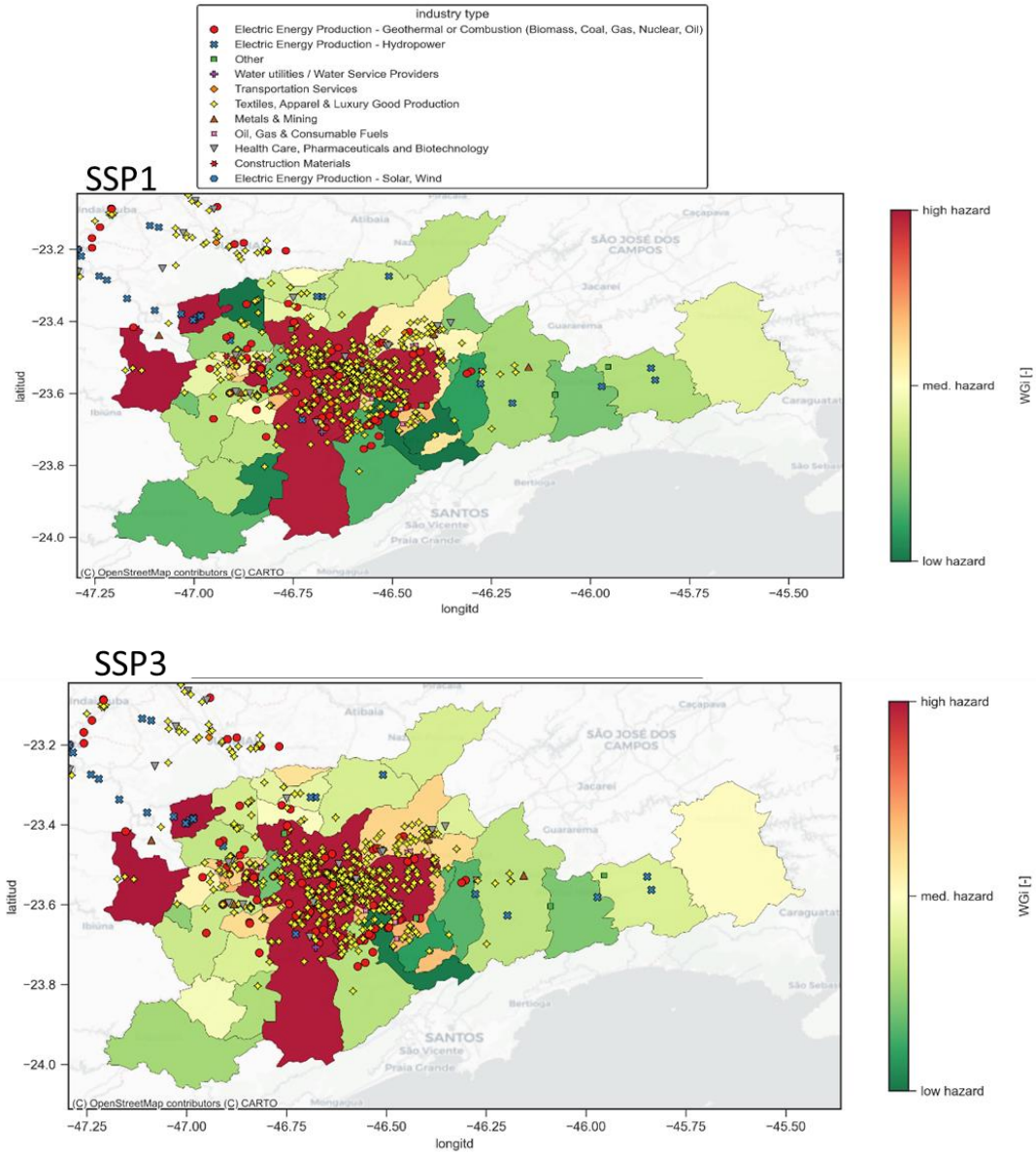

Figure 17. Alto Tietê, São Paulo Economic Zone - Industry-type distribution within the basin under SSP1 and SSP3 scenarios.

Table 12. Alto Tietê Basin, São Paulo Economic Zone – Sector-specific analysis explained

What do the figures tell you?
About the Sector-Specific Analysis • Figures display the concentration of industries per sector within the basin and the water gap index (WGI) for each sub-basin until 2040 under SSP2 and SSP3 scenarios. • Red colours indicate a high hazard, while green colours indicate a low hazard over the analysis period. • Under the SSP3 scenario, WGI is larger than in the SSP1, which can be interpreted from the orange areas. Hazards are similarly high due to high and increasing industrial water demand.
Most Impacted Industry types are:

What do the figures tell you?

- Textile apparel and luxury goods, concentrated in red and orange areas are the most impacted industrial sectors.
- In second place follows the Electric energy production sector (geothermal and combustion followed by hydropower), which is less present in red and orange areas but present in yellow and green areas.

Key Findings are:

- Most Affected Areas: São Paulo and Guarulhos (red areas) face higher water gap risks, considering the concentration of industries there.
- Water Demand: Most industries are located in areas with large WGI, which can increase their risk of water shortages in the future, especially industries with high water dependence, such as textile apparel and luxury goods. Other areas with high water gap index, such as São Roque and Nossa Senhora do Bom Jesus, do not present many industries.
- Scenario Comparison: Under the SSP3 scenario, even more municipalities are likely to present higher hazards (more yellow and orange areas), especially in already industry-concentrated areas

The concentration of companies specializing in textiles, apparel, and luxury goods industries in the city of São Paulo, numbering 684, significantly increases the demand for water within the basin. This industrial concentration underscores the need for efficient water management strategies to mitigate the impact on the basin's water quality and availability.

The textile industry is known for being water-intensive, using large quantities of water for dyeing, finishing, and washing processes[20]. In a region like the São Paulo economic zone, where water resources are under considerable stress, the concentration of textile operations can exert significant pressure on local water supplies. The industry requires high volumes of water and discharges wastewater that, if not adequately treated, can contribute to pollution levels that exacerbate the basin's water quality challenges. Companies may rely on a mix of water sources, including direct withdrawals from surface water sources and water supplied by SABESP, and are subject to environmental regulations to control water use and effluent treatment.

The energy sector's water demand in the basin can vary significantly depending on the type of energy generation and technologies used. Thermal power plants, for example, require substantial amounts of water for cooling processes, whereas renewable energy sources like wind and solar systems have minimal direct water use. Hydropower, which is prevalent in Brazil, also interacts with water resources differently, primarily concerning water management and allocation rather than consumption.

Given the critical or near-critical state of water quality and availability in parts of the São Paulo economic zone, the textile and energy sectors are likely under pressure to adopt water-efficient technologies and practices. This includes recycling and reusing water, improving wastewater treatment, and implementing sustainable water management strategies that align with broader efforts to protect and conserve the basin's water resources.

Although the industrial sector is quite developed in the basin, the domestic sector is the water user champion.

[20] Bastian, E.Y.O. Rocco, J.L.S. (2009). Guia Técnico Ambiental da Industria Textil. CETESB

Figure 18 below displays projected water demand for active economic sectors in the region until 2040 - agribusiness, domestic and industry - considering SSP1 (full line) and SSP3 (dotted line). Under the SSP1 scenario (full line), water demand for the domestic sector is lower than that estimated under the SSP3 scenario (dotted line).

Moreover, the figure shows water demand for agribusiness sectors referred to as irrigation, agriculture and livestock. By irrigation, one means that the water used comes from aquifers and surface water bodies. By agriculture, one means rainwater-fed crops. These differences in water demand by irrigation and agriculture can be estimated due to river basin data availability on national and local water portals. By livestock one means water used to graze cattle.

When comparing socioeconomic sectors, the industry sector's projected water demand is still below the water demand of the domestic, agriculture, and irrigation sectors. **There is an evident seasonal variation in water demand for the agricultural sector/irrigation based on the types of crops planted and harvested during the harvesting season.**

Table 13 provides a summary of water demand per socioeconomic findings.

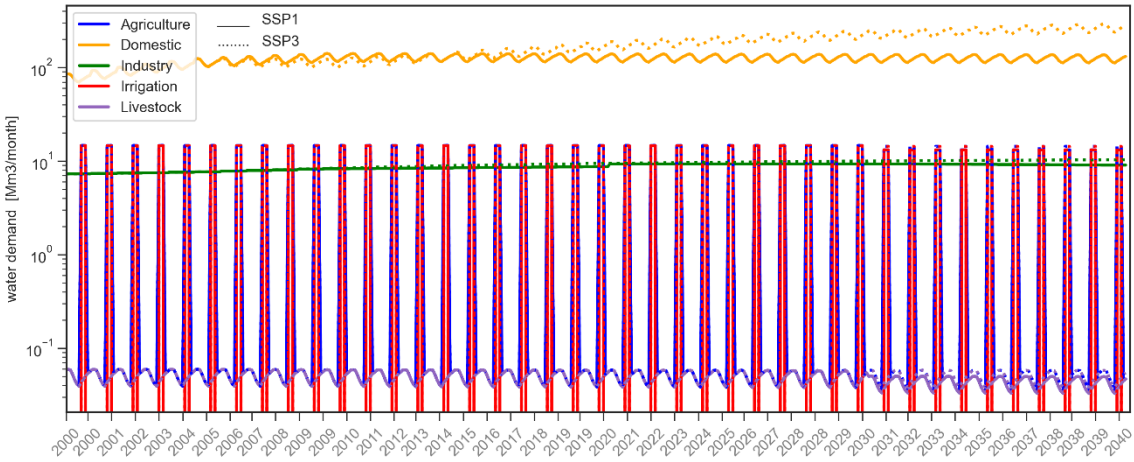

Figure 18. Alto Tietê, São Paulo economic zone - Projected Water Demand by Socioeconomic Sector

Table 13. Alto Tietê, São Paulo economic zone - Evolution of projected water demand per socioeconomic sectors explained.

What do the figures tell you?
About the Socioeconomic Sectors Water Demand Analysis • Figure 19 displays the evolution of water demand per sector under two different scenarios (SSP1: full line and SSP3: dotted line). • The water demand for agribusiness sectors is divided into, i) irrigation, ii) agriculture and iii) livestock. By irrigation, one means that the water used comes from aquifers and surface water bodies. By agriculture, one means rainwater-fed crops. These differences in water demand by irrigation and livestock can be estimated due to river basin data availability on national and local water portals. By livestock one means water used to graze cattle.
Highest Sectoral Water Demand is: • Domestic sector, under both scenarios.

What do the figures tell you?

Key Findings are:

- Projected Demand: The domestic sector has the highest water demand across time and under different scenarios. The Industry sector follows in demand, but it does not have an expressive water demand increase.
- Seasonal Variability: There is a clear seasonal variation of the water demand from the agricultural sector

To complement the findings of the scenario analysis conducted by the WaterLOUPE tool, the Water Risk Filter is used to assess the overall basin risk (see 5.1.2 for a short description of the Water Risk Filter). The Water Risk Filter scores run from 1 to 5, being 5 the highest score, i.e. the worst-case scenario.

Figure 19 summarises average scores from the Water Risk Filter considering 1,423 sites under analysis in the São Paulo economic zone.

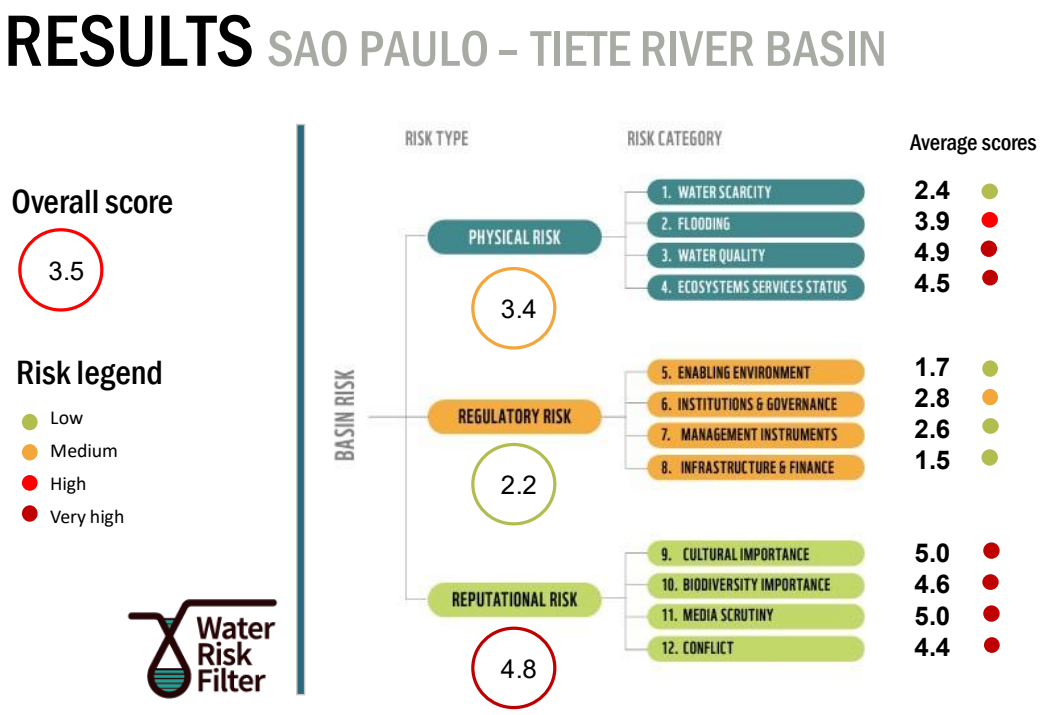

Figure 19. Water Risk Filter average risk score for companies located in the São Paulo economic zone.

The sectoral classification of the analysed sites shows again a strong sector bias due to the limited availability of asset-level data for some sectors. The companies within the textiles, apparel & luxury goods production sectors represent 83% of the analysed sites, as shown in Figure 20. Next, the geothermal or combustion sector companies represent 12% of the analysed sites.

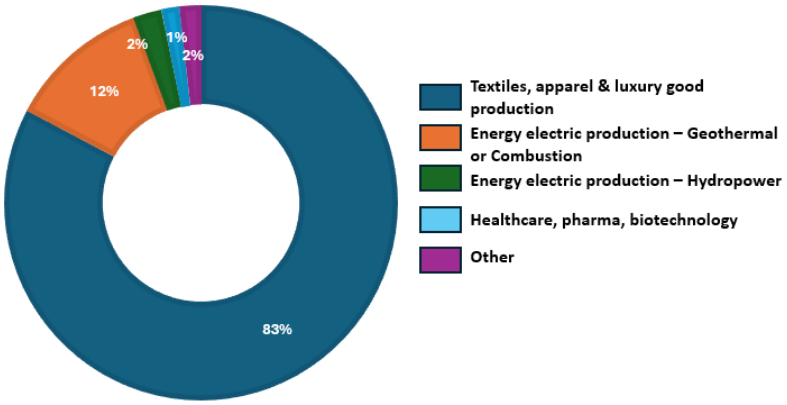

Figure 20 Sites included in the Alto Tietê dataset per sector, showing a bias to sectors with better data availability.

Very high scores (Score of 4.2 and above)
As in the Chennai analysis, reputational risk has the highest score in São Paulo economic zone. This score is influenced by very high scores on all four subcategories of reputational risk:

- First, high cultural diversity implies high perceived **social and cultural importance of water** in the analyzed basin (5)
- Second, **fish species richness** influences the exposure to very high reputational risks (5)
- Third, a very high score on **media scrutiny** (5) shows a high awareness of residents on water-related issues due to national or global media coverage. This includes issues related to the status of the river basin (e.g. water scarcity and pollution), as well as the importance of water for livelihoods (e.g. food shelter).
- Four, as in the previous case study, documented **water-related negative incidents**, criticism, and controversies affect the high-risk score on the conflict category (4.4).

Two risk categories within physical risk also show a very high score: **water quality** (4.9) and **ecosystem service status** (4.4). The first indicates a high risk of three water quality parameters: biological oxygen demand, electrical conductivity, and nitrogen[21]. Regarding the ecosystem service status, its degradation can result in businesses having restricted access in the long term to the quantity and quality of water needed. Companies and investors should collectively work to de-risk not only the fitness of freshwater resources for human use and ecosystems but also current and future ecosystem status.

High scores (Score of 3.4 to 4.2)
Within the analyzed sites, **flooding** occurrence is the only risk category with a high score on average (3.9).

Medium scores (Score of 2.6 to 3.4)
The physical risks of the analyzed sites have a medium score (3.4), meaning that the aggregated results of risk categories covering natural and human-induced conditions of São Paulo economic zone are medium on average. While some categories rate high or very high (flooding, water quality, ecosystem service status), as detailed above, others, such as water scarcity (2.2), present low risk.

Low scores (Score below 2.6)

[21] Biological oxygen demand (BOD) is a widely used umbrella proxy for overall water quality; electrical conductivity (EC) as proxy for salinity balance and pH alteration; and nitrogen, to capture nutrient loading in water bodies. https://riskfilter.org/assets/documents/WaterRiskFilter_Methodology.pdf and Appendix I.

The regulatory risk has a low score (2.2). The regulatory risk score is a result of the aggregation of 4 risk categories. Consequently, its low rate is influenced by low scores on all four of them: existing policies, laws and plans for water management (1.7), stakeholders' engagement in water stewardship implementation (2.8), data and management instruments availability (2.6) and finance of water infrastructure development (1.5)

Figure 21 gives a prioritised overview of the list of 12 risk categories for the São Paulo economic zone, from high to low scores.

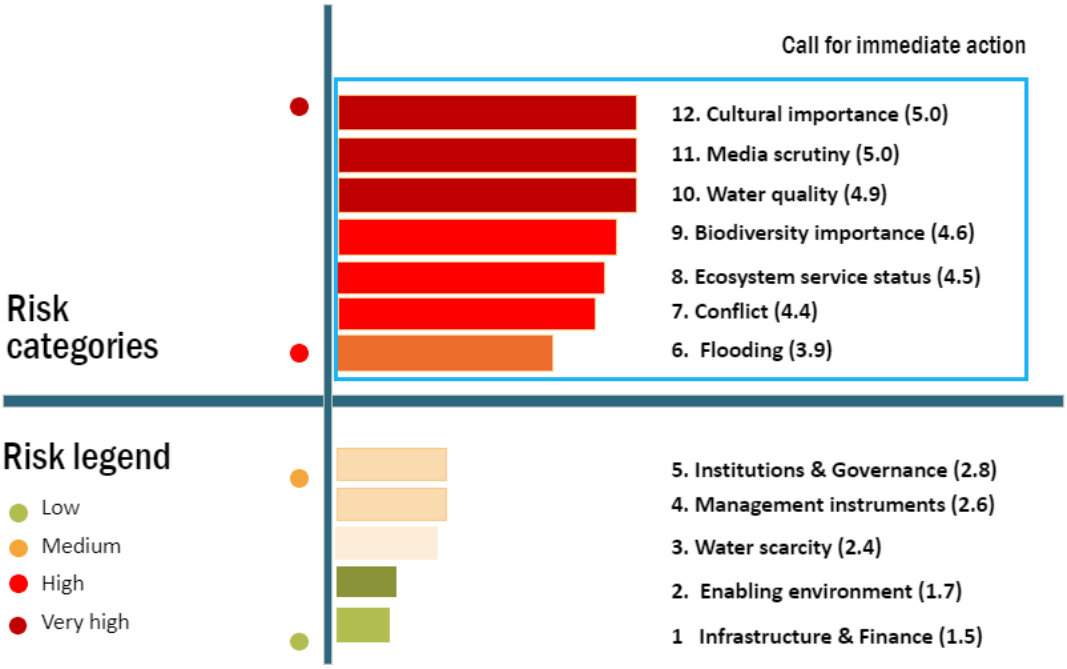

Figure 21 Prioritised overview of risk categories for São Paulo economic zone, with highest scores shown on top.

5.2.3 Water risk assessment and response strategies in the São Paulo economic zone

Following a comprehensive scenario and sector-specific analysis conducted for various economic actors, this section delves into the water risk assessment and outlines potential response strategies within the São Paulo economic zone.

The current dataset predominantly represents the textile and electric energy sectors, revealing a significant limitation. This disproportionate focus may obscure the full spectrum of water risks, particularly for vulnerable yet underrepresented sectors. **Sector-specific data collection enhancement is imperative to construct a more precise profile of water risks affecting diverse industries**. Improved data availability is crucial for informed risk management, enabling precise interventions and formulating effective response strategies.

São Paulo economic zone is an area of immense industrial and economic significance that confronts a spectrum of environmental and socio-economic challenges. These challenges pose considerable risks to the basin's industrial sectors, potentially affecting their sustainability, operational continuity, and the well-being of local communities and the surrounding ecosystem. In response to these multifaceted risks, this section presents an analysis, illustrated through a detailed table, that delineates the potential risks posed by water gaps and general responses for companies located within the São Paulo economic zone.

Given that the analysis identifies the São Paulo economic zone areas of concern for future water gaps under both SSP1 and SSP3 scenarios, it is crucial for industries located in these areas to strategize and adapt accordingly. **The textile, apparel, luxury goods industries, along with electric energy production sectors, are identified as particularly vulnerable due to their high number in the region and dependence on water.**

Table 14 lists general risks and response strategies for companies in the São Paulo economic zone based on desk research and the scenario and sectoral analyses conducted. Risks are categorized into physical, transitional, and reputational categories. Then, strategic response strategies are drafted based on desk research. Responses focus on mitigating impacts, capitalising on emerging opportunities, and fostering resilience. Specific company-level strategies cannot be drafted unless tailored company-level analysis is conducted.

Table 14. São Paulo economic zone scenario analysis- industry risk assessment and response strategies

Risk Type	Risk	Responses
Physical	**Operational Disruptions and Increased Costs**	**Water Recycling and Reuse:** Investing in technologies and processes that enable the recycling and reuse of water within their operations, reducing the demand for freshwater resources. Industries can integrate water stewardship into their CSR strategies, contributing to community efforts to sustainably protect and manage water resources.
		Water-Efficient Technologies: Adoption of water-saving technologies in production processes can significantly reduce water consumption. Highly water-dependent industries, such as food and beverage and manufacturing, can benefit from innovations that minimize water use also considering the seasonality of water gaps.
		Developing Contingency Plans: Developing and implementing plans for drought conditions helps industries anticipate and respond to water shortages. These plans include reducing water usage and identifying engagement strategies with suppliers. Moreover, on-site water storage facilities can provide a buffer during severe water scarcity.
	Water Quality Degradation	**Efficient Wastewater Treatment:** Water quality degradation is a significant concern in the Alto Tietê River basin, given the region's high population density and industrial activity. Stringent regulations and laws at both the state and local levels cover wastewater treatment and aim to control water pollution. For instance, industries are required to install and operate wastewater treatment plants to treat their effluents and meet the standards set by CETESB[22] and other regulatory bodies. This includes primary, secondary, and tertiary treatment processes to remove contaminants and pollutants from wastewater.

[22] **São Paulo State Environmental Company (Companhia Ambiental do Estado de São Paulo - CETESB)**. CETESB is the state agency responsible for enforcing environmental regulations in São Paulo. It issues permits for water use and effluent discharge, monitors water quality, and conducts inspections. **State Decree No. 8,468/1976** establishes specific standards for wastewater discharge and water quality in the state of São Paulo. It requires industries to treat their effluents to meet these standards before discharge.

Risk Type	Risk	Responses
	Supply Chain Vulnerabilities	**Fostering Resilient Suppliers:** Given the industrial water demand increase over time, it's valuable to assess the resilience of supply chains to water scarcity and explore ways of equipping suppliers with the necessary information regarding climate, water and biodiversity challenges projected in the future, enabling supply chains to become more resilient.
Transition	**Regulatory Risks**	**Risk Management and Planning:** Conducting thorough risk assessments, knowing seasonal variabilities, and developing business continuity plans for water scarcity scenarios can help industries prepare for and quickly respond to water-related challenges, better enabling companies to respond to or adapt to regulatory requirements. In São Paulo economic zone, industries must obtain environmental licenses from CETESB, which require detailed assessments of water use, potential impacts, and mitigation measures. This includes developing water management plans as part of the licensing process.
		Engagement in Policy Advocacy: Engaging in policy discussions and ensuring compliance with water use and pollution control regulations are essential steps for industries to contribute to sustainable water management in the basin. Brazil has established several participatory mechanisms that facilitate the involvement of various stakeholders, including industries, in water resource management, such as river basin committees, water agencies, and state water resource councils.
Reputational	**Lack of Communication**	**Transparent Communication:** Companies that proactively manage their water use and contribute to sustainable water management in their regions can enhance their reputation and strengthen their relationships with stakeholders, including customers, employees, and regulators.
	Lack of Stakeholder Acceptance	**Collaborative Engagements:** Engage in community projects to meet local water needs, such as WASH, and increase efforts to improve the state of water resources (quality, quantity, and ecosystems).

6 ESG reporting and localised water risk assessments

Key messages

- ESG reporting enhances transparency on water use, aligns with regulations, engages stakeholders, and supports sustainability.
- Companies in the Chennai and São Paulo economic zone must comply with strict water regulations, including monitoring water usage and adopting practices like zero-liquid discharge (ZLD). These practices must be transparently reported as part of compliance.
- In regions like Chennai and São Paulo, corporate reports often include localized measures such as water stewardship and sustainable management practices. These are crucial for demonstrating compliance with local regulations and proactive risk management.
- Corporate and CDP Water Security reports often lack standardization and may not fully capture localized water risks, limiting their effectiveness. Integrating place-based insights can address these gaps and enhance the impact of water management strategies.
- CDP offers a standardized framework that facilitates consistent measurement and disclosure of water-related data, improving transparency and enabling better stakeholder engagement.
- Localized water risk assessments are essential for improving the accuracy and relevance of ESG reports. Tools like WaterLOUPE and the Water Risk Filter provide detailed, region-specific insights, helping companies address specific water-related risks and opportunities.
- Incorporating local insights into ESG reports can improve communication with stakeholders, provide a more nuanced understanding of water risks, and lead to more effective water management strategies tailored to specific regional conditions.

Environmental, Social, and Governance (ESG) reporting is increasingly important for companies. In the context of water risk assessments and response strategies, ESG reporting serves multiple purposes, such as contributing to the disclosure of water usage and risks, alignment with policies and regulatory frameworks, stakeholder engagement and risk mitigation strategies, and ensuring long-term sustainability and operational continuity.
In the Chennai economic zone, water regulations require industries to monitor and report water usage and effluent discharge. Certain industries, especially in water-scarce regions like Chennai, must adopt zero-liquid discharge (ZLD) practices, which must be reported as part of their compliance.

Companies located in the São Paulo economic zone must comply with national and state water regulations, including obtaining necessary permits and conducting regular environmental impact assessments. CETESB mandates comprehensive water management plans to obtain permits as part of the environmental licensing process.

Similar to Chennai, some companies in the São Paulo economic zone perform water audits and implement efficiency measures. These can be detailed in ESG reports, demonstrating compliance and proactive risk management.

In both the Chennai and São Paulo economic zones, ESG reporting is vital in connecting water risk assessments and response strategies to corporate transparency and accountability. By integrating local-level water risk management into their ESG frameworks, companies can enhance their sustainability performance, comply with regulatory requirements, and build stakeholder trust. This approach ensures that water risks are effectively managed, contributing to the long-term sustainability of the businesses and the regions they operate in.

This section explores the landscape of ESG reporting, focusing on analysing corporate and CDP water security reports. It also advocates for integrating localised water risk assessments to improve reporting.

Specifically, the analysis delves into the water management nuances of 20 selected companies operating in the Chennai (India) and the São Paulo (Brazil) economic zones. The selection process involved consensus among collaborators and consideration of portfolio exposure. Companies included in the analysis are clustered in the food and beverage, manufacturing, and energy sectors[23]. To maintain ethical standards, the companies analyzed in this report remain anonymous, safeguarding confidentiality and impartiality throughout the evaluation process.

6.1 Corporate reporting and localised water risk assessments

Corporate reporting goes beyond financial performance, encompassing the company's impact on society and the environment. It includes a range of ESG metrics and narratives covering environmental stewardship, social responsibility, diversity and inclusion, employee well-being, ethical business practices, and governance structures.

In water risk management, this reporting includes how companies use and manage water resources, comply with regulations, and engage with local communities.

For example, companies in the Chennai economic zone, a water-scarce region, are mandated to adopt rigorous water management practices. The emphasis in the food and beverage sector on water stewardship, for example, aligns with local regulatory requirements for zero-liquid discharge (ZLD) practices. This reflects a broader trend where corporate reporting in Chennai showcases efforts to comply with stringent local regulations while promoting sustainable water use.

Companies located in the São Paulo economic zone, must comply with national and state regulations focusing on water management. **A focus on responsible water management and sustainable practices aligns with regional mandates and environmental assessments**. This emphasis illustrates how corporate reporting in São Paulo economic zone Basin integrates local regulatory and environmental requirements into broader sustainability goals**.**

It is noteworthy that corporate reports, in the majority, give a global perspective of a company’s operation. Nevertheless, localised measures and best practices are described, specifically when those are implemented in water-stressed or water-scarce areas.
Below are key findings from the analysis of corporate reports from companies located in Chennai and São Paulo economic zones and benefits and gaps of corporate reporting.

6.1.1 Key findings from companies corporate reporting analysis

Table 15. Key findings from corporate reporting analysis.

Aspect	Key Findings
Chennai	Food and Beverage Sector: Companies emphasize water stewardship through replenishment and reducing water usage. Manufacturing Sector: Focuses on implementing sustainable water management practices. Energy Sector: Highlights commitments to enhancing water efficiency.

[23] The manufacturing category includes chemical, textile, apparel and high luxury goods.

Aspect	Key Findings
São Paulo	Food and Beverage Sector: Similarly emphasizes water stewardship and sustainable practices. Manufacturing Sector: Concentrates on responsible water management. Energy Sector: Demonstrates commitment to sustainable water practices.

6.1.2 Benefits and gaps of companies' corporate reporting

Table 16. Benefits and gaps of corporate reporting.

Benefits	
Societal Context	Corporate reports frequently include information on engagement with local communities, showcasing efforts to address societal concerns about water availability, quality, and access. This context is crucial for understanding the social dimensions of water management and the company's role within the broader community.
Localised Insights	Corporate reporting often details the company's operations, including specific initiatives and community engagement efforts related to water management. These insights are crucial to help stakeholders understand the company's activities and pledges towards the surrounding environment and communities.
Gaps	
Lack of Standardization	One of the challenges of corporate reporting is the lack of standardised metrics and reporting frameworks across industries and regions. This inconsistency makes it difficult to compare water management practices between companies and assess their relative performance accurately.
Limited Scope	Corporate reports may focus primarily on the company's operations and direct impacts, overlooking broader systemic risks and opportunities related to water management. This narrow scope can fail to address supply chain risks, regulatory changes, or emerging trends affecting water sustainability.

6.2 CDP Water Security reports and localised water risk assessments

Next to corporate reports, CDP Water Security reports of a selected number of companies located in the Chennai and São Paulo economic zones are analysed.

CDP is an organisation that facilitates ESG reporting, running a global disclosure system that enables companies, cities, and regions to measure and manage their environmental impacts. It focuses on climate change, water security, and deforestation.

CDP plays a significant role in the broader ESG reporting ecosystem by providing a platform for environmental disclosure and benchmarking, helping stakeholders assess and address environmental risks and opportunities within their investment and management decisions. The disclosed information is made available to signatories and partially to the public, promoting transparency and encouraging sustainability actions.

In 2022, CDP Global Water Report stated that companies reporting to CDP identified over 2,700 water-related opportunities with a combined value of over US$ 436 billion. Industries with higher water dependency reported the highest number of water-related opportunities, such as the energy and apparel industries. This trend reflects a broader understanding that sustainable practices are integral to long-term profitability and risk management.

In 2023, CDP Global Water Report emphasized managing water resources across supply chains. It highlights that 1 in 5 companies faces significant water-related risks in their supply chain, and companies that assess these risks are better prepared to manage them. Apparel, food, beverage, agriculture, and energy generation are the sectors most engaged in CDP Water Security reporting.

CDP Water Security report is based on a questionnaire that enables companies to disclose important water-related information to evaluate when taking effective action[24]. The data collected by CDP allows investors to make more informed decisions by identifying which companies or assets are more vulnerable to environmental risks or are leading in sustainability practices.

To complement CDP's global perspective, sector-specific results from scenario analysis for the Chennai and São Paulo economic zones can be used to capture the nuanced water risks and opportunities essential for effective management and strategic decision-making. The added value of this report lies in the fact that localised water risk assessments can improve data disclosure on a company level in standardised reporting, such as in CDP Water Security reports.

CDP standardised reporting when combined with risk assessment tools can enhance investors and companies' understanding of opportunities and risks for better decision-making and strategies implementation.

In total, 13 companies located in the Chennai and São Paulo economic zone were analysed. Their CDP Water Security report when publicly accessible was assessed. The assessment consisted in analysing key water-related indicators and the integration of place-based insights. Indicators analysed included i) water withdrawal (in volumes), ii) water discharges monitoring, iii) wastewater treatment practices, iv) water withdrawal from water-stressed areas. Key findings from the CDP Water Security report analysis regarding water-related data coverage are described in the sub-section below.

6.2.1 Key findings from companies' CDP Water Security Reports analysis

Table 17. Key findings from CDP Water Security Reports analysis

Key Findings	
Companies Analysed	Thirteen companies CDP Water Security Reports are analysed, encompassing various industries, including food and beverage, energy production, and manufacturing.
Measurement of Water Withdrawal	95% of the analyzed companies measure water withdrawal on a local watershed level. However, this information is shared in total volumes accounting for all sites covered by the water security report disclosures and **not on a local level.**
Monitoring of Water Discharges	Almost all companies assess water discharges by destination. However, specific details regarding the percentage of facilities that treat wastewater or **water discharge volumes are often not provided**.

[24] CDP Water Security Report from public companies is available online at: CDP

Key Findings	
Relevance of Place-based Indicators	Place-based indicators can enhance companies' compliance with the LEAP approach, facilitating the evaluation of dependencies and impacts on ecosystems and assessing risks and opportunities. This helps companies develop better strategies to deal with future climatic uncertainties.
Wastewater Treatment Practices	Wastewater treatment aspects are not fully incorporated in companies' sustainability measures and strategies, as companies monitor discharge treatment methods on some facilities depending on municipal or regional regulations and environmental permitting conditions.
Water Withdrawal from Water Stressed Areas	Companies in the energy sector withdraw less than 10% of their water from water-stressed areas. However, sectors with higher water consumption, such as food & beverage and manufacturing, exhibit greater withdrawal from water-stressed areas, with approximately 40% of those companies withdrawing 26% to 50% of their water from such areas.

Companies reporting to the CDP Water Security disclosure adopt a global perspective, making place-based insights unfeasible. However, companies could provide place-based insights since most of them already monitor and collect information on a site level.

Scenario analysis results from tools like WRF, WaterLOUPE or other tools can be used to assess sector-specific risks and improve understanding of how different sectors within specific basins face unique water-related risks and opportunities and how various scenarios impact water availability, quality, and management.

These companies span various industries, including food and beverage, energy production, and manufacturing[25]. In total, 13 companies' CDP Water Security Report were analysed.

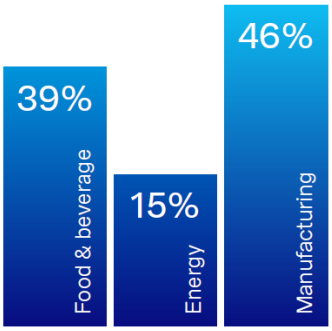

Figure 22. CDP Water Security Reports. Percentage of companies per sector assessed.

The assessment shows that 95% of the companies measure water withdrawal on a local watershed level. This information is shared in total volumes accounting for all sites covered by the water security report disclosures. The same applies to water discharges by destination.

Figure 23 shows the percentage of companies that i) measure water withdrawal locally, ii) treat 100% of the water before discharging, and iii) monitor discharges by destination. A common aspect found was that companies monitor discharge treatment methods in some facilities, depending on municipal and regional regulations and environmental permitting conditions.

[25] Textile, apparel & luxury good, health, nutrition, metal and mining are incorporated in the manufacturing sector

This shows that wastewater treatment aspects are not yet fully incorporated into companies' sustainability measures and strategies. Nevertheless, it is essential to contribute to SDG6.

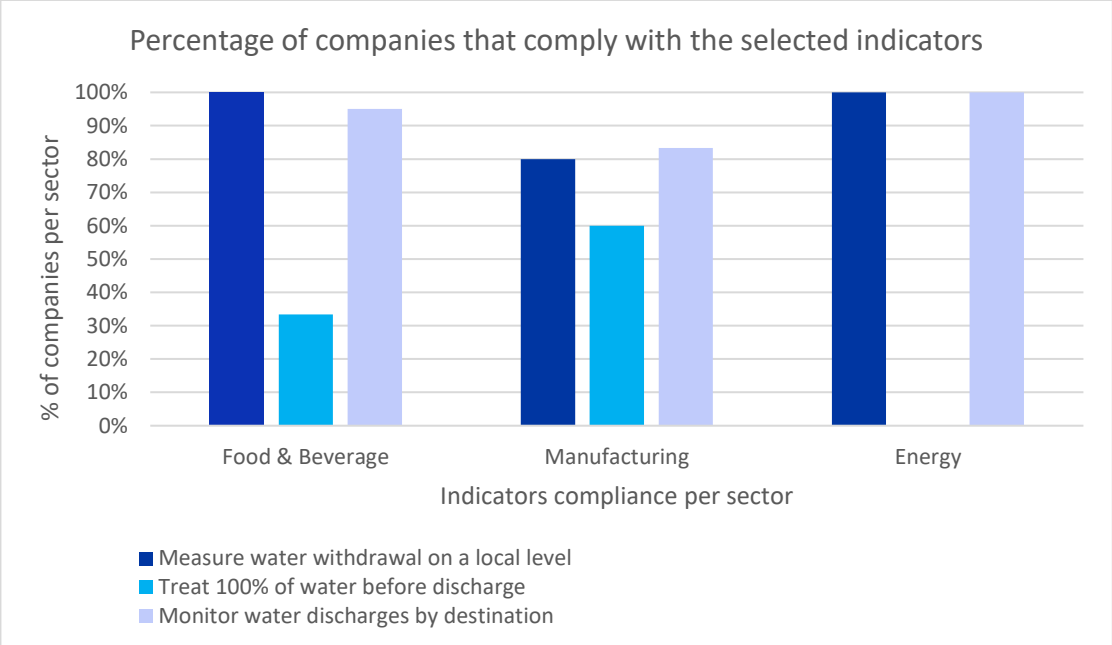

Figure 23. Percentage of companies that comply with selected indicators assessed.

In the assessment of water withdrawal from water-stressed areas across different sectors, companies in the energy sector reported that less than 10% of their water comes from such areas. However, sectors with higher water consumption, such as food & beverage and manufacturing, exhibited greater withdrawal from water-stressed areas. Specifically, approximately 40% of companies withdrew 26% to 50% of their water from water-stressed areas. The proportion denotes the overall water withdrawal, while the vertical axis represents the percentage of companies.

Figure 24 displays the percentage of companies per sector that withdraw water from water-stressed areas proportional to their total water withdrawal.

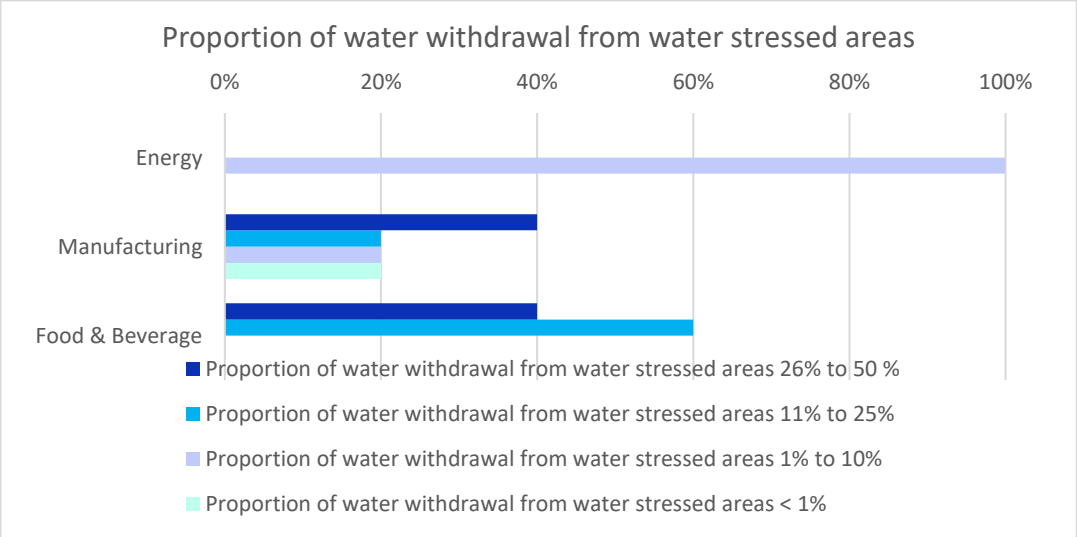

Figure 24. Percentage of companies per sector that withdraw water from water-stressed areas proportional to their complete water withdrawal.

6.2.2 Benefits and gaps of companies' CDP Water Security Reports analysis

In conclusion, CDP Water Security Report standardization facilitates the assessment of long-term performance but also strengthens stakeholder engagement, allowing for more informed dialogues and advocacy for sustainable practices.

However, despite these strengths, CDP reports exhibit notable limitations. The global perspective of the data disclosed often overlooks local nuances, potentially missing specific risks and opportunities that vary by region. This lack of localization can constrain the effectiveness of risk management strategies tailored to specific geographic contexts. Additionally, while the report focus on environmental metrics provides valuable insights, companies may not fully address the broader societal implications of water management practices. Understanding the societal context, including stakeholder perceptions and community concerns, is crucial for companies' comprehensive risk mitigation and investors' effective engagement.

Incorporating localised water risk assessments into CDP reporting is essential for addressing these gaps. By integrating findings from readily available water risk assessment tools, which can offer granular insights into specific river basins and sectors, companies can enhance reporting to better reflect regional realities and societal impacts. This approach will significantly improve the relevance and effectiveness of water management strategies, ensuring that both global and local factors are considered in decision-making processes. Table 18 Table 18summarises benefits and gaps from the analysis.

Incorporating localised water risk assessment findings in CDP reports is crucial for enhancing the relevance and effectiveness of water management strategies.

Table 18. Benefits and gaps of companies' CDP Water Security Reports analysis

Benefits	
Standardised Reporting Framework	CDP offers a standardised reporting framework, enabling consistent measurement and disclosure of environmental data, including water-related metrics. This standardization facilitates comparability credibility and ensures that key information is disclosed transparently.
Stakeholder Engagement	Access to CDP data enables investors to engage with companies more effectively. The information available can be used to initiate dialogues and advocate for sustainable practices.
Assessment of Long-Term Performance	Through CDP reporting, investors can identify companies with strong long-term performance.
Gaps	
Global Perspective	While CDP reports offer valuable global insights, they may lack localization, meaning they may not capture the specific risks and opportunities faced by companies at the local level. This can limit the effectiveness of risk assessment and management strategies tailored to specific geographic contexts.
Limited Societal Context	CDP reports may focus primarily on environmental metrics and may not always

	provide sufficient context on the societal implications of water management practices. Understanding the broader societal context, including stakeholder perceptions and community concerns, is essential for effective stakeholder engagement and risk mitigation

6.3 Integrating localised water risk assessments in ESG reporting (Corporate and CDP reports)

While ESG reporting is critical, it often lacks localised granularity, where tools like WaterLOUPE and the Water Risk Filter (WRF) become invaluable. These tools offer detailed, region-specific insights that can enhance the depth and relevance of ESG reports. A few water risk assessment tools are already available on internet. It is expected that more will be made available in the future, each with specific strengths or weaknesses.

Companies can use these types of tools to:

- **Add local insights to ESG reports (Corporate and CDP Water Security reports)**: These tools can provide granular, region-specific data that can highlight localised water risks and opportunities.
- **Identify specific risks**: Local assessments can pinpoint unique risks such as regional water scarcity, pollution hotspots, or local regulatory challenges.
- **Develop targeted strategies**: By integrating localised data, companies can develop more targeted and effective water risk management strategies. This detailed approach can help companies address specific issues like seasonal water shortages or regional water quality problems and improve reporting.
- **Improve response strategies**: Localised insights help draft more precise response strategies, leading to better alignment with regional conditions and regulatory requirements.
- **Provide place-based insights**: Integrating results from water risks assessment tools into ESG reports, such as corporate and CDP Water Security reports, can enrich the data provided, offering a more nuanced understanding of local water risks and management practices.
- **Enhance transparency**: Adding localised risk assessments to ESG reports, such as corporate and CDP Water Security reports, increases transparency and demonstrates a company's commitment to addressing specific regional water challenges.
- **Improve communication**: Detailed local insights enable companies to communicate more effectively with local stakeholders, addressing specific concerns and demonstrating a deeper understanding of regional water issues.

7 Developing engagement strategies

Key messages

- Effective engagement strategies are crucial for managing water risks and enhancing water stewardship. By leveraging localised insights from scenario analysis, companies and investors can develop targeted approaches to address specific water-related challenges.
- The CERES framework offers a structured approach to valuing water, guiding companies in aligning their water management practices with global sustainability goals and investor expectations.
- Tailored scenario analyses help companies understand the unique water risks and opportunities in different regions, allowing for more informed decision-making and risk mitigation.
- Scenario analyses provide valuable, region-specific insights that can be used to develop robust water management strategies. For instance, São Paulo faces risks related to urban water demand, while Chennai must contend with seasonal water scarcity.
- Understanding and incorporating socio-economic factors into water management strategies is essential for aligning with stakeholder expectations and addressing potential social risks.
- Companies need to stay ahead of future trends, such as increased regulatory scrutiny or shifts in consumer behaviour, which may impact water availability, quality, and demand.
- Different sectors face distinct water-related risks depending on their water sources and usage. Tailoring risk management strategies to these specifics is crucial for effective engagement.
- Access to asset-level data enhances the understanding of water risks and enables more precise and impactful interventions. Even without such data, engaging with suppliers and operational clusters in high-risk areas is vital.

Effective engagement strategies are crucial for investors and companies addressing the water-related risks and opportunities identified through scenario analyses. This chapter delves into how the insights gained from water risk assessment and scenario analyses tools that can be leveraged to develop strategic approaches for managing water risks and enhancing water stewardship.

By translating localised and sector-specific findings into actionable engagement tactics, the chapter aims to bridge the gaps highlighted in ESG reporting and promote long-term resilience in water management. It explores the importance of tailored risk management strategies, socio-economic factors' impact, and future trends' significance in shaping robust engagement plans.

An examination of case studies from the São Paulo and Chennai economic zones provides practical recommendations for addressing water risks in critical economic hotspots. It highlights how investors can effectively use scenario analysis to foster sustainable water practices and drive informed decision-making.

In developing effective engagement strategies, it is essential to consider comprehensive frameworks that guide corporate behaviour towards sustainable water management. One such framework is provided by CERES, which has developed a set of six expectations for valuing water. These expectations are aligned with the UN Global Compact CEO Water Mandate’s commitment areas and the UN’s 2030 Sustainable Development Goal for Water (SDG6). They serve as an ambition for large companies to reach by 2030 and form the foundation for informing and measuring the progress of investor engagements with companies.

The CERES Corporate Expectations for Valuing Water core indicators are:

1 **Water Quantity**: Companies do not negatively impact water availability in water-scarce areas across their value chain. This includes setting time-bound, science-based targets to address these impacts and publishing progress towards meeting these commitments.

2 **Water Quality**: Companies do not negatively impact water quality across their value chain. They should set and publicize goals to mitigate water quality issues from both point and nonpoint sources.

3 **Ecosystem Protection**: Companies should avoid contributing to the conversion of critical natural ecosystems and actively work to restore degraded habitats. This involves setting and adhering to ecosystem protection and restoration targets.

4 **Access to Water and Sanitation**: Companies contribute to the resilience of communities by ensuring universal and equitable access to WASH. This includes adopting policies that respect human rights to water and sanitation and advocating for improved water governance and infrastructure.

5 **Board Oversight**: Corporate boards and senior management oversee water management efforts, integrating water risks and opportunities into strategic decisions and linking water management to executive compensation.

6 **Public Policy Engagement**: Companies ensure their public policy engagements and lobbying activities are aligned with sustainable water resource management outcomes.

Incorporating these expectations into engagement strategies can give companies and investors a clear framework to assess and influence corporate water management practices. The CERES framework emphasizes the importance of disclosure, governance, and proactive policy engagement, critical components for sustainable water stewardship.

7.1 Findings from localised water risk assessments

Localised scenario analysis is valuable for bridging ESG reporting gaps by providing a forward-looking perspective on water-related risks and opportunities. By developing scenarios that explore different climate and water shortage conditions, companies can better understand the potential impacts of climate change, regulatory changes, and other drivers on water availability, quality, and demand.

- **Localised insights**: Scenario analysis allows companies to tailor scenarios to specific geographic regions, providing localised insights into water-related risks and opportunities. By considering regional variations in climate, hydrology, and socio-economic factors, companies can develop more robust risk management strategies that account for local conditions.

For example, in São Paulo economic zone, localised scenarios highlight the risks associated with urban water demand and industrial usage, while in Chennai, they address the challenges of seasonal water scarcity and monsoon variability.

- **Societal context**: Scenario analysis can incorporate socio-economic factors and stakeholder preferences, providing a more comprehensive understanding of the societal context surrounding water management. By considering the social dimensions of water sustainability, companies can identify potential social risks and opportunities and develop strategies that align with stakeholder expectations.

For example, in both basins, the societal context includes engaging with local communities to understand their water needs and concerns and integrate these insights into corporate water management plans.

- **Future trends:** Scenario analysis enables companies to explore a range of possible futures, including scenarios that incorporate different trends and drivers of change. Companies can identify emerging risks and opportunities by assessing how these trends may impact water availability, quality, and demand and adapt their strategies accordingly.

For example, future trends in Chennai and São Paulo economic zone include increased regulatory scrutiny on water usage, technological advancements in water efficiency, and shifts in consumer behaviour towards more sustainable products.

7.2 Findings from case studies analyses

- **High risk in key areas:** When analysing the watersheds, we see that the main risks materialize in relatively small parts. Not coincidentally, these are also the areas where most economic activities occur. So, the concentration of economic activities makes sense from an economic, supply chain, and production perspective, but it can lead to increasing water risks in specific parts of a watershed that matter most from an investor's point of view. This also leads to the incorrect perspective that the majority of the watershed is not at risk and, therefore, will not impact the economic activities in a watershed.

For instance, investors need to focus on hotspots where economic activities and water risks converge, ensuring that mitigation strategies are in place for these critical areas. For instance, São Paulo and Guarulhos cities and Adyar and Cooum sub-basins in the Chennai economic zone are areas with high economic activities and high number of water gaps.

- **Differing risk profiles in each economic zone:** there are clear differences in water risk profiles between the Chennai and *São Paulo economic zones*, resulting in varied urgency for addressing sub-topics such as flooding, water scarcity, and water quality.

For instance, in Chennai, the primary focus may be on managing water scarcity and ensuring reliable water supply during dry seasons, while in the São Paulo economic zone, flood management and water quality control may be more pressing.

- **Corporate water sources are important:** For corporate water use and risk mitigation options, it matters if companies retrieve their water from groundwater, surface water or utilities. This also determines the type of risk companies will face and how other users and utility companies influence possibilities for risk mitigation.

For instance, companies relying on groundwater in Chennai may need to invest in recharge and sustainable extraction practices, while those in São Paulo dependent on surface water must focus on maintaining water quality and managing flood risks.

- **Timeframes matter:** The use of long-term scenarios, including climate change and societal change, is crucial to understanding water risks and making long-term investment decisions. Also, looking to a shorter timeframe is essential to understand that in a watershed with sufficient good quality water there are still substantial (economic) risks when shortages arise one month or more of the year.

For instance, a short-term drought in Chennai can severely disrupt manufacturing operations, highlighting the need for resilient infrastructure and diversified water sources.

- **Sectoral data limitations**: The overrepresentation of specific sectors in the data implies data analysis limitations. The findings from these case studies should be seen as illustrative examples rather than comprehensive analyses applicable to all sectors. This limitation underscores the need for a broader data collection effort across various industries to achieve a complete picture of water risks. A critical call to action is encouraging more companies to report detailed water risk data, thus enabling a more comprehensive analysis.

For instance, given the overrepresentation of specific sectors in the analysis and lack of data of other analysis. To address sectoral data limitations, companies should enhance their data collection, asset's location disclosure, improve asset and supply chain tracking and engage in industry-wide collaborative efforts.

7.3 Balanced output of report

- **Asset-level data use is key for better risk understanding**: There are great tools in the space if access to asset-level data is available. With access to asset-level data, a much greater understanding and detail can be drawn from existing tools, allowing for far more nuanced questions with companies and a better understanding of how financial impacts could result from water and climate risks. Moreover, asset-level data enables precise water usage, risks, and impacts tracking, facilitating targeted interventions and efficient resource allocation.

- **Engaging in supplier and operational clusters contributes to risk preparedness**: Even without asset-level data, asking questions about supplier and operational clusters is possible. There are many catchments globally where industries and water risk collide. It is advisable to check if investors are located in these clusters and engage them on their preparedness for water and climate risks. Engaging with suppliers in high-risk areas can ensure that the entire supply chain is resilient, not just the company's direct operations.

- **Linking risks to financial impacts improves materiality assessments**: Understanding which risks drive which financial impacts allows investors to ask more material questions. Different types of water risks manifest differently from a financial perspective. Knowing whether to expect operational interruption, asset depreciation, or sales losses due to reputational impacts can enable better company engagement. Thus, investors can engage more effectively by understanding water and climate risk exposure and the links between these risks and financial impacts. Investors can also advocate for including water risk metrics in financial reporting, ensuring that water risks are adequately reflected in financial statements and valuations.

- **Understanding what the value at risk and the potential costs are associated with action or inaction**: Integrating financial data into the analysis to build the internal business case for acting on water risks (both impacts and dependencies) and to demonstrate the materiality of water risks in the local context of the business is critical to both understanding the severity of the risks and prioritizing solutions. For example, Ceres' report, **Development of a Company-Level Cost-Benefit Analysis Framework** describes a stepwise approach to calculate the potential direct-to-business and societal returns on investment for water interventions.

8 Company-level Action: Utilizing Results for Impact

Key messages

- Effective management requires considering both environmental and socioeconomic factors, understanding the interplay between water availability, industrial activities, and community needs
- Scenario analysis enables organizations to anticipate and prepare for varying conditions, aiding in decision-making by assessing potential impacts of climate projections and regulatory change
- Using tools like CDP Reports, WaterLOUPE, and WWF Water Risk Filter provides detailed insights into water-related risks and opportunities, facilitating effective risk assessments and strategic planning.
- Accurate mapping of assets and supply chains is crucial for understanding localized water risks. Incorporating asset values into risk assessments helps prioritize vulnerable industries and enhance risk management strategies.
- Engaging with local governments, communities, and businesses is essential for effective water management. Collaboration fosters transparency and strengthens stakeholder relationships
- Investors should assess financial exposure, evaluate resilience, and incorporate site-specific water risk data into decision-making. Engaging with companies to ensure robust water management strategies is vital.
- Companies must stay ahead of future trends, such as regulatory changes and shifts in consumer behaviour, that may impact water availability, quality, and demand. Tailoring strategies to specific sector risks is crucial for effective management.
- Improving data collection and tracking of asset and supply chain water usage is fundamental for precise interventions. Engaging with suppliers and operational clusters in high-risk areas remains important even without detailed asset-level data.

Building on the case studies of the Chennai and São Paulo economic zones and the discussion on addressing water risks and ESG data gaps, this chapter highlights the importance of an **integrated approach to water risk management to be taken by companies.** Effective risk management considers both environmental and socioeconomic factors, understanding the interplay between water availability, industrial activities, and environmental and community needs.

A crucial component of effective water risk management is the adoption of scenario analysis. This approach enables organizations to anticipate and prepare for various conditions by exploring various potential scenarios. **Scenario analysis helps companies and investors make informed decisions by considering how different factors, such as climate projections and regulatory changes, could impact water risks and opportunities**.

To implement scenario analysis effectively, companies should conduct initial assessments to identify and understand potential water-related risks. Regular reviews of these scenarios are essential to incorporate new data, regulatory changes, and shifts in operational context. Additionally, significant changes such as new regulations or major investments should trigger updates to scenario analyses.

The process involves defining scenarios that consider factors such as climate projections and water scarcity levels and tailoring these scenarios to reflect local water risks and regional variations. Engaging stakeholders, including local communities, regulators, and industry experts, in the scenario planning process ensures comprehensive assessments.

Integrating the insights from these analyses into decision-making processes can effectively guide strategic planning and risk management.

For instance, companies like SABESP, a major water utility company serving the São Paulo region, employ scenario analysis to manage water risks related to supply and demand. SABESP's approach includes evaluating potential scenarios of water availability and quality issues due to climate change and urban growth[26]. This helps in planning and implementing strategies for sustainable water management and infrastructure investment.

Utilizing and combining tools like CDP, WaterLOUPE, and WWF Water Risk Filter enables companies to access detailed data on water-related risks and opportunities, facilitating informed decision-making and strategic planning to mitigate risks and capitalize on opportunities. Conducting thorough risk assessments and developing business continuity plans are essential for managing water-related challenges. This involves identifying potential water risks, assessing their impacts, and implementing measures to mitigate risks and ensure resilience.
In addition, companies should adopt **forward-looking strategies** to address future water risks and ensure long-term sustainability. This includes setting science-based targets, implementing water stewardship practices, and investing in innovative water efficiency and recycling technologies.

Companies and investors can refer to established frameworks such as the CERES Corporate Expectations for Valuing Water to implement these strategies effectively. These expectations provide a comprehensive guide for managing water risks and promoting sustainable water practices.

For instance, adhering to the CERES expectations on water quantity and quality can help companies **set science-based targets** and publish progress, fostering transparency and accountability[27]. Similarly, focusing on ecosystem protection, WASH, board oversight, and public policy engagement, as CERES outlines, can ensure that water management efforts are comprehensive and effective. This alignment with CERES expectations document supports sustainable water management and enhances the company's reputation and long-term value creation.

A significant challenge identified in this study is the lack of localised data on assets and supply chains, which hampers effective water risk management and scenario planning. To address this, companies must invest in accurately mapping their assets and supply chains, a foundational step crucial for understanding localised water risks and implementing targeted mitigation strategies.

Another challenge is the lack of incorporation of asset values at risk. An important next step to build on the current analysis is to incorporate the value of assets at risk into water risk assessments. **By quantifying the financial value of assets exposed to water risks, stakeholders can better understand the potential economic impacts of water-related disruptions**. This approach allows companies and investors to prioritize the most vulnerable industries and assets, enabling more effective risk management strategies and resource allocation.

Stakeholders should prioritize including asset values in water risk analyses and developing and standardizing methodologies for asset valuation in the context of water risks.

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[26]For more information about SABESP scenarios development, access: www.sabesp.com.br
[27] Science-based targets provide a clearly-defined pathway for companies to reduce greenhouse gas (GHG) emissions, helping prevent the worst impacts of climate change and future-proof business growth. For more information, access: Science Based Targets Initiative.

Enhanced reporting practices that include asset value data will improve transparency and support better-informed decision-making. Collaborating to share data and best practices will also facilitate more comprehensive and actionable insights.

Collaboration with stakeholders, including local governments, communities, and other businesses, is crucial for effective water management. Engaging in **collective action** initiatives and transparent communication fosters collaboration and strengthens stakeholder relationships.

Addressing water risks and ESG data gaps requires a holistic approach, incorporating data-driven decision-making, collaboration, innovation, and transparent communication to ensure sustainable water management and long-term business resilience.

Understanding these risks enables investors to:

- **Assess financial exposure:** By evaluating the localised impact of extreme weather events and water scarcity, investors can better gauge potential financial losses or gains, adjusting their portfolios to mitigate risk and capitalize on opportunities.
- **Evaluate resilience:** Investors can nudge companies to develop robust water management strategies to be better positioned to withstand localised disruptions. Companies that effectively manage water-related risks will likely be more resilient in environmental challenges, leading to more stable long-term returns.
- **Enhance decision-making:** Incorporating site-specific water risk data into investment decisions allows a more nuanced understanding of a company's vulnerability to environmental changes. This leads to more informed investment choices, active ownership, and aligns portfolios with sustainable and resilient business practices.
- **Drive value creation:** Investors can drive value creation by seeking both financial returns and alignment with ESG criteria and sustainability frameworks and regulations (such as the TNFD). Companies that proactively address water risks and implement effective mitigation strategies can enhance their operational efficiency, reduce costs associated with water management, and build a reputation for sustainability. This can translate into long-term value creation and competitive advantage.

8.1 Data Providers Action: Improving ESG Data

Data providers play a critical role in enhancing water risk management and ESG reporting. They supply the data that companies and investors rely on for assessing water risks and opportunities. **Accurate, timely, and localised data is essential for effective scenario analysis and decision-making.**

Tools such as CDP reports, WaterLOUPE, and WWF Water Risk Filter offer valuable insights by showcasing data on water-related risks and opportunities. However, the effectiveness of these tools depends on the quality and granularity of the data they use. The lack of granular and robust data is an opportunity for data providers to use localised water risk assessments methodologies to integrate context and place-based insights in datasets. They can ensure that their data is comprehensive and context or regionally specific to capture local water risks and opportunities accurately.

Some of the challenges regarding data provision include data accessibility, robustness, comparability and interoperability. Localised water risk assessments can help address the challenges regarding data provision enhance the role of data providers by:

- **Enhancing data accuracy and granularity**: Region-specific water risk assessments, provide detailed insights into water risks and opportunities that are crucial for localised decision-making. By integrating tools as illustrated in this report, data providers can supply more accurate and granular data, reflecting specific regional conditions and risks. The integration of localised assessments helps data providers refine their models to better capture local water issues, resulting in improved accuracy and reliability of the data used for scenario analysis and risk management.

- **Improving data comparability and standardization:** For effective benchmarking and comparison, data needs to be standardised. Inconsistent data formats or metrics across different providers can make it challenging to compare water risks and opportunities across sectors and regions. Localised assessments can help in developing standardised metrics and benchmarks that align with regional water risks, supporting the creation of uniform reporting frameworks and enhancing comparability across companies and regions.

- **Improving interoperability:** Interoperability between different data systems and tools is essential for seamless integration and analysis. Ensuring that data from various sources can be easily combined and analysed together enhances the overall effectiveness of risk management strategies. Localised water risk assessments can help identify and address gaps in existing data, ensuring that regional specifics are included. This approach addresses both direct and indirect water risks, including supply chain and regulatory challenges. The methodologies and findings from localised assessments can guide the development of interoperable data systems, ensuring that data from different sources and regions can be integrated effectively, enhancing overall data utility.

Data providers should focus on improving the accessibility and transparency of their data. By offering detailed and clear information on water risks, companies can better understand their exposure and integrate these insights into their risk management strategies**. Collaboration between data providers, companies, and stakeholders is crucial for enhancing data quality, reliability, accessibility and interoperability.**

8.2 Investor Action: Engagement

Several engagement questions can be extrapolated from the analyses, focusing on how companies use scenario analysis to map water risks in their operations and supply chains, integrate these findings into decision-making processes, and address water risks comprehensively.

As investors undertake active stewardship activities with their portfolio companies, they can work with companies to ensure they are appropriately mitigating risk with a lens on local water insights. For instance, investors, through the Ceres Valuing Water Finance Initiative, are engaging **large companies from four water intensive industries** on how to address their broad water impacts[28]. These companies, while at different stages of their water journeys, all have the potential to better steward and protect freshwater resources within their business operations and supply chains to drive meaningful change at the local and global scales. The initiative calls on companies to meet the **Corporate Expectations for Valuing Water**, a set of six science-based, actionable expectations.

Within this framework of investor engagement, questions to be considered include:

1 Does the company conduct a water risk assessment alongside a scenario analysis component?

[28] Valuing Water Finance Initiative | Ceres: Sustainability is the bottom line

2 What is the scope of water risk assessment (i.e. does it include water quality, access and ecosystem assessments)?
3 How often does the company assess water risks, and what tool(s) does it use to map water risks in:
    a. Its operations
    b. Its supply chain
4 Does the company integrate the findings from this analysis in decision-making regarding:
    a. Deciding on locations for its own operations
    b. For mergers and acquisitions
    c. For sourcing decisions
    d. To inform water-related corporate commitments and strategies especially in sites and suppliers located in high-water risk areas
    e. To prioritize collective action efforts based on the risk profile of its sites and suppliers and identify stakeholders to collaborate with.
5 Does the company measure/monitor volumes of water withdrawals, consumption, and discharges in:
    a. Its operations
    b. Its supply chain
6 How does the company address water risks in its supply chain, and what steps does it take to mitigate them with suppliers?
7 Does the company report the key watersheds, including those at medium to high risk for water stress, where its operations and supply chains are located?
8 Does the company report on the full spectrum of potential water risks, including water quality, water scarcity, and flooding for its assets and supply chain?
9 Does the company report on and consider potential opportunities presented by mitigating water risks within its assets and supply chain?
10 How does the company consider the different risk profiles of these watersheds?
11 How does the company collaborate with other water users and stakeholders in its key watersheds?

8.3 Conclusion

Addressing water risks and bridging ESG data gaps requires a multifaceted approach that combines data-driven decision-making, collaboration, and innovation.

To this end, stakeholders should prioritize the following actions:

- **Enhance place-based data collection and disclosure**: Develop and implement robust systems for collecting comprehensive data on sector-specific water usage and risks. This includes addressing sectors that are currently underrepresented in available data.

- **Improve asset and supply chain data tracking**: Companies should invest in better tracking of their assets and supply chains to understand their water dependencies and risks more accurately. This foundational step is crucial for effective water risk management.

- **Engage in collaborative efforts**: Engage in industry-wide collaborations and partnerships to share data, improve reporting standards, and develop best practices for water management.

By leveraging water risk assessment tools, investors and companies can gain detailed insights into water-related risks and opportunities, facilitating informed and strategic planning. Implementing robust water management strategies, setting science-based targets, and investing in water-efficient technologies are essential for ensuring long-term sustainability and resilience.

Moreover, fostering collaboration with stakeholders and engaging in collective action initiatives strengthens relationships and enhances water stewardship efforts. For investors, understanding and assessing water risks enable better financial exposure assessment, resilience evaluation, informed decision-making, and value creation.

By adopting a holistic approach to water risk management, companies and investors can navigate the complex landscape of environmental challenges and contribute to sustainable water management and long-term business resilience.

ANNEX I Water Risk Filter definitions of risk types and risk categories

- **Physical risks** account for whether water in the river basin is too little (scarcity), too much (flooding), unfit for use (quality), and/or the surrounding ecosystems are degraded, and in turn, negatively impacting water ecosystem services (ecosystem service status).
- **Regulatory risk** is linked to how water is managed (or governed) in the area or country. Thus, it is heavily tied to the concept of good governance and the fact that businesses thrive in a stable, effective and properly implemented regulatory environment.
- **Reputational risk** is linked to stakeholders' and local communities' perceptions of whether companies conduct business sustainably or responsibly with respect to water.

Risk Type	Risk Category	Indicator name	Description
PHYSICAL	**1. Water Scarcity**	Aridity Index	Provides information about the potential availability of water in regions with low water demand,
		Water Depletion	Measures the ratio of surface and ground water consumptive use to available renewable water
		Baseline Water Stress	Measures the ratio of total surface and groundwater withdrawals to available renewable water
		Blue Water Scarcity	Measures the ratio of the blue water footprint to the total blue water availability.
		Available Water Remaining (AWARE)	Measures the available water remaining in each river basin relative to the world average, after human and aquatic ecosystem demands have been met.
		Drought Frequency Probability	Multi-scalar drought index applying both precipitation and temperature data to detect, monitor and analyze different drought types and impacts in the context of global warming.
		Projected Change in Drought Occurrence	Predictions or estimations regarding how the frequency, severity, or duration of drought events is expected to alter in the future based on both global climate and hydrological models
	2. Flooding	Estimated Flood Occurrence	Empirical evidence of large flood events since 1985 to present, registered by the Dartmouth Flood Observatory's Global Active Archive of Large Flood Event
		Projected Change in Flood Occurrence	Predictions or estimations regarding how the frequency, severity, or duration of flood events is expected to alter in the future based on both global climate and hydrological models
	3. Water Quality	Surface Water Quality Index	It comprises three water quality parameters with well documented direct and indirect negative effects on water security for both humans and freshwater biodiversity: (1) biological oxygen demand (BOD) as a widely used umbrella proxy for overall water quality; (2) electrical conductivity (EC) as proxy for salinity balance and pH alteration; and (3) nitrogen, to capture nutrient loading in water bodies
	4. Ecosystem Services Status	Fragmentation Status of Rivers	Compilation of a geometric network of the global river system and associated attributes, such as hydro-geometric properties, as well as pressure indicators to calculate an integrated connectivity status index (CSI)
		Catchment Ecosystem Services Degradation Level	Variation on the percentage of tree cover loss within river basins during the period 2000-2020 as a proxy to represent catchment ecosystem services degradation,
		Projected Impacts on Freshwater Biodiversity	project changes [% increase or decrease] in freshwater fish extinction rate by ~2090 due to climate-related decrease in water availability, as a proxy to estimate the projected impacts of climate change on freshwater biodiversity.

Risk Type	Risk Category	Indicator name	Description
REGULATORY	**5. Enabling Environment**	Freshwater Policy Status (SDG 6.5.1)	Depicts the conditions that help to support the implementation of Integrated Water Resource Management (IWRM) based on n SDG 6.5.1. Degree of IWRM Implementation "National Water Resources Policy" indicator, which corresponds to one of the three national level indicators under the Enabling Environment category.
		Freshwater Law Status (SDG 6.5.1)	Depicts the conditions that help to support the implementation of Integrated Water Resource Management (IWRM) based on n SDG 6.5.1. Degree of IWRM Implementation "National Water Resources Law(s)" indicator, which corresponds to one of the three national level indicators under the Enabling Environment category.
		Implementation Status of Water Management Plans (SDG 6.5.1)	Depicts the conditions that help to support the implementation of Integrated Water Resource Management (IWRM) based on n SDG 6.5.1. Degree of IWRM Implementation "National IWRM Plans" indicator, which corresponds to one of the three national level indicators under the Enabling Environment category.
	6. Institutions & Governance	Corruption Perceptions Index	Based on the latest Transparency International's data: the Corruption Perceptions Index 2020. This index aggregates data from different sources that provide perceptions of business, people and country experts on the level of corruption in the public sector.
		Freedom in the World Index	Based the latest Freedom House's data: the Freedom in the World 2021, an annual global report on political rights and civil liberties, composed of numerical ratings and descriptive texts for each country and a select group of territories.
		Private Sector Participation in Water Management (SDG 6.5.1)	Based on SDG 6.5.1. Degree of Integrated Water Resource Management (IWRM) Implementation "Private Sector Participation in Water Resources Development, Management and Use" indicator, which corresponds to one of the six national level indicators under the Institutions and Participation category
	7. Management Instruments	Management Instruments for Water Management (SDG 6.5.1)	Based on SDG 6.5.1. Degree of Integrated Water Resource Management (IWRM) Implementation "Sustainable and efficient water use management" indicator, which corresponds to one of the five national level indicators under the Management Instruments category
		Groundwater Monitoring Data Availability and Management	Measures the level of availability of groundwater monitoring data at country level as groundwater management decisions rely strongly on data availability. Based on a combination of three criteria developed by WWF and IGRAC: 1) Status of country groundwater monitoring programme, 2) groundwater data availability for NGOs, and 3) Public access to processed groundwater monitoring data.
		Density of Runoff Monitoring Stations	Measures the density of water monitoring stations as water management decisions rely strongly on data availability
	8. Infrastructure & Finance	Access to Safe Drinking Water	Based on the Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (WHO/UNICEF) 2021 data
		Access to Sanitation	Based on the Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (WHO/UNICEF) 2021 data
		Financing for Water Resource Development and Management (SDG 6.5.1)	Based on the average "Financing" score of UN SDG 6.5.1. Degree of Integrated Water Resource Management (IWRM) Implementation database. The UN SDG 6.5.1 database contains a category on financing that assesses different aspects of budgeting and financing made available and used for water resources development and management from various sources
REPUTATIONAL	**9. Cultural Importance**	Cultural Diversity	Based on the count of ethnolinguistic groups by country as a proxy of cultural diversity.
	10. Biodiversity importance	Freshwater Endemism	Based on Freshwater Ecoregions of the World (FEOW) 2015 data developed by WWF and TNC.
		Freshwater Biodiversity Richness	Based on the Freshwater Ecoregions of the World (FEOW) 2015 data developed by WWF and TNC, and the count of fish species is used as a representation of freshwater biodiversity richness
	11. Media Scrutiny	National Media Coverage	Based on joint qualitative research by WWF and Tecnoma (Typsa Group). It indicates how aware local residents

Risk Type	Risk Category	Indicator name	Description
			typically are of water-related issues due to national media coverage.
		Global Media Coverage	Based on joint qualitative research by WWF and Tecnoma (Typsa Group). It indicates how aware local residents typically are of water-related issues due to global media coverage.
	12. Conflict	Conflict News Events	Counts and registers of documented negative incidents, criticism and controversies that can affect a company's reputational risk.
		Hydro-political Likelihood	Based on the assessment of hydro-political risk. This spatial modelling used historical cross-border water interactions as indicators of the magnitude of corresponding water joint-management issues, then determined the main parameters affecting water conflicts, and calculated the likelihood of hydro-political issues.

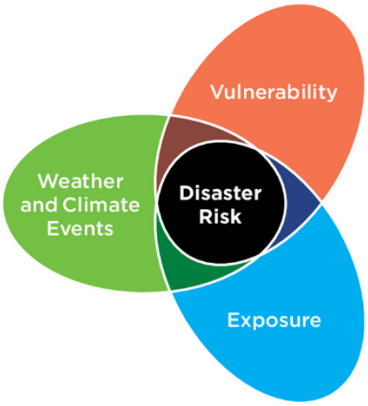
ANNEX II WaterLOUPE methodology explained

The WaterLOUPE methodology offers a comprehensive framework for assessing water scarcity risks across decades. The decision of taking a decadal approach is linked to potential timeframes for interventions and climate change impact, which require a longer timeframe to measure and show results. This assessment integrates the impacts of climate change and socioeconomic developments, drawing on two Shared Socioeconomic Pathways (SSPs) scenarios[29]. The methodology unfolds in four critical steps, each designed to build understanding of water scarcity risks.

Characteristics	SSP1	SSP2	SSP3
Name	Sustainability Taking the Green Road	Middle of the Road	Regional Rivalry Rocky Road
Population	Low population growth	Continuation of current developments	Low population growth in rich countries and high population growth in other countries
Economic growth	Low	Continuation of current developments	Slow
International cooperation and trade	Effective	Continuation of current developments	Barriers
Policy types	Focused on sustainable development	Continuation of current developments	Focused on security

Water scarcity risk concept

Common Definition	What it means in WaterLOUPE
Hazard: natural or human-triggered event with adverse impacts	Occurrence of water gap events (unmet demand)
Vulnerability: characteristics of a group that makes them susceptible to damage	Marginal value of water associated with unmet demand*
Exposure: people or assets present in the geographic area of hazards	Relative size of each user based on water demand (sector with larger demand result in higher exposure).



** Marginal value of water refers to the value of an additional unit of water for each sector*

Step 1: Set up the analysis and collect data

At the heart of WaterLOUPE's approach is the analysis of water gaps, which is defined as the periods when water demand surpasses water availability, leading to adverse outcomes. The

[29] Shared Socioeconomic Pathways (SSPs) are scenarios used by researchers to analyse how global society, demographics, and economics might change over the 21st century. For more information access : SSP Database (iiasa.ac.at)

methodology recognizes that the impact of water gaps varies among different sectors (e.g. agriculture, households, industry), with impoverished communities often being the most affected due to their limited ability to cope.

Step 2: Select models and scenarios of future conditions
WaterLOUPE's risk concept is grounded in three core components: hazard, vulnerability, and exposure. The risk is quantified through indicators that merge data on water availability (or the lack thereof) with demand—this quantification helps calculate the Water Gap Score. Additional data on the exposed population, Gross Domestic Product (GDP), and land use provide insights into future water demand by sector (domestic, agriculture, and industry) and the community's capacity to withstand water scarcity.

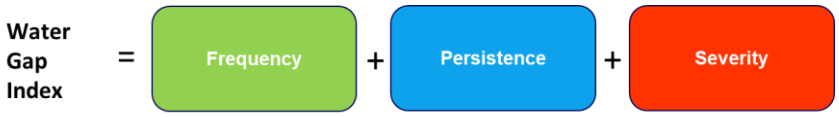


Figure 25. Water Gap Index

Step 3: Quantify and visualize water scarcity risks
The index calculation begins with determining the hazard index, reflecting the frequency, persistence, and severity of water gaps. Subsequently, the exposure and vulnerability indexes are computed for each sector. Exposure is defined by a sector's relative water demand, while vulnerability is assessed based on the utility value of water volumes, differing across user groups. This step considers the diminishing marginal utility of income or consumption to establish the vulnerability index.

Step 4: Sectoral and Temporal Comparisons
The final risk score integrates the various characteristics of water gaps (frequency, persistence, severity) with exposure and vulnerability levels across districts and sectors. Additionally, an average monthly water gap for each municipality within the specified time horizons is calculated. This facilitates a comparative analysis between SSP scenarios and different water users, identifying minimum, mean, and maximum water risk levels. Such comparisons pinpoint areas at lower, average and high risk under two SSP scenarios, guiding stakeholders in making informed decisions.

Through this structured methodology, the WaterLOUPE tool provides a detailed, actionable picture of water scarcity risks, enabling stakeholders to identify vulnerable areas and prioritize interventions.

ANNEX III Key Term Definitions

Cascading risks	The phenomenon where the manifestation of risk extends beyond a single operation, and affects or creates new risks to practices of other stakeholders
ESG	Environment, Social and Governance
ESG Reporting	ESG reporting is the disclosure of measurable information covering an organisation's operations and risks in three areas: environmental stewardship, social responsibility and corporate governance.
Exposure	People or assets present in the geographical study area
Frequency	How often does a water gap occur.
Hydrology	Hydrology is the scientific study of the movement, distribution, and management of water in the unit of analysis, including the water cycle, water resources, and drainage basin sustainability.
Persistence	How long does a water gap last.
Resilience	Resilience is the ability to anticipate, prepare for, and respond to hazardous events, trends, or disturbances related to climate
Risk	The probability of an event X impact severity X a site/corporation’s vulnerability. Risk is typically articulated in qualitative framing (high to low), but also sometimes quantified in financial terms. Also referred to as risk exposure in this paper.
Scarcity	The risk of water scarcity is estimated using simple indicators of hazard, exposure, and vulnerability, which are translated into a normalized index score, which is referred to as the water scarcity risk index (WSRI)
Severity	How large is a water gap.
Vulnerability	Characteristics of a group that makes them susceptible to damage. Lack of coping capacity.
Water Gap Index	Simple arithmetic average of frequency, severity and persistency of a water gap.

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