WWF Water Risk Filter
Methodology Documentation

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The WWF Water Risk Filter is a corporate and portfolio-level screening and prioritization tool to enable companies and investors to assess and respond to their water risks both now and in the future.

This Water Risk Filter Methodology documentation describes the water risk assessment framework, underlying structure and data sources for both basin and operational risk assessment as well as scenario risk assessment. This methodology documentation is updated periodically to reflect latest data updates and other changes as need be, so please ensure you are using the latest version available on the website https://waterriskfilter.org/explore/dataandmethods. References should be indicated as "WWF Water Risk Filter (2021)".

Also check the Water Risk Filter Tutorial and in case of questions, please contact the WWF Water Risk Filter Team at waterriskfilter@wwf.de

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A. Water Risk Assessment Framework

The Water Risk Filter's risk assessment is based on a company's geographic location, which informs a site's basin-related risks, as well as characteristics of its operating nature (e.g., its reliance upon water, its water use performance given the nature of the business/site), which informs a site's operational-related risks. This section outlines the background behind how both basin risk and operational risk are calculated in the Assess section of the Water Risk Filter tool.

In general, the Water Risk Filter follows a three-level hierarchy: 1) **risk indicator**, 2) **risk category**, 3) **risk type**, and the aggregation of those three levels together is referred as the **Overall Risk**. This structure was put in place for the following reasons:

1. There is a general acceptance of these three broad "types" of corporate water risks[1]: Physical, Regulatory and Reputational risk. This helps to ensure consistency and aligned approaches to water risk assessments and offers users a familiar approach.
2. Employing a hierarchical framework that consist of not only broad risk types, but more specific risk categories (or sub-types), accomplishes four things:
    i. A more comprehensive coverage *within* these broader risk types. For example, physical water risk comprises not only water scarcity, but also flooding, water quality, and ecosystem related risks. By dividing into these risk categories, it helps to take into account these different dimensions within physical risk as an example.
    ii. Given that the Water Risk Filter operates at both the global and local (region or country) level, the risk type/category structure also ensures a level of consistency in coverage between global and local datasets, since indicators may vary. In other words, the category structure enables the flexibility of adopting different local indicators whilst maintaining a similar logical structure and output across datasets.
    iii. It allows a direct comparison of basin vs. operational risks of same type or category.
    iv. It allows a differential number of indicators per category as well as for indicators to be added or removed in the risk categories while maintaining relative consistency from year to year.

[1] The CEO Water Mandate – Driving Harmonization of Water-Related Terminology, Discussion Paper, September 2014, https://ceowatermandate.org/terminology/

1. Basin Risk Assessment

Following the three-level hierarchy, the basin risk assessment cover the following aspects:

- **Physical**: represents both natural and human-induced conditions of river basins. It comprises the risk categories: 1) Water Scarcity, 2) Flooding, 3) Water Quality, and 4) Ecosystem Services Status. Therefore, physical risks account for if water is too little, too much, unfit for use, and/or the surrounding ecosystems are degraded, and in turn, negatively impacting water ecosystem services.
- **Regulatory**: Regulatory water risk is heavily tied to the concept of good governance and that businesses thrive in a stable, effective and properly implemented regulatory environment. It is aligned to the UN Sustainable Development Goal Target 6.5 (SDG 6.5.1), and comprises the risk categories: 5) Enabling Environment (largely concerned with laws & policies), 6) Institutions & Governance (concerned with the ability to convene and engage), 7) Management Instruments (concerned with data & enforcement), and 8) Infrastructure & Finance (concerned with whether funds are accessible to build critical water-related infrastructure)[2].
- **Reputational:** While a considerable amount of reputational water risk is operational (not basin-related), there are some basin pre-conditions that make reputational water risk more likely to manifest. Reputational risk represents stakeholders' and local communities' perceptions on whether companies conduct business sustainably or responsibly with respect to water. It comprises the risk categories: 9) Cultural Importance (of water to local communities), 10) Biodiversity Importance (freshwater biodiversity), 11) Media Scrutiny (coverage of water-related issues), and 12) Conflict (risk of hydro-political conflicts in the river basins).

Altogether the Water Risk Filter contains a total of 32 basin risk indicators (see Table 1) which are based predominantly on freely available external, peer-reviewed datasets (see section 1.1. for detailed description of each basin risk indicator). These indicators are reviewed and updated (either with new data or with a new indicator) annually, drawing upon the latest research and best available data.

Risk indicators can be aggregated into the 12 Basin Risk Categories, which in turn can be aggregated into the 3 risk types: Physical, Regulatory and Reputational, as mentioned above. Finally, the aggregation of the risk types makes the Overall Basin Risk score. The risk score classification is consistent throughout all risk indicators, categories, types as well as in the Overall Basin Risk. However, indicators' risk scores are given as integers, while aggregated risk scores (categories, types and the overall) can have decimals:

[2] While access to safe drinking water, adequate sanitation and hygiene awareness (WASH) could have been considered a physical risk, it was classified within the regulatory risk category 8) Infrastructure & Finance, largely because it tends to be most prevalent in cases where critical WASH infrastructure is lacking.

Risk indicators
1 Very low risk
2 Low risk
3 Medium risk
4 High risk
5 Very high risk

Risk categories, types, and Overall Risk	
1.0 – 1.4	Very low risk
1.4 – 1.8	
1.8 – 2.2	Low risk
2.2 – 2.6	
2.6 – 3.0	Medium risk
3.0 – 3.4	
3.4 – 3.8	High risk
3.8 – 4.2	
4.2 – 4.6	Very high risk
4.6 – 5.0	

Aggregated risk scores are computed by applying industry-specific weightings. The Water Risk Filter contains default industry-specific weightings for a total of 25 industry categories (see Appendix 1 for detailed information of default weightings for each industry). These industry categories were developed based on a harmonized list of different standard industry classifications (i.e., Global Industry Classification Systems - GICS, CDP industry classification, etc.). For the purpose of the Water Risk Filter, a narrowed down list of 25 industry categories was identified, since some broader GICS classifications (e.g., Food and Beverage) face greater water risk and therefore are better served through disaggregation, while others facing lower water risk (e.g., Professional Services, Software, Real Estate, Financial Institutions) need not be disaggregated and were therefore grouped into the same category. The default industry-specific weightings are based on multiple stakeholder consultations and peer reviews with experts from different NGOs, academics, financial institutions and businesses. The weightings are also informed by sector trends from CDP Water Security data.

It should be noted that the logic that underpins the water risk assessment is to evaluate average, recent water risk conditions and some level of future risk. In other words, it is looking at typical conditions with a bias towards more recent circumstances. Conversely, it is not intended to assess real-time water risk conditions.

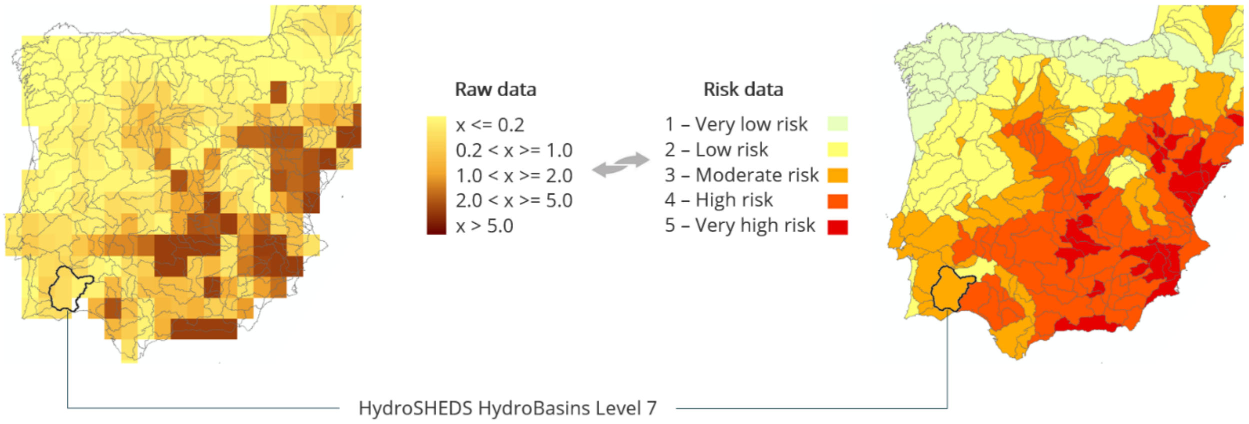
Table 1. Three-level hierarchy of the basin risk assessment framework: risk type, category and indicator. This table lists the global risk indicators.

Risk type	Risk category	Risk indicator
Physical Risk	1 - Water Scarcity	1.0 – Aridity Index 1.1 - Water Depletion 1.2 - Baseline Water Stress 1.3 - Blue Water Scarcity 1.4 - Available Water Remaining (AWARE) 1.5 - Drought Frequency Probability 1.6 - Projected Change in Drought Occurrence
	2 - Flooding	2.1 - Estimated Flood Occurrence 2.2 - Projected Change in Flood Occurrence
	3 - Water Quality	3.1 - Surface Water Quality Index *3.1.1 - Biological Oxygen Demand (BOD)* *3.1.2 - Electrical Conductivity (EC)* *3.1.3 - Nitrogen (N)*
	4 - Ecosystem Services Status	4.1 - Fragmentation Status of Rivers 4.2 - Catchment Ecosystem Services Degradation Level 4.3 - Projected Impacts on Freshwater Biodiversity
Regulatory Risk	5 - Enabling Environment	5.1 - Freshwater Policy Status (SDG 6.5.1) 5.2 - Freshwater Law Status (SDG 6.5.1) 5.3 - Implementation Status of Water Management Plans (SDG 6.5.1)
	6 - Institutions & Governance	6.1 - Corruption Perceptions Index 6.2 - Freedom in the World Index 6.3 - Private Sector Participation in Water Management (SDG 6.5.1)
	7 - Management Instruments	7.1 - Management Instruments for Water Management (SDG 6.5.1) 7.2 - Groundwater Monitoring Data Availability and Management 7.3 - Density of Runoff Monitoring Stations
	8 - Infrastructure & Finance	8.1 - Access to Safe Drinking Water 8.2 - Access to Sanitation 8.3 - Financing for Water Resource Development and Management (SDG 6.5.1)
Reputational Risk	9 - Cultural Importance	9.1 - Cultural Diversity
	10 - Biodiversity Importance	10.1 - Freshwater Endemism 10.2 – Freshwater Biodiversity Richness
	11 - Media Scrutiny	11.1 – National Media Coverage 11.2 – Global Media Coverage
	12 - Conflict	12.1 - Conflict News Events 12.2 - Hydro-political Likelihood

1.1. Global dataset

The 32 global basin risk indicators are described in detail in this section, including information on the rationale, the thresholds for the risk score classification, and data sources. This information can also be downloaded in a tabular format in website https://waterriskfilter.org/explore/dataandmethods.

To produce risk indicators the raw datasets are first spatially aggregated or transposed to a common scale, of river basins (i.e. watersheds), and then classified into the 5 risk score classes (i.e. 1-to-5 values). This normalization process (as illustrated below) allows for easy comparison between indicators, and also allows indicators to be aggregated with others.



The spatial aggregation unit for the basin risk data and map visualization is either at 1) HydroSHEDS[3] HydroBASINS Level 7; 2) WMO Basins[4], which are an aggregation of HydroBASINS into hydrographic regions; or 3) Country boundaries[5]. Depending on the nature of the raw data, data are aggregated/transposed to the most suitable level. Data have been primarely aggregated/transposed using the HydroBASINS Level 7 layer, however, where data are derived from a list of countries with respective values in its raw format, these were represented using country boundaries. Table 2 shows the level of spatial aggregation used for each risk indicator.

Table 2. Level of spatial aggregation for basin risk indicators

Basin Risk indicator	Raw data	Aggregation
1.0 – Aridity Index	Raster	HydroBASIN Level 7
1.1 - Water Depletion	Raster	HydroBASIN Level 7
1.2 - Baseline Water Stress	Polygon	HydroBASIN Level 7
1.3 - Blue Water Scarcity	Raster	HydroBASIN Level 7
1.4 - Available Water Remaining (AWARE)	Polygon	WMO Basins
1.5 - Drought Frequency Probability	Raster	HydroBASIN Level 7

[3] Lehner, B., Grill G. (2013): Global river hydrography and network routing: baseline data and new approaches to study the world's large river systems. Hydrological Processes, 27(15): 2171–2186. Data is available at www.hydrosheds.org
[4] Global Runoff Data Centre - GRDC (2020). WMO Basins and Sub-Basins / Global Runoff Data Centre, GRDC. 3rd, rev. ext. ed. Koblenz, Germany: Federal Institute of Hydrology (BfG). https://www.bafg.de/GRDC/EN/02_srvcs/22_gslrs/223_WMO/wmo_regions_node.html
[5] World coutries (Updated: Sep 29, 2021). https://www.arcgis.com/home/item.html?id=d974d9c6bc924ae0a2ffea0a46d71e3d

1.6 - Projected Change in Drought Occurrence	Raster	HydroBASIN Level 7
2.1 - Estimated Flood Occurrence	Polygon	HydroBASIN Level 7
2.2 - Projected Change in Flood Occurrence	Raster	HydroBASIN Level 7
3.1 - Surface Water Quality Index	Raster	HydroBASIN Level 7
4.1 - Fragmentation Status of Rivers	Polyline	HydroBASIN Level 6
4.2 - Catchment Ecosystem Services Degradation Level	Raster	HydroBASIN Level 7
4.3 - Projected Impacts on Freshwater Biodiversity	Polygon	HydroBASIN Level 7
5.1 - Freshwater Policy Status (SDG 6.5.1)	List of countries	Country boundaries
5.2 - Freshwater Law Status (SDG 6.5.1)	List of countries	Country boundaries
5.3 - Implementation Status of Water Management Plans (SDG 6.5.1)	List of countries	Country boundaries
6.1 - Corruption Perceptions Index	List of countries	Country boundaries
6.2 - Freedom in the World Index	List of countries	Country boundaries
6.3 - Private Sector Participation in Water Management (SDG 6.5.1)	List of countries	Country boundaries
7.1 - Management Instruments for Water Management (SDG 6.5.1)	List of countries	Country boundaries
7.2 - Groundwater Monitoring Data Availability and Management	List of countries	Country boundaries
7.3 - Density of Runoff Monitoring Stations	Point	WMO Basins
8.1 - Access to Safe Drinking Water	List of countries	Country boundaries
8.2 - Access to Sanitation	List of countries	Country boundaries
8.3 - Financing for Water Resource Development and Management (SDG 6.5.1)	List of countries	Country boundaries
9.1 - Cultural Diversity	List of countries	Country boundaries
10.1 - Freshwater Endemism	Polygon	HydroBASIN Level 7
10.2 - Freshwater Biodiversity Richness	Polygon	HydroBASIN Level 7
11.1 - National Media Coverage	List of countries	Country boundaries
11.2 - Global Media Coverage	List of countries	Country boundaries
12.1 - Conflict News Events	List of countries	Country boundaries
12.2 - Hydro-political Likelihood	Raster	HydroBASIN Level 7

All of the basin risk indicators are reviewed and, as appropriate, updated on an annual basis using latest available data. Table 3 provides an overview of update frequency of the underlying raw datasets, latest date of raw data available, and data access/data cut of raw data currently used for Water Risk Filter. The update frequencies are categorized into several categories as listed below:

- No updating: These data sets are generated as one time datasets and may be updated in the future, but it is unknown as to whether they will be
- Infrequent: These data sets are updated from time to time and on an irregular basis
- Annual: These data sets are updated annually
- Monthly: These data sets are updated monthly
- Continuously: These data sets are updated weekly or more frequently

Note that where the update frequency of the raw dataset is more frequent than annual, the most recent cut is taken, but the Water Risk Filter's update frequency remains on an annual basis.

Table 3. Data update information

Basin Risk indicator	Update frequency of raw dataset	Latest raw data available	Data access for WRF
1.0 - Aridity Index	Infrequent	2019	September 2020
1.1 - Water Depletion	Infrequent	2016	May 2018
1.2 - Baseline Water Stress	Infrequent	2019	May 2018
1.3 - Blue Water Scarcity	No updating	2016	May 2019
1.4 - Available Water Remaining (AWARE)	No updating	2018	September 2020
1.5 - Drought Frequency Probability	Monthly	2021	August 2021
1.6 - Projected Change in Drought Occurrence	No updating	2018	May 2018
2.1 - Estimated Flood Occurrence	Continuously	2021	August 2021
2.2 - Projected Change in Flood Occurrence	No updating	2018	May 2018
3.1 - Surface Water Quality Index	No updating	2019	September 2020
4.1 - Fragmentation Status of Rivers	No updating	2019	May 2019
4.2 - Catchment Ecosystem Services Degradation Level	Annual	2020	August 2021
4.3 - Projected Impacts on Freshwater Biodiversity	No updating	2013	August 2017
5.1 - Freshwater Policy Status (SDG 6.5.1)	Annual	2020	July 2021
5.2 - Freshwater Law Status (SDG 6.5.1)	Annual	2020	July 2021
5.3 - Implementation Status of Water Management Plans (SDG 6.5.1)	Annual	2020	July 2021
6.1 - Corruption Perceptions Index	Annual	2020	August 2021
6.2 - Freedom in the World Index	Annual	2021	August 2021
6.3 - Private Sector Participation in Water Management (SDG 6.5.1)	Annual	2020	July 2021
7.1 - Management Instruments for Water Management (SDG 6.5.1)	Annual	2020	July 2021
7.2 - Groundwater Monitoring Data Availability and Management	Infrequent	2019	March 2019
7.3 - Density of Runoff Monitoring Stations	Continuously	2021	August 2021
8.1 - Access to Safe Drinking Water	Bi-annual	2019	August 2021
8.2 - Access to Sanitation	Bi-annual	2019	August 2021
8.3 - Financing for Water Resource Development and Management (SDG 6.5.1)	Annual	2020	July 2021
9.1 - Cultural Diversity	No updating	2000	June 2019
10.1 - Freshwater Endemism	No updating	2015	September 2017
10.2 - Freshwater Biodiversity Richness	No updating	2015	September 2017
11.1 - National Media Coverage	No updating	2011	2011
11.2 - Global Media Coverage	No updating	2011	2011
12.1 - Conflict News Events	Monthly	2021	July 2021
12.2 - Hydro-political Likelihood	No updating	2018	April 2019

1.1.1. Physical Risk

The Water Risk Filter physical risk represents both natural and human-induced conditions of river basins. It comprises four risk categories covering different aspects of physical risks: water scarcity, flooding, water quality, and ecosystem services status. Therefore, physical risks account for if water is too little, too much, unfit for use, and/or the surrounding ecosystems are degraded, and in turn, negatively impacting water ecosystem services.

Risk Category 1. Water Scarcity

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

The Water Risk Filter risk category water scarcity is a comprehensive and robust metric as it integrates a total of 7 best available and peer-reviewed datasets covering different aspects of scarcity as well as different modelling approaches: aridity index, water depletion, baseline water stress, blue water scarcity, available water remaining, drought frequency probability, and projected change in drought occurrence.

1.0. Aridity Index

The Global Aridity Index[6] is a global climate data for the 1970-2000 period, related to evapotranspiration processes and rainfall deficit for potential vegetative growth, based on the implementation of a Penman-Montieth Reference Evapotranspiration (ET0) equation. Although it is not considered when computing the risk category 1.water scarcity, it can be used to depict deserts and other arid areas in risk assessments.

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) aggregate the raster data to the HydroBASINS level 7 using the area-weighted average value; 2) classify it into the 5 risk score classes, following the thresholds according to UNEP climatic zones[7], as in the table below.

Water Risk Filter Risk Score	Aridity Index Classes	Thresholds
1 – Very Low Risk	Humid	x > 0.65
2 – Low Risk	Dry sub-humid	0.50 < x <= 0.65
3 – Moderate Risk	Semi-arid	0.20 < x <= 0.50
4 – High Risk	Arid	0.03 < x <= 0.20
5 – Very High Risk	Hyper-arid	x <= 0.03

[6] Trabucco, A., & Zomer, R. Global Aridity Index and Potential Evapotranspiration (ET0) Climate Database v2. figshare. Fileset (2019). https://doi. org/10.6084/m9. figshare, 7504448, v3. https://cgiarcsi.community/2019/01/24/global-aridity-index-and-potential-evapotranspiration-climate-database-v2/

[7] United Nations Environment Programme - UNEP (1992). World Atlas of Desertification; Edward Arnold: London, UK.

1.1. Water Depletion

Water depletion[8] measures the ratio of surface and ground water consumptive use to available renewable water. This indicator is based on model outputs from WaterGAP3 to compute average annual and monthly values, for the period 1971-2000, and to map seasonal depletion and dry-year depletion.

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) aggregate the categorical raster data to the HydroBASINS level 7 using the majority value; 2) classify it into the 5 risk score classes, following the raw data's authors classification, as in the table below.

Water Risk Filter Risk Scores	Water Depletion Classes
1 – Very Low Risk	Annual average <5% depleted
2 – Low Risk	Annual average is 5-25% depleted
3 – Moderate Risk	Dry-year depletion: Annual average is 25-75% depleted, but at least 3 out of 30 years had at least one month with monthly depletion ratio >75%
4 – High Risk	Seasonal depletion: Annual average is 25-75% depleted, but at least one month every year, the monthly depletion ratio is >75%
5 – Very High Risk	Annual average >75% depleted

1.2. Baseline Water Stress

The World Resources Institute's Baseline water stress[9] measures the ratio of total surface and groundwater withdrawals to available renewable water. This indicator is based on model outputs from PCR-GLOBWB 2 to compute average monthly values, for the period 1960-2014, then to produce regression values for the year 2014 (baseline). Note that, although this indicator is called "water stress", it does not explicitly take into account environmental flow requirements, water quality, or access to water.

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) transpose the values in polygon shapefile of HydroBASINS level 6 to level 7 using the Pfafstetter coding system; 2) classify it into the 5 risk score classes, following the raw data's authors classification, as in the table below.

Water Risk Filter Risk Scores	Baseline Water Stress Classes	Thresholds
1 – Very Low Risk	Low	x <= 0.1
2 – Low Risk	Low-medium	0.1 < x <= 0.2
3 – Moderate Risk	Medium-high	0.2 < x <= 0.4
4 – High Risk	High	0.4 < x <= 0.8
5 – Very High Risk	Extremely high / Arid	x > 0.8

[8] Brauman, K. A., Richter, B. D., Postel, S., Malsy, M., & Flörke, M. (2016). Water depletion: An improved metric for incorporating seasonal and dry-year water scarcity into water risk assessments. Elem Sci Anth, 4. http://www.earthstat.org/water-depletion-watergap3-basins/

[9] Hofste, R., Kuzma, S., Walker, S., ... & Sutanudjaja, E.H. (2019). Aqueduct 3.0: Updated decision relevant global water risk indicators. Technical note. Washington, DC: World Resources Institute. https://www.wri.org/resources/data-sets/aqueduct-global-maps-30-data

1.3. Blue Water Scarcity

Blue water scarcity[10] measures the ratio of the blue water footprint to the total blue water availability. This indicator is based on the global standard for water footprint assessment to compute average monthly values (10-year average for the period 1996-2005).

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) aggregate the raster data (annual average value) to the HydroBASINS level 7 using the area-weighted average value; 2) classify it into the 5 risk score classes, following the raw data's authors classification, as in the table below.

Water Risk Filter Risk Scores	Blue Water Scarcity Classes	Thresholds
1 – Very Low Risk	-	x <= 0.2
2 – Low Risk	Low	0.2 < x <= 1.0
3 – Moderate Risk	Moderate	1.0 < x <= 2.0
4 – High Risk	Significant	2.0 < x <= 5.0
5 – Very High Risk	Severe	x > 5.0

1.4. Available Water Remaining (AWARE)

Available Water Remaining (AWARE)[11] measures the available water remaining in a given river basin relative to the world average, after human and aquatic ecosystem demands have been met. This indicator is based on the Water Use in Life Cycle Assessment (WULCA) to quantify the potential of water deprivation to either humans or ecosystems (for the year 2010) and serves in calculating the impact score of water consumption in Life Cycle Assessments or to calculate a water scarcity footprint as per ISO 14046.

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) transpose the values (AWARE100 total annual weighted average) in polygon shapefile to the HydroBASINS level 7 using the area-weighted average value; 2) classify it into the 5 risk score classes, following a 5-quantile classification (no data excluded), as in the table below.

Water Risk Filter Risk Scores	Thresholds
1 – Very Low Risk	x <= 0.043
2 – Low Risk	0.043 < x <= 0.203
3 – Moderate Risk	0.203 < x <= 0.848
4 – High Risk	0.848 < x <= 0.465
5 – Very High Risk	x > 0.465

[10] Mekonnen, M. M., & Hoekstra, A. Y. (2016). Four billion people facing severe water scarcity. Science advances, 2(2), e1500323. https://waterfootprint.org/en/resources/waterstat/water-scarcity-statistics/
[11] Boulay, A. M., Bare, J., Benini, L., Berger, M., Lathuillière, M. J., Manzardo, A., ... & Ridoutt, B. (2018). The WULCA consensus characterization model for water scarcity footprints: assessing impacts of water consumption based on available water remaining (AWARE). The International Journal of Life Cycle Assessment, 23(2), 368-378. https://wulca-waterlca.org/aware/

1.5. Drought Frequency Probability

The Standardized Precipitation and Evaporation Index (SPEI)[12] is a 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.

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) compute the relative frequency probability of hydrological drought events of moderate magnitude occurring in any given year (i.e. ratio of the number of months when index is below or equal to events of moderate magnitude (SPEI <= -1) to the total number of possible outcomes, considering the last 10 years (August 2011 – July 2021) as reference period); 2) aggregate the data to the HydroBASINS level 7 using the area-weighted average value; 3) classify it into the 5 risk score classes, following an equal intervals classification, as in the table below.

Water Risk Filter Risk Scores	Thresholds
1 – Very Low Risk	x <= 0.2
2 – Low Risk	0.2 < x <= 0.4
3 – Moderate Risk	0.4 < x <= 0.6
4 – High Risk	0.6 < x <= 0.8
5 – Very High Risk	x > 0.8

1.6. Projected Change in Drought Occurrence

This risk indicator is based on a multi-model simulation that applies both global climate and hydrological models from the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP)[13]. The 2.5th percentile of soil moisture is calculated for pre-industrial conditions (1661-1860), and defined as the drought threshold. Then years are counted in which soil moisture falls below this threshold for at least 7 consecutive months, and it is estimated the probability that an event of at least this magnitude occurs in a given year. Results are expressed in terms of percentage change in probability between pre-industrial and the time that the average global temperature reach 2°C warming (around the year 2050, based on RCPs 2.6 and 6.0).

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) aggregate the raster data to the HydroBASINS level 7 using the area-weighted average value; 2) classify it into the 5 risk score classes, following the thresholds in the table below.

Water Risk Filter Risk Scores	Projected Change Classes	Thresholds
1 – Very Low Risk	No change or decrease in droughts	x <= 0.01
2 – Low Risk	Up to 2% increase in droughts	0.01 < x <= 0.02
3 – Moderate Risk	Up to 4% increase in droughts	0.02 < x <= 0.04
4 – High Risk	Up to 6% increase in droughts	0.04 < x <= 0.06
5 – Very High Risk	More than 6% increase in droughts	x > 0.06

[12] Vicente-Serrano, S. M., Beguería, S., & López-Moreno, J. I. (2010). A multiscalar drought index sensitive to global warming: the standardized precipitation evapotranspiration index. Journal of climate, 23(7), 1696-1718. https://spei.csic.es/index.html

[13] Frieler, K., Lange, S., Piontek, F., Reyer, C. P., Schewe, J., Warszawski, L., ... & Geiger, T. (2017). Assessing the impacts of 1.5 C global warming–simulation protocol of the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP2b). Geoscientific Model Development. https://www.geosci-model-dev.net/10/4321/2017/

Risk Category 2. Flooding

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

The Water Risk Filter risk category flooding considers historical patterns and future trends. The historical patterns are based on empirical evidence of large flood events since 1985 to present, derived from a wide variety of news, governmental, instrumental, and remote sensing sources. Future trends are based on ensemble projections that apply both global climate and hydrological models to compute projected changes in frequency of floods in a 2°C scenario.

2.1. Estimated Flood Occurrence

This risk indicator is based on empirical evidence of large flood events since 1985 to present, registered by the Dartmouth Flood Observatory's Global Active Archive of Large Flood Events[14]. It includes floods due to overflowing rivers, lakes, or oceans; caused by heavy rainfall, rapid snowmelt, dams or levees break, or storm surge from tropical cyclones or tsunami in coastal areas. The data is derived from a wide variety of news, governmental, instrumental, and remote sensing sources.

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) aggregate the polygon shapefile data to the HydroBASINS level 7 using the count of overlapping polygons in each basin; 2) classify it into the 5 risk score classes, following the thresholds in the table below.

Water Risk Filter Risk Scores	Thresholds
1 – Very Low Risk	x = 0
2 – Low Risk	1 <= x <= 2
3 – Moderate Risk	2 < x <= 10
4 – High Risk	10 < x <= 35
5 – Very High Risk	x > 35

2.2. Projected Change in Flood Occurrence

This risk indicator is based on a multi-model simulation that applies both global climate and hydrological models from the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP)[15], and subsequent flood modeling with the global inundation model CaMa-Flood. The 100-year discharge is calculated for pre-industrial conditions (1661-1860), and defined as the flood threshold. Then years are counted in which occurs a 100-year discharge or greater, and it is estimated the probability that an event of at least this magnitude occurs in a given year. Results are expressed in terms of percentage

[14] Brakenridge, G. R. (2021). Global active archive of large flood events. Dartmouth Flood Observatory, University of Colorado. http://floodobservatory.colorado.edu/Archives/index.html

[15] Frieler, K., Lange, S., Piontek, F., Reyer, C. P., Schewe, J., Warszawski, L., ... & Geiger, T. (2017). Assessing the impacts of 1.5 C global warming–simulation protocol of the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP2b). Geoscientific Model Development. https://www.geosci-model-dev.net/10/4321/2017/

change in probability between pre-industrial and the time that the average global temperature reach 2°C warming (around the year 2050, based on RCPs 2.6 and 6.0).

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) aggregate the raster data to the HydroBASINS level 7 using the area-weighted average value; 2) classify it into the 5 risk score classes, following the thresholds in the table below.

Water Risk Filter Risk Scores	Projected Change Classes	Thresholds
1 – Very Low Risk	No change or decrease in floods	$x <= 0.01$
2 – Low Risk	Up to 5% increase in floods	$0.01 < x <= 0.05$
3 – Moderate Risk	Up to 10% increase in floods	$0.05 < x <= 0.10$
4 – High Risk	Up to 15% increase in floods	$0.10 < x <= 0.15$
5 – Very High Risk	More than 15% increase in floods	$x > 0.15$

Risk Category 3. Water Quality

Water quality indicates whether water resources are fit for human use and ecosystems alike. Poor water quality – water pollution – can impact business indirectly by causing ecosystems destabilization or serious health issues as well as directly through increased operating costs and as reduction in production or growth.

The Water Risk Filter risk category water quality considers parameters with well documented direct and indirect negative effects on water security for both humans and freshwater biodiversity, which are aligned to the Sustainable Development Goal (SDG) 6.3.2: biological oxygen demand (BOD) as 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.

3.1. Surface Water Quality Index

The Surface Water Quality Index[16] is based on a combination of monitoring data and a Machine Learning prediction model. It comprises three water quality parameters with well documented direct and indirect negative effects on water security for both humans and freshwater biodiversity, which are aligned to the Sustainable Development Goal (SDG) 6.3.2: biological oxygen demand (BOD) as 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.

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) aggregate the raster data to the HydroBASINS level 7 using the area-weighted average value; 2) classify it into the 5 risk score classes, following the raw data's authors classification (i.e. by the 20th, 40th, 70th, and 90th percentiles), as in the table below.

[16] Damania, R., Desbureaux, S., Rodella, A. S., Russ, J., & Zaveri, E. (2019). Quality unknown: The invisible water crisis. The World Bank. https://openknowledge.worldbank.org/handle/10986/32245

Water Risk Filter Risk Scores	Thresholds
1 – Very Low Risk	x <= -1.66
2 – Low Risk	-1.66 < x <= -0.79
3 – Moderate Risk	-0.79 < x <= 1.24
4 – High Risk	1.24 < x <= 5.22
5 – Very High Risk	x > 5.22

In addition to the risk indicator 3.1. Surface Water Quality Index, the three underlying water quality parameters (BOD, electrical conductivity, and nitrogen) are included as sub-risk indicators, applying the same processing steps.

Risk Category 4. Ecosystem Services Status

Ecosystems provide business, people and communities with a wide range of goods and services such as climate and streamflow regulation, water purification, species habitats maintenance, balance of soil biodiversity, pests and diseases, among many others. Therefore, the degradation of ecosystems can result in businesses having restricted access in the long-term to the quantity and quality of water needed for their activities as well as other ecosystem services they rely on.

The Water Risk Filter risk category ecosystem services status is informed by indicators of fragmentation status of rivers (i.e. Connectivity Status Index – CSI); catchment degradation (i.e. forest loss, as forests play an important role in terms of water regulation, supply and pollution control); and projected change in freshwater fish extinction.

4.1. Fragmentation Status of Rivers

The mapping world's free-flowing rivers[17] is a 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). This indicator uses the CSI to calculate the percentage of the river basins' volume considered as fragmented (CSI < 95%).

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) aggregate the polyline shapefile data to the HydroBASINS level 6 calculating the percentage of the basins' volume (considering only river reaches of order <= 8) classified as fragmented (i.e. not classified as 'Free-flowing'); 2) classify it into the 5 risk score classes, following the thresholds in the table below.

Water Risk Filter Risk Scores	Thresholds
1 – Very Low Risk	x = 0 (All free-flowing)
2 – Low Risk	0 < x <= 0.2
3 – Moderate Risk	0.2 < x <= 0.7
4 – High Risk	0.7 < x <= 0.9
5 – Very High Risk	x > 0.9

[17] Grill, G., Lehner, B., Thieme, M., Geenen, B., Tickner, D., Antonelli, F., ... & Macedo, H. E. (2019). Mapping the world's free-flowing rivers. Nature, 569(7755), 215. https://figshare.com/articles/Mapping_the_world_s_free-flowing_rivers_data_set_and_technical_documentation/7688801

4.2. Catchment Ecosystem Services Degradation Level

This risk indicator is based on the forest cover data[18] as a proxy to represent catchment ecosystem services degradation, as forests play an essential role in terms of water regulation, supply and pollution control. It calculates the percentage of tree cover loss within river basins during the period 2000-2020.

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) aggregate the raster data (forest loss) to the HydroBASINS level 7 calculating the percentage of forest cover loss relative to basins' area; 2) classify it into the 5 risk score classes, following the thresholds in the table below.

Water Risk Filter Risk Scores	Thresholds
1 – Very Low Risk	x <= 0.01
2 – Low Risk	0.01 < x <= 0.02
3 – Moderate Risk	0.02 < x <= 0.05
4 – High Risk	0.05 < x <= 0.2
5 – Very High Risk	x > 0.2

4.3. Projected Impacts on Freshwater Biodiversity

This risk indicator is based on project changes (percentage increase or decrease) in freshwater fish extinction rate by ~2090 due to climate-related decrease in water availability (based on A2 SRES)[19], as a proxy to estimate the projected impacts of climate change on freshwater biodiversity.

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) transpose the values in polygon shapefile to the HydroBASINS level 7 using the majority value; 2) classify it into the 5 risk score classes, following the raw data's authors classification, as in the table below.

Water Risk Filter Risk Scores	Projected Change Classes	Thresholds
1 – Very Low Risk	No change or decrease in fish extinction rates	x <= 0
2 – Low Risk	Up to 5% increase in fish extinction rates	0 < x <= 0.05
3 – Moderate Risk	Up to 20% increase in fish extinction rates	0.05 < x <= 0.2
4 – High Risk	Up to 50% increase in fish extinction rates	0.2 < x <= 0.5
5 – Very High Risk	More than 50% increase in fish extinction rates	x > 0.5

18 Hansen, M. C., Potapov, P. V., Moore, R., Hancher, M., Turubanova, S. A. A., Tyukavina, A., ... & Kommareddy, A. (2013). High-resolution global maps of 21st-century forest cover change. science, 342(6160), 850-853. https://glad.earthengine.app/view/global-forest-change
19 Tedesco, P. A., Oberdorff, T., Cornu, J. F., Beauchard, O., Brosse, S., Dürr, H. H., ... & Hugueny, B. (2013). A scenario for impacts of water availability loss due to climate change on riverine fish extinction rates. Journal of Applied Ecology, 50(5), 1105-1115. http://atlas.freshwaterbiodiversity.eu/atlasApp/full/?map=3.2.1-fish-extinction-rates-climate-change

1.1.2. Regulatory Risk

The Water Risk Filter regulatory risk is heavily tied to the concept of good governance and that businesses thrive in a stable, effective and properly implemented regulatory environment. It is aligned to the UN Sustainable Development Goal Target 6.5 (SDG 6.5.1) framework and comprises four risk categories: enabling environment, institutions & governance, management instruments, and infrastructure & finance.

The Water Risk Filter integrated, when possible, the datasets collected by the UNEP for monitoring countries progress to achieve UN Sustainable Development Goal 6.5.1 on the degree of implementation of Integrated Water Resource Management (IWRM), which is measured on a scale of zero to 100, based on the degree of implementation in a self-assessed country questionnaire.

Risk Category 5. Enabling Environment

Enabling environment measures existing policies, laws and plans to support IWRM implementation. Unstable, ineffective and poorly implemented enabling environment can potentially undermine business viability.

The Water Risk Filter risk category enabling environment is informed by SDG 6.5.1 indicators: freshwater policy status (i.e. national water resources policy); freshwater law status (i.e. national water resources law(s)); and implementation status of water management plans (i.e. national IWRM plans).

5.1. Freshwater Policy Status (SDG 6.5.1)

This risk indicator is based on SDG 6.5.1. Degree of IWRM Implementation "National Water Resources Policy" indicator[20], which corresponds to one of the three national level indicators under the Enabling Environment category. For SDG 6.5.1, enabling environment depicts the conditions that help to support the implementation of IWRM, which includes legal and strategic planning tools for IWRM.

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) transpose the values from list of countries to the country boundaries; 2) classify it into the 5 risk score classes, following the thresholds in the table below.

Water Risk Filter Risk Scores	Thresholds
1 – Very Low Risk	x > 70
2 – Low Risk	50 < x <= 70
3 – Moderate Risk	30 < x <= 50
4 – High Risk	10 < x <= 30
5 – Very High Risk	0 < x <= 10

[20] UNEP & UNEP-DHI (2021). SDG Indicator 6.5.1 database for reporting year 2020 (second round of reporting on indicator). Data available from IWRM Data Portal: http://iwrmdataportal.unepdhi.org

5.2. Freshwater Law Status (SDG 6.5.1)

This risk indicator is based on SDG 6.5.1. Degree of Integrated IWRM Implementation "National Water Resources Law(s)" indicator[21], which corresponds to one of the three national level indicators under the Enabling Environment category. For SDG 6.5.1, enabling environment depicts the conditions that help to support the implementation of IWRM, which includes legal and strategic planning tools for IWRM.

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) transpose the values from list of countries to the country boundaries; 2) classify it into the 5 risk score classes, following the thresholds in the table below.

Water Risk Filter Risk Scores	Thresholds
1 – Very Low Risk	x > 70
2 – Low Risk	50 < x <= 70
3 – Moderate Risk	30 < x <= 50
4 – High Risk	10 < x <= 30
5 – Very High Risk	0 < x <= 10

5.3. Implementation Status of Water Management Plans (SDG 6.5.1)

This risk indicator is based on SDG 6.5.1. Degree of IWRM Implementation "National IWRM Plans" indicator[22], which corresponds to one of the three national level indicators under the Enabling Environment category. For SDG 6.5.1, enabling environment depicts the conditions that help to support the implementation of IWRM, which includes legal and strategic planning tools for IWRM.

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) transpose the values from list of countries to the country boundaries; 2) classify it into the 5 risk score classes, following the thresholds in the table below.

Water Risk Filter Risk Scores	Thresholds
1 – Very Low Risk	x > 70
2 – Low Risk	50 < x <= 70
3 – Moderate Risk	30 < x <= 50
4 – High Risk	10 < x <= 30
5 – Very High Risk	0 < x <= 10

[21] UNEP & UNEP-DHI (2021). SDG Indicator 6.5.1 database for reporting year 2020 (second round of reporting on indicator). Data available from IWRM Data Portal: http://iwrmdataportal.unepdhi.org
[22] UNEP & UNEP-DHI (2021). SDG Indicator 6.5.1 database for reporting year 2020 (second round of reporting on indicator). Data available from IWRM Data Portal: http://iwrmdataportal.unepdhi.org

Risk Category 6. Institutions & Governance

Institutions & Governance measures the range and roles of political, social, economic and administrative institutions, and the ability to convene and engage other stakeholder groups that help to support IWRM implementation. Unstable and ineffective institutions & governance can potentially undermine business viability.

The Water Risk Filter risk category institutions & governance is informed by three indicators: the corruption perceptions index; the freedom in the world index; and the Sustainable Development Goal (SDG) 6.5.1 indicator on private sector participation in water management.

6.1. Corruption Perceptions Index

This risk indicator is based on the latest Transparency International's data: The Corruption Perceptions Index 2020[23]. 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.

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) transpose the values from list of countries to the country boundaries; 2) classify it into the 5 risk score classes, following the thresholds in the table below.

Water Risk Filter Risk Scores	Thresholds
1 – Very Low Risk	x >= 80
2 – Low Risk	80 < x >= 60
3 – Moderate Risk	60 < x >= 40
4 – High Risk	40 < x >= 20
5 – Very High Risk	x < 20

6.2. Freedom in the World Index

This risk indicator is based on the latest Freedom House's data: the Freedom in the World 2021[24], 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. The 2021 edition involved more than 125 analysts and nearly 40 advisers with global, regional, and issue-based expertise to covers developments in 195 countries and 15 territories from January 1, 2020, through December 31, 2020.

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) transpose the values from list of countries to the country boundaries; 2) classify it into the 5 risk score classes, following the thresholds in the table below.

[23] Transparency International (2021). Corruption Perceptions Index 2020. Berlin: Transparency International. https://images.transparencycdn.org/images/CPI2020_Report_EN_0802-WEB-1_2021-02-08-103053.pdf
[24] Freedom House (2021). Freedom in the world 2021. Washington, DC: Freedom House. https://freedomhouse.org/sites/default/files/2021-02/FIW2021_World_02252021_FINAL-web-upload.pdf

Water Risk Filter Risk Scores	Thresholds
1 – Very Low Risk	x >= 75
2 – Low Risk	75 < x >= 50
3 – Moderate Risk	50 < x >= 40
4 – High Risk	40 < x >= 30
5 – Very High Risk	x < 30

6.3. Private Sector Participation in Water Management (SDG 6.5.1)

This risk indicator is based on SDG 6.5.1. Degree of IWRM Implementation "Private Sector Participation in Water Resources Development, Management and Use" indicator[25], which corresponds to one of the six national level indicators under the Institutions and Participation category.

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) transpose the values from list of countries to the country boundaries; 2) classify it into the 5 risk score classes, following the thresholds in the table below.

Water Risk Filter Risk Scores	Thresholds
1 – Very Low Risk	x > 70
2 – Low Risk	50 < x <= 70
3 – Moderate Risk	30 < x <= 50
4 – High Risk	10 < x <= 30
5 – Very High Risk	0 < x <= 10

Risk Category 7. Management Instruments

Management instruments measures data availability, tools and activities that enable decision-makers and users to make rational and informed choices between alternative actions that help to support IWRM implementation. Ineffective and poorly implemented management instruments can potentially undermine business viability.

The Water Risk Filter risk category management instruments is informed by three indicators: Sustainable Development Goal (SDG) 6.5.1 indicator on sustainable and efficient water use management; groundwater monitoring data availability and management; and density of runoff monitoring stations.

[25] UNEP & UNEP-DHI (2021). SDG Indicator 6.5.1 database for reporting year 2020 (second round of reporting on indicator). Data available from IWRM Data Portal: http://iwrmdataportal.unepdhi.org

7.1. Management Instruments for Water Management (SDG 6.5.1)

This risk indicator is based on SDG 6.5.1. Degree of Integrated Water Resource Management (IWRM) Implementation "Sustainable and efficient water use management" indicator[26], which corresponds to one of the five national level indicators under the Management Instruments category. For SDG 6.5.1, management instruments refer to the tools and activities that enable decision-makers and users to make rational and informed choices between alternative actions.

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) transpose the values from list of countries to the country boundaries; 2) classify it into the 5 risk score classes, following the thresholds in the table below.

Water Risk Filter Risk Scores	Thresholds
1 – Very Low Risk	x > 70
2 – Low Risk	50 < x <= 70
3 – Moderate Risk	30 < x <= 50
4 – High Risk	10 < x <= 30
5 – Very High Risk	0 < x <= 10

7.2. Groundwater Monitoring Data Availability and Management

This risk indicator measures the level of availability of groundwater monitoring data at country level as groundwater management decisions rely strongly on data availability. The level of groundwater monitoring data availability for groundwater management is determined according to a combination of three criteria developed by WWF and IGRAC[27]: 1) Status of country groundwater monitoring programme, 2) groundwater data availability for NGOs, and 3) Public access to processed groundwater monitoring data.

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) transpose the values from list of countries to the country boundaries; 2) classify it into the 5 risk score classes, following the table below.

Water Risk Filter Risk Scores	Groundwater Monitoring Data Availability and Management Classes
1 – Very Low Risk	National groundwater monitoring programmes, that provide data for NGOs and processed information suitable for non-experts
2 – Low Risk	Some national programmes and limited data availability
3 – Moderate Risk	Some national programmes and no data availability
4 – High Risk	Limited national programmes and no data availability
5 – Very High Risk	No or very limited national programmes and no data availability

[26] UNEP & UNEP-DHI (2021). SDG Indicator 6.5.1 database for reporting year 2020 (second round of reporting on indicator). Data available from IWRM Data Portal: http://iwrmdataportal.unepdhi.org

[27] UN IGRAC (2019). Global Groundwater Monitoring Network GGMN Portal. UN International Groundwater Resources Assessment Centre (IGRAC). https://www.un-igrac.org/special-project/ggmn-global-groundwater-monitoring-network

7.3. Density of Runoff Monitoring Stations

This risk indicator measures the density of water monitoring stations as water management decisions rely strongly on data availability. The Global Runoff Data Base was used to estimate the number of monitoring stations per 1000km^2 of the main river system (database access date: August 2021).

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) aggregate the point shapefile data to the WMO Basins calculating the density (stations per 1000km^2) for each basin; 2) classify it into the 5 risk score classes, following the thresholds in the table below.

Water Risk Filter Risk Scores	Thresholds
1 – Very Low Risk	x > 50
2 – Low Risk	20 < x <= 50
3 – Moderate Risk	5 < x <= 20
4 – High Risk	1 <= x <= 5
5 – Very High Risk	x < 1

Risk Category 8. Infrastructure & Finance

Infrastructure & Finance measures access to clean water and sanitation as well as existing budgeting and financing made available and used for water resources development and management. Low funding for water resources development and water infrastructure can potentially undermine business viability.

The Water Risk Filter risk category infrastructure & finance is informed by three indicators: percentage of population with access to safe drinking water; access to basic sanitation services; and the Sustainable Development Goal (SDG) 6.5.1 indicator on financing for water resource development and management.

8.1. Access to Safe Drinking Water

This risk indicator is based on the Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (WHO/UNICEF) 2021 data[28]. It provides estimates on the use of water, sanitation and hygiene by country for the period 2000-2020.

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) transpose the values from list of countries to the country boundaries; 2) classify it into the 5 risk score classes, following the thresholds in the table below.

Water Risk Filter Risk Scores	Thresholds
1 – Very Low Risk	x > 0.95
2 – Low Risk	0.9 < x <= 0.95
3 – Moderate Risk	0.8 < x <= 0.9
4 – High Risk	0.6 < x <= 0.8
5 – Very High Risk	x <= 0.6

[28] WHO (World Health Organization) and United Nations Children's Fund (UNICEF), Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP) (2021) Progress on household drinking water, sanitation and hygiene 2000-2020: five years into the SDGs. Available online: https://washdata.org/data

8.2. Access to Sanitation

This risk indicator is based on the Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (WHO/UNICEF) 2021 data[29]. It provides estimates on the use of water, sanitation and hygiene by country for the period 2000-2020.

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) transpose the values from list of countries to the country boundaries; 2) classify it into the 5 risk score classes, following the thresholds in the table below.

Water Risk Filter Risk Scores	Thresholds
1 – Very Low Risk	x > 0.95
2 – Low Risk	0.9 < x <= 0.95
3 – Moderate Risk	0.8 < x <= 0.9
4 – High Risk	0.6 < x <= 0.8
5 – Very High Risk	x <= 0.6

8.3. Financing for Water Resource Development and Management (SDG 6.5.1)

This risk indicator is based on the average "Financing" score of UN SDG 6.5.1. Degree of 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[30].

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) transpose the values from list of countries to the country boundaries; 2) classify it into the 5 risk score classes, following the thresholds in the table below.

Water Risk Filter Risk Scores	Thresholds
1 – Very Low Risk	x > 70
2 – Low Risk	50 < x <= 70
3 – Moderate Risk	30 < x <= 50
4 – High Risk	10 < x <= 30
5 – Very High Risk	0 < x <= 10

[29] WHO (World Health Organization) and United Nations Children's Fund (UNICEF), Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (JMP) (2021) Progress on household drinking water, sanitation and hygiene 2000-2020: five years into the SDGs. Available online: https://washdata.org/data

[30] UNEP & UNEP-DHI (2021). SDG Indicator 6.5.1 database for reporting year 2020 (second round of reporting on indicator). Data available online: https://www.sdg6data.org/indicator/6.5.1

1.1.3. Reputational Risk

The Water Risk Filter reputational risk represents stakeholders' and local communities' perceptions on whether companies conduct business sustainably or responsibly with respect to water. It comprises four risk categories: cultural importance of water to local communities, freshwater biodiversity importance, media scrutiny/coverage of water-related issues, and risk of hydro-political conflicts in the river basins.

Risk Category 9. Cultural Importance

Water is a social and cultural good for local communities, indigenous and traditional people in their daily life, religion and culture. Businesses can potentially face reputational risk if a cultural good is perceived as negatively impacted or violated.

The Water Risk Filter risk category cultural importance considers the diversity of ethnolinguistic groups globally, as a proxy of cultural diversity.

9.1. Cultural Diversity

This risk indicator is based on the count of ethnolinguistic groups by country[31] as a proxy of cultural diversity. The rationale is that the greater the number of culture within a given region, the greater the chance that water is perceived as a social and/or cultural good and that would pose reputational risk to businesses.

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) transpose the values from list of countries to the country boundaries; 2) classify it into the 5 risk score classes, following the thresholds in the table below.

Water Risk Filter Risk Scores	Thresholds
1 – Very Low Risk	x <= 10
2 – Low Risk	10 < x <= 25
3 – Moderate Risk	25 < x <= 50
4 – High Risk	50 < x <= 100
5 – Very High Risk	x > 100

[31] Oviedo, G., Maffi, L., & Larsen, P. B. (2000). Indigenous and traditional peoples of the world and ecoregion conservation: An integrated approach to conserving the world's biological and cultural diversity. Gland: WWF (World Wide Fund for Nature) International. Available online: https://terralingua.org/shop/indigenous-and-traditional-peoples-of-the-world-and-ecoregion-conservation/

Risk Category 10. Biodiversity Importance

Biodiversity importance indicates whether a basin is home to a rich, diverse and healthy ecosystem. Businesses operating in basins of high biodiversity importance are likely to be exposed to higher reputational risks.

The Water Risk Filter risk category biodiversity importance is informed by two indicators from the WWF and TNC work Freshwater Ecoregions of the World (FEOW): freshwater endemism, and freshwater biodiversity richness.

10.1. Freshwater Endemism

This risk indicator is based on the Freshwater Ecoregions of the World (FEOW) 2015 data[32] developed by WWF and TNC. The rationale is that companies operating in river basins with higher number of endemic fish species are exposed to higher reputational risks.

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) transpose the values in polygon shapefile to the HydroBASINS level 7 using the majority value; 2) classify it into the 5 risk score classes, following the raw data's authors classification, as in the table below.

Water Risk Filter Risk Scores	Thresholds
1 – Very Low Risk	x = 0
2 – Low Risk	0 < x <= 5
3 – Moderate Risk	5 < x <= 10
4 – High Risk	10 < x <= 25
5 – Very High Risk	x > 25

10.2. Freshwater Biodiversity Richness

This risk indicator is based on the Freshwater Ecoregions of the World (FEOW) 2015 data[33] developed by WWF and TNC, and the count of fish species is used as a representation of freshwater biodiversity richness. The rationale is that companies operating in river basins with higher number of fish species are exposed to higher reputational risks.

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) transpose the values in polygon shapefile to the HydroBASINS level 7 using the majority value; 2) classify it into the 5 risk score classes, following the raw data's authors classification, as in the table below.

Water Risk Filter Risk Scores	Thresholds
1 – Very Low Risk	0 < x <= 20
2 – Low Risk	20 < x <= 40
3 – Moderate Risk	40 < x <= 70
4 – High Risk	70 < x <= 150
5 – Very High Risk	x > 150

[32] WWF & TNC (2015). Freshwater Ecoregions of the World. http://www.feow.org/
[33] WWF & TNC (2015). Freshwater Ecoregions of the World. http://www.feow.org/

Risk Category 11. Media Scrutiny

Media scrutiny indicates how aware stakeholders and local communities typically are about water-related issues due to national and international media coverage. Businesses can potentially face reputational risk when operating in countries with high media coverage.

The Water Risk Filter risk category media scrutiny is informed by two indicators developed by WWF and Tecnoma: one representing national coverage, and one representing international (global) coverage.

11.1. National Media Coverage

This risk indicator is 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 national media coverage. The status of the river basin (e.g., water scarcity and pollution) is taken into account, as well as the importance of water for livelihoods (e.g., food and shelter).

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) transpose the values from list of countries to the country boundaries; 2) classify it into the 5 risk score classes, following the thresholds in the table below.

Water Risk Filter Risk Scores	Thresholds
1 – Very Low Risk	None
2 – Low Risk	> 1 per year
3 – Moderate Risk	> 1 per 6 months
4 – High Risk	> 1 per month
5 – Very High Risk	> 1 per week

11.2. Global Media Coverage

This risk indicator is based on joint qualitative research by WWF and Tecnoma (Typsa Group). It indicates how aware people are of water-related issues due to global media coverage. Familiarity to and media coverage of the region and regional water-related disasters are taken into account.

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) transpose the values from list of countries to the country boundaries; 2) classify it into the 5 risk score classes, following the thresholds in the table below.

Water Risk Filter Risk Scores	Thresholds
1 – Very Low Risk	None
2 – Low Risk	> 1 per year
3 – Moderate Risk	> 1 per 6 months
4 – High Risk	> 1 per month
5 – Very High Risk	> 1 per week

Risk Category 12. Conflict

Conflict indicates whether there has been documented negative news (e.g. incidents, criticism and controversies) that can affect a company's reputational risk as well as historical political conflicts due to competition over limited water resources.

The Water Risk Filter risk category is informed by two indicators: RepRisk's country weighted score of negative news; and an index of hydro-political issues magnitude.

12.1. Conflict News Events

This risk indicator is based on 2021 data collected by RepRisk[34] on counts and registers of documented negative incidents, criticism and controversies that can affect a company's reputational risk. These negative news events are labelled per country and industry class.

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) transpose the values (sum of all sectors and impacts' weighted score) from list of countries to the country boundaries; 2) classify it into the 5 risk score classes, following the thresholds in the table below.

Water Risk Filter Risk Scores	Thresholds
1 – Very Low Risk	x <= 33
2 – Low Risk	33 < x <= 102
3 – Moderate Risk	102 < x <= 364
4 – High Risk	364 < x <= 3200
5 – Very High Risk	x > 3200

12.2. Hydro-political Likelihood

This risk indicator is based on the assessment of hydro-political risk[35]. 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.

To produce the Water Risk Filter indicator the raw data was processed as follow: 1) aggregate the raster data to the HydroBASINS level 7 using the area-weighted average value; 2) classify it into the 5 risk score classes, following the thresholds in the table below.

Water Risk Filter Risk Scores	Hydro-political Risk Scores
1 – Very Low Risk	x <= 0.15
2 – Low Risk	0.15 < x <= 0.3
3 – Moderate Risk	0.3 < x <= 0.4
4 – High Risk	0.4 < x <= 0.5
5 – Very High Risk	x > 0.5

[34] RepRisk & WWF (2021). Due diligence database on ESG and business conduct risks. RepRisk. https://www.reprisk.com/

[35] Farinosi, F., Giupponi, C., Reynaud, A., Ceccherini, G., Carmona-Moreno, C., De Roo, A., ... & Bidoglio, G. (2018). An innovative approach to the assessment of hydro-political risk: A spatially explicit, data driven indicator of hydro-political issues. Global environmental change, 52, 286-313. https://doi.org/10.1016/j.gloenvcha.2018.07.001

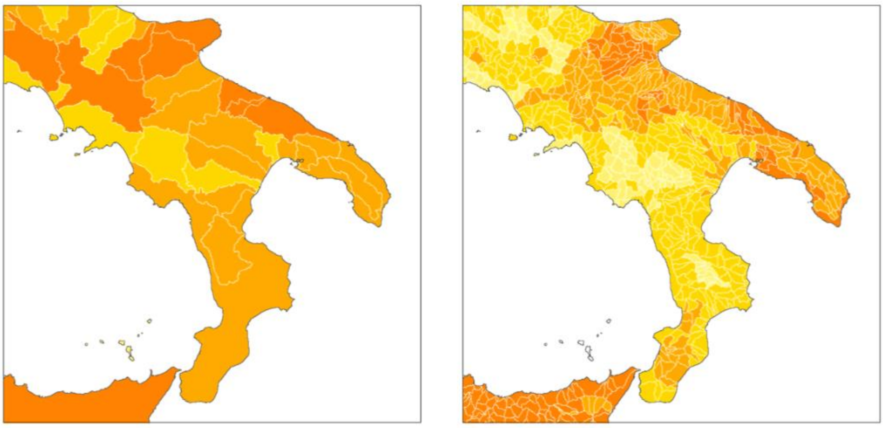
1.2. Region and Country datasets

Even though the Water Risk Filter global dataset is based on the best available data, WWF acknowledges that more detailed assessments can provide better results, as local scale data often represent a more realistic overview of the water related concerns that might impact companies' operations. Also, higher resolution assessments will lead to more specific mitigation strategies, resulting in better performances from the companies and for the environment. Therefore, the Water Risk Filter has developed and integrated higher resolutions datasets to provide local indicators and to enable risk assessment at a finer scale for:

- Regions: Europe, Greater Mekong
- Countries: Brazil, Chile, Colombia, Great Britain, Hungary, South Africa, Spain

The risk assessment framework and weighting structure remain the same as for the global, but, where possible, it draws on more appropriate datasets, which are either: 1) spatially more disaggregated; 2) temporally more recent and/or likely to be updated; 3) scientifically more accurate (e.g. new methodologies); 4) politically more acceptable (e.g. from regional/national authorities). For more information, please refer to the local datasets' descriptions, sources and links in the website https://waterriskfilter.org/explore/dataandmethods.

The spatial resolution used for the local datasets is the HydroSHEDS HydroBasins Level 12, instead of the level 7 used in the global dataset. Figure below illustrates this difference in spatial resolution.



Global scale
HydroBASINS Level 7
(Basins of approx. 1,500 km^2)

Local scale
HydroBASINS Level 12
(Basins of approx. 135 km^2)

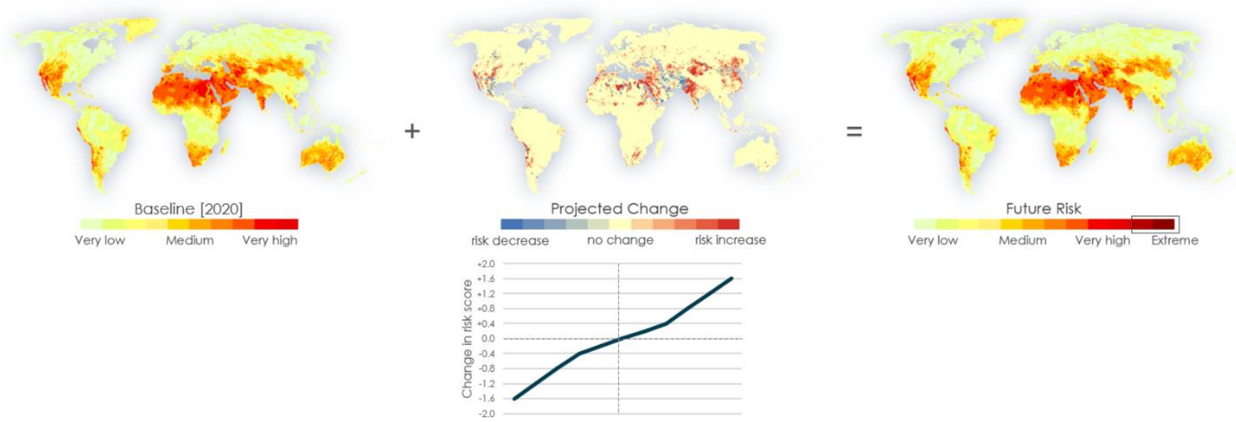
Since the local datasets use different indicators, it is important to note that water risk assessments using any local dataset will not be directly comparable with assessments using the global dataset or any other local datasets. Therefore, the Water Risk Filter will only allow to use region or country datasets when assessing a company or group with all sites located entirely within a specific region or country and for which the Water Risk Filter has a local dataset available.

For businesses and investors with a large number of operations, suppliers or assets both across the world and in countries with high resolution data available, the online tool allows users to group sites or assets (e.g. by country or region) in order to conduct independent assessments (e.g. each group of sites assessed with the most relevant dataset: local or global datasets).

1.3. Scenarios of Water Risk

The Water Risk Filter scenarios dataset builds on the framework of the tool's current basin risk assessment, but integrates 2030 and 2050 quantitative projections of water risks. In line with the Task Force on Climate-related Financial Disclosure (TCFD)[36] recommendations, the scenarios dataset is based on a combination of the most relevant climate scenarios (IPCC CMIP5 Representative Concentration Pathways – RCP)[37] and socio-economic scenarios (IIASA Shared Socioeconomic Pathways – SSP)[38]. More specifically, the risk scores of the year 2020 (baseline) are added with projected changes based on climate impact ensemble projections that account for climate (e.g., temperature, precipitation, wind) and socio-economic variables (e.g., population, GDP, technological developments), and represent the consequences and effects of climate and socio-economic changes on water resources. Accordingly, the pathways for the Water Risk Filter scenarios follow the respective narratives described in table 4.

Similar to the basin risk indicators of current risk, each of the raw datasets of projected change are also spatially aggregated to a common scale of river basins (HydroSHEDS HydroBASINS level 7) and have values normalized, but in this case to range from -1.6 (risk decrease) to +1.6 (risk increase), with zero being equal to no change. Normalized values of risk changes, under the various scenarios, were then added to the baseline (year 2020) scores to generate the future risk scores. Therefore, some regions of the world which have very high risk in the baseline and are projected to have increased risk can have future risk scores beyond 5.0, which is then considered as extreme risk (i.e., whereas current risk has five classes, future risk has six). The image below illustrates the process.



This process was performed for 10 risk categories independently (see Table 5), therefore, risk scores can also be aggregated to the risk types physical, regulatory, and reputational, as well as to the overall risk, by applying the same industry-specific weightings as in the current risk (see Appendix 1). More

[36] TCFD (2017). The Use of Scenario Analysis in Disclosure of Climate-Related Risks and Opportunities. Technical Supplement. https://assets.bbhub.io/company/sites/60/2020/10/FINAL-TCFD-Technical-Supplement-062917.pdf

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

[38] Riahi, K., Van Vuuren, D. P., Kriegler, E., Edmonds, J., O'neill, B. C., Fujimori, S., ... & Tavoni, M. (2017). The Shared Socioeconomic Pathways and their energy, land use, and greenhouse gas emissions implications: An overview. Global environmental change, 42, 153-168 . Database available at https://iiasa.ac.at/web/home/research/researchPrograms/Energy/SSP_Scenario_Database.html

specific details of pre-processing and thresholds used for each risk category are described below. Note, however, that scenarios data is not available at the risk indicators level due to data availability.

Table 4. Overview of the narratives of the Water Risk Filter Scenarios pathways.

	Optimistic	Current trend	Pessimistic
Climate aspects [39]	Moderate emissions RCP2.6 / RCP4.5	Intermediate emissions RCP4.5 / RCP6.0	High emissions RCP6.0 / RCP8.5
	• Moderate mitigation measures so that GHG emissions are halved by 2050	• Intermediate mitigation measures so that GHG emissions peak around mid-century, then start declining	• Business-as-usual so that GHG emissions continue to rise throughout the 21st century
	• Increase of global mean surface temperature is not likely to exceed 2ºC by the end of the 21st century	• Increase of global mean surface temperature is likely to exceed 2ºC by the end of the 21st century	• Increase of global mean surface temperature is likely to exceed 4ºC by the end of the 21st century
Socio-economic aspects, [40] extended towards water availability and use [41]	Sustainability SSP1	Middle of the road SSP2	Regional rivalry SSP3
	• Emphasis on human and nature well-being	• Current social and economic trends continue	• Emphasis on national issues due to regional conflicts and nationalism
	• Effective and persistent cooperation and collaboration across the local, national, regional international scales and between public organizations, private sector and civil society within and across all scales of governance	• Relatively weak coordination and cooperation among national and international institutions, the private sector, and civil society for achieving sustainable development goals	• Societies are becoming more skeptical about globalization. Global governance, institutions and leadership are relatively weak
	• Rapid technological change	• Technological progress but no major breakthroughs	• Low investment in technology development
	• Improved resource efficiency	• Modest decline in resource use intensity	• Increase in resource use intensity
	• Sustainability concerns; more stringent environmental regulation implemented	• Moderate awareness of the environmental consequences of choices when using natural resources. Environmental systems experience degradation	• Environmental policies have very little importance. Serious degradation of environmental systems in some regions
	• Research and technology development reduce the challenges of access to safe water and improved sanitation	• Access to safe water and improved sanitation in low-income countries makes unsteady progress	• Growing population and limited access to safe water and improved sanitation challenge human and natural systems

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

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

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

The Water Risk Filter Scenarios is a result of collaboration between WWF and multiple research groups with expertise in each of the specific aspects of water risk. Table 5 lists the projected change data (i.e. ensemble projections) used and respective sources.

Table 5. Overview of the ensemble projections used in the Water Risk Filter Scenarios.

Risk type	Risk category	Ensemble Projection	Source
Physical Risk	1 - Water Scarcity	Water Scarcity Water Scarcity	IIASA Water Program Water Scarcity Atlas
	2 - Flooding	Return period of 100-year flood discharge	The University of Tokyo
	3 - Water Quality	N, P and BOD loading	IFPRI (CGIAR)
	4 - Ecosystem Services Status	Environmental Flow Future Hydropower Reservoirs and Dams	NIES Japan Global Dam Watch
Regulatory Risk	5 - Enabling Environment	Extended narratives towards water availability Hydro-Economic classification (Water Scarcity & GDP)	IIASA Water Program IIASA Water Program & IIASA World Population Program
	6 - Institutions & Governance		
	7 - Management Instruments		
	8 - Infrastructure & Finance		
Reputational Risk	9 - Cultural Importance	Not available	-
	10 - Biodiversity Importance	Amphibians species richness	SBiK-F
	11 - Media Scrutiny	Not available	-
	12 - Conflict	Hydro-political issues	EC JRC

Risk Category 1. Water Scarcity (Scenarios)

The scenarios are derived from the Water Risk Filter water scarcity risk in the year 2020 (baseline), added with projected changes (i.e. percentage point change in water scarcity). In this case, using the average of the normalized risk change from the two sources as described below.

To produce the normalized projected change values from the International Institute for Applied Systems Analysis (IIASA)[42] the raw data was processed as follow: 1) compute the change (Change = [Scenario] – [Reference period]) based on ensemble projections (see table A); 2) aggregate the raster

[42] Greve, P., Kahil, T., Mochizuki, J., Schinko, T., Satoh, Y., Burek, P., ... & Wada, Y. (2018). Global assessment of water challenges under uncertainty in water scarcity projections. Nature Sustainability, 1(9), 486-494. https://doi.org/10.1038/s41893-018-0134-9

data to the HydroBASINS level 7 using the area-weighted average value; 3) classify it into the 11 risk change classes, as in table B.

Table A. Data used as reference period and scenarios.

Scenario	Ensemble Projection
Reference period	Multi-Model median centered at 2010, under RCP6.0 and SSP2
Optimistic 2030	Multi-Model median centered at 2030, under RCP4.5 and SSP1
Current trend 2030	Multi-Model median centered at 2030, under RCP6.0 and SSP2
Pessimistic 2030	Multi-Model median centered at 2030, under RCP6.0 and SSP3
Optimistic 2050	Multi-Model median centered at 2050, under RCP4.5 and SSP1
Current trend 2050	Multi-Model median centered at 2050, under RCP6.0 and SSP2
Pessimistic 2050	Multi-Model median centered at 2050, under RCP6.0 and SSP3

Table B. Risk change classes and thresholds.

Water Risk Filter Risk Change	Thresholds
-1.6 (risk decrease)	x <= -0.40
-1.2	-0.40 < x <= -0.20
-0.8	-0.20 < x <= -0.10
-0.4	-0.10 < x <= -0.05
-0.2	-0.05 < x <= -0.02
0 (no change)	-0.02 < x <= 0.02
+0.2	0.02 < x <= 0.05
+0.4	0.05 < x <= 0.10
+0.8	0.10 < x <= 0.20
+1.2	0.20 < x <= 0.40
+1.6 (risk increase)	x > 0.40

To produce the normalized projected change values from Water Scarcity Atlas' futures tool[43] the raw data was processed as follow: 1) compute the change (Change = [Scenario] – [Reference period]) based on ensemble projections (see table C); 2) transpose the values in polygon shapefile to the HydroBASINS level 7 using the max value; 3) classify it into the 11 risk change classes, as in table B.

Table C. Data used as reference period and scenarios.

Scenario	Ensemble Projection
Reference period	Multi-Model median centered at 2011, under RCP6.0 and SSP2
Optimistic 2030	Multi-Model median centered at 2021, under RCP4.5 and SSP1
Current trend 2030	Multi-Model median centered at 2021, under RCP6.0 and SSP2
Pessimistic 2030	Multi-Model median centered at 2021, under RCP6.0 and SSP3
Optimistic 2050	Multi-Model median centered at 2041, under RCP4.5 and SSP1
Current trend 2050	Multi-Model median centered at 2041, under RCP6.0 and SSP2
Pessimistic 2050	Multi-Model median centered at 2041, under RCP6.0 and SSP3

[43] Kummu, M., Fader, M., Gerten, D., Guillaume, J. H., Jalava, M., Jägermeyr, J., ... & Varis, O. (2017). Bringing it all together: linking measures to secure nations' food supply. Current opinion in environmental sustainability, 29, 98-117. https://doi.org/10.1016/j.cosust.2018.01.006

Risk Category 2. Flooding (Scenarios)

The scenarios are derived from the Water Risk Filter flooding risk in the year 2020 (baseline), added with projected changes (i.e. return period of 100-year flood discharge)[44].

To produce the normalized projected change values the raw data was processed as follow: 1) compile projected change data based on ensemble projections (see table A); 2) aggregate the raster data to the HydroBASINS level 7 using the area-weighted average value; 3) classify it into the 11 risk change classes, as in table B.

Table A. Data used as reference period and scenarios.

Scenario	Ensemble Projection
Reference period	Historical data (1971-2000)
Optimistic 2030	Multi-Model mean centered at 2030, under RCP2.6
Current trend 2030	Multi-Model mean centered at 2030, under RCP4.5
Pessimistic 2030	Multi-Model mean centered at 2030, under RCP8.5
Optimistic 2050	Multi-Model mean centered at 2050, under RCP2.6
Current trend 2050	Multi-Model mean centered at 2050, under RCP4.5
Pessimistic 2050	Multi-Model mean centered at 2050, under RCP8.5

Table B. Risk change classes and thresholds.

Water Risk Filter Risk Change	Thresholds
-1.6 (risk decrease)	x > 1000
-1.2	500 < x <= 1000
-0.8	250 < x <= 500
-0.4	125 < x <= 250
-0.2	105 < x <= 125
0 (no change)	95 < x <= 105
+0.2	75 < x <= 95
+0.4	50 < x <= 75
+0.8	25 < x <= 50
+1.2	10 < x <= 25
+1.6 (risk increase)	x <= 10

Risk Category 3. Water Quality (Scenarios)

The scenarios are derived from the Water Risk Filter water quality risk in the year 2020 (baseline), added with projected changes (i.e. changes in N, P, and BOD loading as ton/km^2 year)[45].

[44] Hirabayashi, Y., Mahendran, R., Koirala, S., Konoshima, L., Yamazaki, D., Watanabe, S., ... & Kanae, S. (2013). Global flood risk under climate change. Nature Climate Change, 3(9), 816-821. http://dx.doi.org/10.1038/nclimate1911

[45] Xie, H., & Ringler, C. (2017). Agricultural nutrient loadings to the freshwater environment: the role of climate change and socioeconomic change. Environmental Research Letters, 12(10), 104008. https://doi.org//10.1088/1748-9326/aa8148

To produce the normalized projected change values the raw data was processed as follow: 1) compute the change (Change = [Scenario] – [Reference period]) based on ensemble projections (see table A); 2) aggregate the raster data to the HydroBASINS level 7 using the area-weighted average value; 3) classify it into the 11 risk change classes, as in table B (for N and BOD) and in table C (for P).

Table A. Data used as reference period and scenarios.

Scenario	Ensemble Projection
Reference period	Estimation for the year 2000, based on historical data
Optimistic 2030	Model median centered at 2030, under MIROC A1B Optimistic
Current trend 2030	Model median centered at 2030, under MIROC A1B Medium
Pessimistic 2030	Model median centered at 2030, under MIROC A1B Pessimistic
Optimistic 2050	Model median centered at 2050, under MIROC A1B Optimistic
Current trend 2050	Model median centered at 2050, under MIROC A1B Medium
Pessimistic 2050	Model median centered at 2050, under MIROC A1B Pessimistic

Table B. Risk change classes and thresholds.

Water Risk Filter Risk Change	Thresholds
-1.6 (risk decrease)	x <= -5
-1.2	-5 < x <= -2
-0.8	-2 < x <= -1
-0.4	-1 < x <= -0.5
-0.2	-0.5 < x <= -0.2
0 (no change)	-0.2 < x <= 0.2
+0.2	0.2 < x <= 0.5
+0.4	0.5 < x <= 1
+0.8	1 < x <= 2
+1.2	2 < x <= 5
+1.6 (risk increase)	x > 5

Table C. Risk change classes and thresholds.

Water Risk Filter Risk Change	Thresholds
-1.6 (risk decrease)	x <= -0.4
-1.2	-0.4 < x <= -0.2
-0.8	-0.2 < x <= -0.1
-0.4	-0.1 < x <= -0.05
-0.2	-0.05 < x <= -0.02
0 (no change)	-0.02 < x <= 0.02
+0.2	0.02 < x <= 0.05
+0.4	0.05 < x <= 0.1
+0.8	0.1 < x <= 0.2
+1.2	0.2 < x <= 0.4
+1.6 (risk increase)	x > 0.4

Risk Category 4. Ecosystem Services Status (Scenarios)

The scenarios are derived from the Water Risk Filter ecosystem services status risk in the year 2020 (baseline), added with projected changes (i.e. percentage change in environmental flow, and density of dams in free-flowing rivers). In this case, stacking the normalized risk change from the two sources as described below.

To produce the normalized projected change environmental flow values[46] the raw data was processed as follow: 1) compute the change (Change = [Scenario] – [Reference period]) based on ensemble projections (see table A); 2) aggregate the raster data to the HydroBASINS level 7 using the area-weighted average value; 3) classify it into the 11 risk change classes, as in table B.

Table A. Data used as reference period and scenarios.

Scenario	Ensemble Projection
Reference period	Multi-Model mean centered at 2000
Optimistic 2030	Multi-Model mean centered at 2030, under RCP2.6
Current trend 2030	Multi-Model mean centered at 2030, under RCP6.0
Pessimistic 2030	Multi-Model mean centered at 2030, under RCP8.5
Optimistic 2050	Multi-Model mean centered at 2050, under RCP2.6
Current trend 2050	Multi-Model mean centered at 2050, under RCP6.0
Pessimistic 2050	Multi-Model mean centered at 2050, under RCP8.5

Table B. Risk change classes and thresholds.

Water Risk Filter Risk Change	Thresholds
-1.6 (risk decrease)	x > 0.80
-1.2	0.60 < x <= 0.80
-0.8	0.40 < x <= 0.60
-0.4	0.20 < x <= 0.40
-0.2	0.05 < x <= 0.20
0 (no change)	-0.05 < x <= 0.05
+0.2	-0.20 < x <= -0.05
+0.4	-0.40 < x <= -0.20
+0.8	-0.60 < x <= -0.40
+1.2	-0.80 < x <= -0.60
+1.6 (risk increase)	x <= -0.80

To produce the normalized values of projected density of dams in free-flowing rivers two datasets were processed as follow: 1) compute the length of free-flowing rivers[47] (RIV_ORD <= 6 & CSI_FF2 = 1)

[46] Hanasaki, N., Kanae, S., Oki, T., Masuda, K., Motoya, K., Shirakawa, N., ... & Tanaka, K. (2008). An integrated model for the assessment of global water resources--Part 1: Model description and input meteorological forcing. Hydrology & Earth System Sciences, 12(4). https://doi.org/10.5194/hess-12-1007-2008

[47] Grill, G., Lehner, B., Thieme, M., Geenen, B., Tickner, D., Antonelli, F., ... & Macedo, H. E. (2019). Mapping the world's free-flowing rivers. Nature, 569(7755), 215. https://figshare.com/articles/Mapping_the_world_s_free-flowing_rivers_data_set_and_technical_documentation/7688801

in each HydroBASINS level 4; 2) compute the number of dams under construction and planned[48], separately, in each HydroBASINS level 4; 3) calculate the density of dams per 100km of free-flowing rivers, based on the assumptions as in table C; 4) classify it into the 6 risk change classes, as in table D.

Table C. Assumptions for density of dams in free-flowing rivers.

Scenario	Assumption
Optimistic 2030	Only dams of status 'under construction' ended-up operating and therefore negatively impacting connectivity of free-flowing rivers
Current trend 2030	Only dams of status 'under construction' ended-up operating and therefore negatively impacting connectivity of free-flowing rivers
Pessimistic 2030	Only dams of status 'under construction' ended-up operating and therefore negatively impacting connectivity of free-flowing rivers
Optimistic 2050	Only dams of status 'under construction' ended-up operating and therefore negatively impacting connectivity of free-flowing rivers
Current trend 2050	Dams of both status 'under construction' and 'planned' ended-up operating and therefore negatively impacting connectivity of free-flowing rivers
Pessimistic 2050	Dams of both status 'under construction' and 'planned' ended-up operating and therefore negatively impacting connectivity of free-flowing rivers

Table D. Risk change classes and thresholds.

Water Risk Filter Risk Change	Thresholds
0 (no change)	x = 0
+0.2	0 < x <= 0.1
+0.4	0.1 < x <= 0.2
+0.8	0.2 < x <= 0.5
+1.2	0.5 < x <= 1
+1.6 (risk increase)	x > 1

Regulatory Risk Categories (Scenarios)

The scenarios are derived from the Water Risk Filter regulatory risk catories (5. Enabling Environment; 6. Institutions & Governance; 7. Management Instruments; and 8. Infrastructure & Finance) in the year 2020 (baseline), added with assumptions (i.e. change in risk, individually for each risk category) based on the work from International Institute for Applied Systems Analysis (IIASA) Water program: the hydro-economic classification[49], and on the Shared Socioeconomic Pathways' extended narratives towards water availability[50].

[48] Zarfl, C., Lumsdon, A. E., Berlekamp, J., Tydecks, L., & Tockner, K. (2015). A global boom in hydropower dam construction. Aquatic Sciences, 77(1), 161-170. https://doi.org/10.1007/s00027-014-0377-0
[49] Fischer, G., Hizsnyik, E., Tramberend, S., & Wiberg, D. (2015). Towards indicators for water security-A global hydro-economic classification of water challenges. http://pure.iiasa.ac.at/id/eprint/11676/
[50] Wada, Y., Flörke, M., Hanasaki, N., Eisner, S., Fischer, G., Tramberend, S., ... & Burek, P. (2016). Modeling global water use for the 21st century: The Water Futures and Solutions (WFaS) initiative and its approaches. Geoscientific Model Development, 9(1), 175-222. https://doi.org/10.5194/gmd-9-175-2016

The hydro-economic classification was used because it is a way to account that both climate and socio-economic changes are expected to be uneven around the world – and that they will pose different challenges. This system classifies the world in a two-dimensional space, as in figure below, where: **H** is the hydrological complexity, i.e. magnitude of challenges to satisfy water use requirements, using projections of water scarcity[51]; and **E** is the economic-institutional coping capacity, e.g. determined by economic strength and institutions, using projections of GDP per capita[52] as proxy (see thresholds in table A). Note that such simplification is needed to overcome the challenge that not all socio-economic variables are available as spatially explicity projection data.

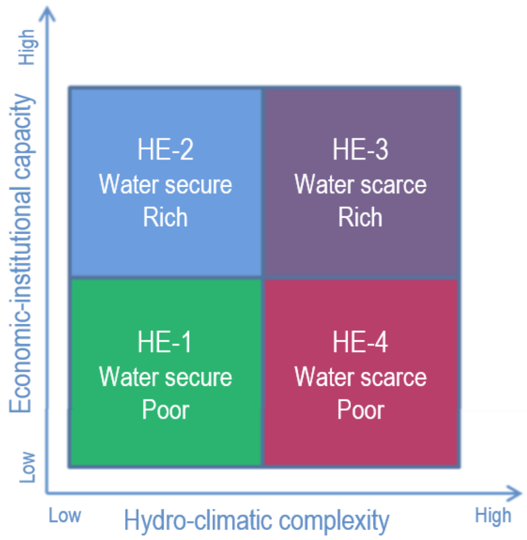
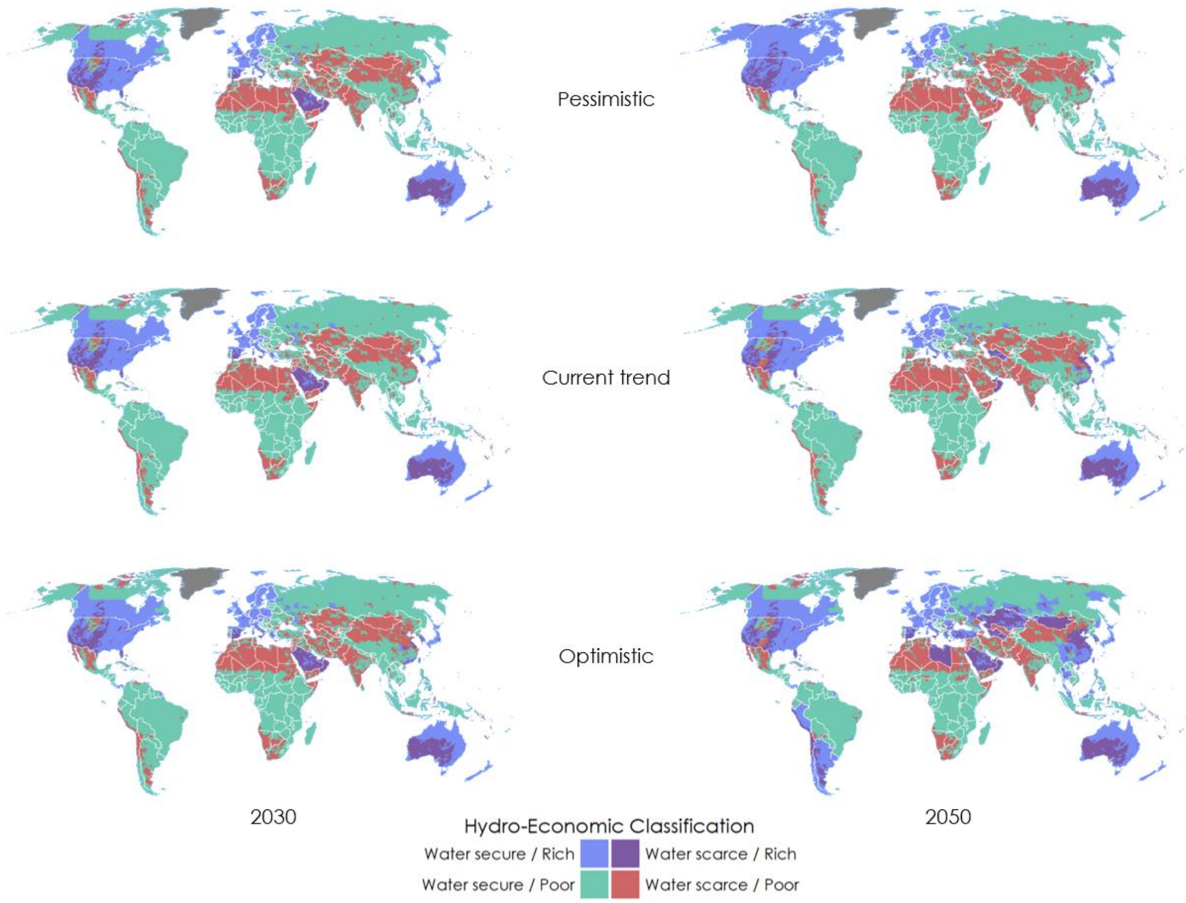


Table A. Hydro-Economic (HE) regions and thresholds.

HE Region	Thresholds for 2030	Thresholds for 2050
HE-1	H <= 0.2 and E < 30	H <= 0.2 and E < 40
HE-2	H <= 0.2 and E >= 30	H <= 0.2 and E >= 40
HE-3	H > 0.2 and E >= 30	H > 0.2 and E >= 40
HE-4	H > 0.2 and E < 30	H > 0.2 and E < 40

[51] Greve, P., Kahil, T., Mochizuki, J., Schinko, T., Satoh, Y., Burek, P., … & Wada, Y. (2018). Global assessment of water challenges under uncertainty in water scarcity projections. Nature Sustainability, 1(9), 486-494. https://doi.org/10.1038/s41893-018-0134-9
[52] Riahi, K., Van Vuuren, D. P., Kriegler, E., Edmonds, J., O'neill, B. C., Fujimori, S., … & Tavoni, M. (2017). The Shared Socioeconomic Pathways and their energy, land use, and greenhouse gas emissions implications: An overview. Global environmental change, 42, 153-168 . Database available at https://iiasa.ac.at/web/home/research/researchPrograms/Energy/SSP_Scenario_Database.html



Subsequently, a set of assumptions (Table B) are made for the regulatory risk categories in each of the Hydro-Economic (HE) regions. The assumptions are based on the Shared Socioeconomic Pathways' extended narratives towards water availability (see table D with selected narratives relevant for regulatory risk categories – see Wada et al. 2016 for full narratives), and considering that the risk categories slightly differ in terms of which factor(s) primarily drive(s) changes, thus the assumptions:

Factor E: Changes primarily due to economic conditions.

Limited access to investment in the poor regions HE-1 and HE- 4 is a major barrier for the implementation of environmental-friendly technologies. Whereas, the rich regions HE-2 and HE-3 have the economic and institutional potential to invest in and to transfer to state-of-the-art technologies.

Factor H: Changes primarily due to hydro-climatic conditions.

The difficult hydro-climatic conditions in HE- 4 force even poor regions to spend some of their limited available capital for implementing new technologies, leading to better progress in technological change compared to also poor regions in HE-1, where water is abundant. Similar situation occurs in water scarce regions HE-3, the urgency to implement water-saving technologies results in stronger decreases of water use intensities driven by technological improvements compared to HE-2, which would also have the means to implement new technologies but lack the incentive due to sufficient water resources.

Table B. Scenario assumptions for regulatory risk categories.

		Optimistic				Current trend				Pessimistic			
Risk category	Factor	HE-1 Water secure Poor	HE-2 Water secure Rich	HE-3 Water scarce Rich	HE-4 Water scarce Poor	HE-1 Water secure Poor	HE-2 Water secure Rich	HE-3 Water scarce Rich	HE-4 Water scarce Poor	HE-1 Water secure Poor	HE-2 Water secure Rich	HE-3 Water scarce Rich	HE-4 Water scarce Poor
5. Enabling Environment	E/H	↘	=	↘	↘	↗	↗	=	↗	↑	↗	=	↑
6. Institutions & Governance	E/H	↘	=	↘	↘	↗	↗	=	↗	↑	↑	↘	↑
7. Management Instruments	E	↘	↘	↘	↘	↗	=	=	↗	↑	↘	↘	↑
8. Infrastructure & Finance	E	↘	↘	↘	↘	↗	↘	↘	↗	↑	↘	↓	↑

↓ Risk is assumed to decrease strongly
↘ Risk is assumed to decrease
= Risk is assumed to maintain
↗ Risk is assumed to increase
↑ Risk is assumed to increase strongly

These assumptions are then translated into risk score changes as in table C.

Table C. Risk change assumptions and risk score change.

Water Risk Filter Risk Change Assumptions	Risk Change by 2030	Risk Change by 2050
↓ Risk is assumed to decrease strongly	-0.6	-1.6
↘ Risk is assumed to decrease	-0.3	-0.8
= Risk is assumed to maintain	0 (no change)	0 (no change)
↗ Risk is assumed to increase	+0.3	+0.8
↑ Risk is assumed to increase strongly	+0.6	+1.6

Table D. Selected narratives relevant for regulatory risk categories.

	Optimistic (SSP1 Sustainability)	**Current trend** (SSP2 Middle of the road)	**Pessimistic** (SSP3 Regional rivalry)
5. Enabling Environment	"Policies shift to optimize resource use efficiency associated with urbanizing lifestyles." Global standards dominate. Regions HE-1, HE-3 and HE-4 implement more stringent environmental regulations. Region HE-2 already had stringent regulations and because water is abundant, they have no motivation to change.	"Weak environmental regulation and enforcement trigger only slow technological progress in water use efficiencies." Regions HE-1, HE-2 and HE-4 decline in the enabling environment because poor regions prioritize production and/or because water is abundant, thus it is not a priority issue. In HE-3, policy and laws continue with current trends and are thus maintained.	"Environmental policies have very little importance." Regions HE-1 and HE-4 decline heavily in the enabling environment because poor regions prioritize production. HE-2 also degrades because water is not a priority, but due to additional resources, the degradation is not as severe. Region HE-3 faces water scarcity and see the need to implement more stringent regulations. While their good economic condition makes changes possible, political interference results that risk maintains.
6. Institutions & Governance	"Effective institutions. Effective and persistent cooperation and collaboration across the local, national, regional and international scales and between public organizations, the private sector and civil society within and across all scales of governance." Global institutions support developing countries. Regions HE-1 and HE-4 improve their institutions and governance. Region HE-2 and HE-3 already had good institutions and governance, but in HE-2 because water is abundant, they have no motivation to change.	"Moderate corruption slows effectiveness of development policies. Relatively weak coordination and cooperation among national and international institutions, the private sector, and civil society for addressing environmental concerns." Regions HE-1, HE-2 and HE-4 experiences deterioration in their institutions and governance because corruption prevails in poor regions and/or because water is abundant, thus it is not a priority issue.	"Global governance and institutions are weak. Weak cooperation among organizations and institutions. Rational management of cross-country watersheds is hampered by regional rivalry and conflicts over cross- country shared water resource increase." Regions HE-1, HE-2 and HE-4 experiences deterioration in their institutions and governance because corruption prevails in poor regions and/or because water is abundant, thus it is not a priority issue. Region HE-3 faces water scarcity and see the need to improve their institutions and governance. Their good economic condition allows investments.
7. Management Instruments	"More stringent environmental regulation implemented." Global institutions support developing countries. All four HE regions improve management instruments.	"Weak environmental regulation and enforcement trigger only slow technological progress in water use efficiencies." Poor regions (regions HE-1 and HE-4) have limited financial resources to enforce regulations and to monitor. Rich regions (regions HE-2 and HE-3) follow historical trends and management instruments maintain.	"Weak environmental regulation and enforcement hamper technological progress in water use efficiencies." Poor regions (regions HE-1 and HE-4) have limited financial resources to enforce regulations and to monitor. Rich regions (regions HE-2 and HE-3) can afford improvements.
8. Infrastructure & Finance	"Industrialized countries support developing countries in their development goals by providing access to human and financial resources and new technologies." All four HE regions improve access to infrastructure and finance.	"Growing population and intensity of resource aggravates degradation of water resources. Access to health care, safe water, and sanitation services are affected by population growth and heterogeneities within countries." Poor regions (regions HE-1 and HE-4) have limited financial resources to invest in infrastructure. As population grows, access to infrastructure diminishes. Rich regions (regions HE-2 and HE-3) can afford improvements.	"National rivalries between the countries slow down the progress towards development goals and increase competition for natural resources." Poor regions (regions HE-1 and HE-4) have limited financial resources to invest in infrastructure. As population grows fast, access to infrastructure diminishes dramatically. Rich regions (regions HE-2 and HE-3) can afford improvements but more funds are placed into water scarce regions (HE-3) than in water abundant regions.

Risk Category 10. Biodiversity Importance (Scenarios)

The scenarios are derived from the Water Risk Filter biodiversity importance risk in the year 2020 (baseline), added with projected changes (i.e. percentage change in amphibians species richness)[53].

To produce the normalized projected change values the raw data was processed as follow: 1) compute the change (Change = [Scenario] – [Reference period]) based on ensemble projections (see table A); 2) aggregate the raster data to the HydroBASINS level 7 using the area-weighted average value; 3) classify it into the 11 risk change classes, as in table B.

Table A. Data used as reference period and scenarios.

Scenario	Ensemble Projection
Reference period	Multi-Model mean, based on historical data (1980–2009)
Optimistic 2030	Multi-Model mean centered at 2030, under RCP2.6
Current trend 2030	Multi-Model mean centered at 2030, under RCP6.0
Pessimistic 2030	Multi-Model mean centered at 2030, under RCP6.0
Optimistic 2050	Multi-Model mean centered at 2050, under RCP2.6
Current trend 2050	Multi-Model mean centered at 2050, under RCP6.0
Pessimistic 2050	Multi-Model mean centered at 2050, under RCP6.0

Table B. Risk change classes and thresholds.

Water Risk Filter Risk Change	Thresholds
-1.6 (risk decrease)	x > 80
-1.2	60 < x <= 80
-0.8	40 < x <= 60
-0.4	20 < x <= 40
-0.2	5 < x <= 20
0 (no change)	-5 < x <= 5
+0.2	-20 < x <= -5
+0.4	-40 < x <= -20
+0.8	-60 < x <= -40
+1.2	-80 < x <= -60
+1.6 (risk increase)	x <= -80

[53] Biber, M. F., Voskamp, A., Niamir, A., Hickler, T., & Hof, C. (2020). A comparison of macroecological and stacked species distribution models to predict future global terrestrial vertebrate richness. Journal of Biogeography, 47(1), 114-129. https://doi.org/10.1111/jbi.13696

Risk Category 12. Conflict (Scenarios)

The scenarios are derived from the Water Risk Filter biodiversity importance risk in the year 2020 (baseline), added with projected changes (i.e. change in likelihood of hydro-political issues)[54].

To produce the normalized projected change values the raw data was processed as follow: 1) compute the change (Change = [Scenario] – [Reference period]) based on ensemble projections (see table A); 2) aggregate the raster data to the HydroBASINS level 7 using the area-weighted average value; 3) classify it into the 11 risk change classes, as in table B.

Table A. Data used as reference period and scenarios.

Scenario	Ensemble Projection
Reference period	Model mean, based on historical data (1997–2012)
Optimistic 2030	Multi-Model mean centered at 2030, under RCP4.5
Current trend 2030	Multi-Model mean centered at 2030, under RCP4.5
Pessimistic 2030	Multi-Model mean centered at 2030, under RCP8.5
Optimistic 2050	Multi-Model mean centered at 2050, under RCP4.5
Current trend 2050	Multi-Model mean centered at 2050, under RCP4.5
Pessimistic 2050	Multi-Model mean centered at 2050, under RCP8.5

Table B. Risk change classes and thresholds.

Water Risk Filter Risk Change	Thresholds
-1.6 (risk decrease)	x <= -0.40
-1.2	-0.40 < x <= -0.30
-0.8	-0.30 < x <= -0.20
-0.4	-0.20 < x <= -0.10
-0.2	-0.10 < x <= -0.05
0 (no change)	-0.05 < x <= 0.05
+0.2	0.05 < x <= 0.10
+0.4	0.10 < x <= 0.20
+0.8	0.20 < x <= 0.30
+1.2	0.30 < x <= 0.40
+1.6 (risk increase)	x > 0.40

[54] Farinosi, F., Giupponi, C., Reynaud, A., Ceccherini, G., Carmona-Moreno, C., De Roo, A., ... & Bidoglio, G. (2018). An innovative approach to the assessment of hydro-political risk: A spatially explicit, data driven indicator of hydro-political issues. Global Environmental Change, 52, 286-313. https://doi.org/10.1016/j.gloenvcha.2018.07.001

2.0. Operational Risk Assessment

The framework of the operational risk assessment is aligned to of the basin risk assessment, and also follows a three-level hierarchy: 1) risk indicator, 2) risk category, 3) risk type, and the aggregation of those three levels together is referred as the Overall Operational Risk.

A site's operational-related risk exposure is based on its proprietary characteristics as a water user. Operational water risk is assessed by filling in the Water Risk Filter Operational Risk Questionnaire, which is to be completed at site level. The questionnaire was developed through an iterative stakeholder consultation process in order to capture the most important aspects of operational water risk.

Users can choose to conduct a rapid or full assessment for each site entered. All answers to the questionnaire can be completed directly online or offline using a Microsoft Excel sheet, and the answers to the questionnaire can be saved and uploaded for a single or multiple sites:

- In 'Assess Operational Risk' tab, users can complete online the questionnaire for a selected site
- In 'Manage Sites and Portfolio' tab, users can perform an upload of operational data for one or multiple sites using the offline Microsoft Excel sheet. With the offline Microsoft Excel sheet, an user can send the excel to others (e.g. site managers) who can then enter the information directly in the excel and send it back so that the user can compile all operational data from multiple sites to perform a bulk upload.

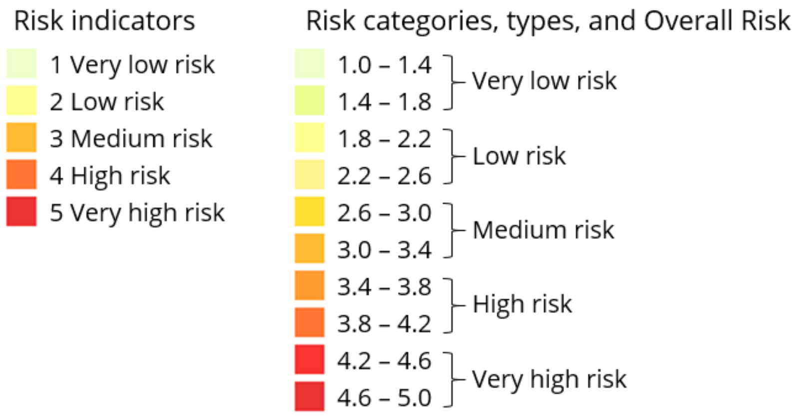
2.1. Operational Risk Questionnaire

The detailed assessment questionnaire contains 22 questions (i.e. indicators), whereas the rapid assessment questionnaire consists of only 10 questions, both covering all three risk types: Physical, Regulatory and Reputational. However, the operational risk section does not have complete coverage of all of the basin risk categories. Under Physical Risk it is restricted to Water Scarcity and Water Quality, under Regulatory Risk it is restricted to Enabling Environment and Institutions & Governance, and under Reputational Risk it is restricted to Media Scrutiny and Conflict.

In addition, the detailed assessment contains some additional operational questions (i.e., non-risk indicator questions) which do not influence the risk scores but can help better assess operational risks (e.g. source of water withdrawal and discharge) and prioritize across a portfolio of sites/assets by exploring issues of materiality (e.g. production volume and value).

While the short version questionnaire will provide a rapid operational risk assessment, the higher the quality of input data, the better quality the assessment output will be. Therefore, users are encouraged to complete the full version questionnaire for more comprehensive operational risk assessment results.

The operational risk assessment is based on the same aggregation principles and risk score classification as the basin risk assessment. For each question in the operational questionnaire users have five possible answers, each of them representing a risk score (1-to-5 value). The risk scores from the operational questions can be aggregated into the 6 Operational Risk Categories, which in turn can be aggregated into the 3 risk types: Physical, Regulatory and Reputational. Finally, the aggregation of the risk types makes the Overall Operational Risk score.



Similar to the basin risk assessment, each operational risk indicator, risk category and risk type have industry-specific weightings. The Water Risk Filter contains default industry-specific weightings for a total of 25 industry categories (see Appendix 2 for detailed information on the default weightings for each industry). The default industry-specific weightings are based on multiple stakeholder consultations and peer reviews with experts from different NGOs, academics, financial institutions and businesses. The weightings are also informed by sector trends from CDP Water Security data.

The specific indicators in the operational risk section were developed and selected in two phases. In the first phase (2012-2017), the indicators were established based on multiple stakeholder consultations and peer reviews with experts from different NGOs, academics, financial institutions and businesses. Between 2018 to present, some adjustments were made to the indicators based on a combination of alignment to the 2018 CDP Water Security Questionnaire, as well as feedback from corporate users and WWF experience in working with users over the years.

Previously the Water Risk Filter contained an additional 15 operational response questions. These questions did not influence the operational risk scores but were included to estimate a site's water stewardship maturity level, in order to tailor the set of recommended response actions in the Respond section. As the Respond section in is currently in redevelopment, the 15 operational response questions have been removed from the questionnaire and are under review.

Table 4. Three-level hierarchy of the operational risk assessment framework: risk type, category and indicator.

Risk type	Risk category	Short version	Risk indicator
Physical Risk	1 - Water Scarcity	Yes	O1 - Form of water consumption
		Yes	O2 - Importance of water in operations
			O3 - Historical issues with shared water challenges
			O4 - Total water withdrawn (approximate)
			O4a - Specific water withdrawal
			O4b - Fresh surface water withdrawal
			O4c - Brackish surface water withdrawal
			O4d - Groundwater withdrawal
			O4e - Seawater / ocean water withdrawal
			O4f - Produced / processed water withdrawal
			O4g - Third-party water withdrawal
			O5 - Total water discharged (approximate)
			O5a - Specific water discharge
			O5b - Discharge to fresh surface water
			O5c - Discharge to brackish water
			O5d - Discharge to groundwater
			O5e - Discharge to seawater/ocean water
			O5f - Discharge to long term storage
			O5g - Discharge to third-party
			O6 - Water-intensive energy source dependence
	3 - Water Quality		O7 - Total wastewater discharged into environment
			O7a - Amount of Nitrogen discharged
			O7b - Amount of Phosphorus discharged
		Yes	O8 - Treatment requirements - before use
		Yes	O9 - Treatment requirements - prior to discharge
			O10 - Toxic chemicals used or stored on site
		Yes	O11 - Ability to impact downstream water quality
Regulatory Risk	5 - Enabling Environment	Yes	O12 - Regulatory scrutiny facing site
			O13 - Planned regulatory changes
	6 - Institutions & governance	Yes	O14 - Quality standards compliance
			O15 - Historical penalties or fines
			O15a - Amount of fines/penalties
			O16 - Presence and participation in basin stakeholder water user platform
Reputational Risk	11 - Media Scrutiny		O17 - Local media exposure
			O18 - Global media exposure
	12 - Conflict	Yes	O19 - Relative water use of site within basin (User/Polluter)
		Yes	O20 - Local brand recognition
		Yes	O21 - Water stewardship maturity
			O22 - Involvement in water disputes with others
Other			O23 - Annual production volume
			O24 - Production unit
			O25 - Approximate production value
			O25a - Specific production value
			O26 - Currency
			O27- Number of employees
			O28 - Comments

3.0. Water Risk Assessments Results

In the Analyse Risk tab within the WRF online tool's Assess section, users can analyse both current and future water risks for a company, group or an individual site using various visualization types (i.e., maps, graphs and tables). All risk scores can be downloaded in excel format for further details and offline analysis.

Whilst risk assessment results are available at a site level, the WWF Water Risk Filter is designed to be used as a corporate and portfolio-level screening and prioritization tool. By analysing water risks for all sites within a selected company or group of interest (e.g. value chain component, business unit or geography), companies and investors will be able to prioritize on what and where it matters the most to mitigate water risk for enhancing business resilience and contributing to a sustainable future. Furthermore, WWF recommends assessing water risks across a company's value chain and for this reason provides default options to group sites according to Supply Chain Management (SCM) classification.

A comprehensive overall water risk assessment result is obtained when both basin and operational risk assessments have been fully conducted. However, results can be obtained by only conducting a basin risk assessment and through all stages of completion of the operational risk assessment. For companies or investors with a large portfolio of sites, we recognize that gathering operational data may be challenging. Therefore, WWF recommends to start by identifying high priority sites from a business materiality lens (e.g high production volume and value) with high water dependence (e.g. high water withdrawal) and facing high basin risk in order to focus data gathering efforts for these identified high priority sites.

For a step-by-step process on how to conduct a water risk assessment and analyse water risks, please check the [Water Risk Filter Tutorial](). To receive tailored expert support for water risk assessments and recommendations on water stewardship strategy and contextual water targets, contact the WWF Water Risk Filter Team at waterriskfilter@wwf.de

B. Respond Section

The Respond section in the WRF online tool is currently under redevelopment. WWF will inform all registered users via email when it will be the case of its re-launch.

The Respond section will aim to provide corporate-level recommendations to help address identified water risks for selected companies and groups of interest. This section is being developed out of WWF's experience of working with companies with the objective to guide users in identifying contextually-appropriate response actions which in turn will help inform their water stewardship strategies and contextual water targets.

For expert support from WWF on developing and implementing water stewardship strategies and contextual water targets, please contact the WWF Water Risk Filter Team at waterriskfilter@wwf.de

C. APPENDIX 1. Weightings in the Basin Risk Assessment

Table 1. Weightings for each basin risk indicator (not industry-specific).

Risk type	Risk category	Risk indicator	Weightings
Physical Risk	1 - Water Scarcity	1.0 – Aridity Index	0%
		1.1 - Water Depletion	20%
		1.2 - Baseline Water Stress	20%
		1.3 - Blue Water Scarcity	10%
		1.4 - Available Water Remaining (AWARE)	20%
		1.5 - Drought Frequency Probability	20%
		1.6 - Projected Change in Drought Occurrence	10%
	2 - Flooding	2.1 - Estimated Flood Occurrence	95%
		2.2 - Projected Change in Flood Occurrence	5%
	3 - Water Quality	3.1 - Surface Water Quality Index	100%
	4 - Ecosystem Services Status	4.1 - Fragmentation Status of Rivers	70%
		4.2 - Catchment Ecosystem Services Degradation Level	25%
		4.3 - Projected Impacts on Freshwater Biodiversity	5%
Regulatory Risk	5 - Enabling Environment	5.1 - Freshwater Policy Status (SDG 6.5.1)	35%
		5.2 - Freshwater Law Status (SDG 6.5.1)	55%
		5.3 - Implementation Status of Water Management Plans (SDG 6.5.1)	10%
	6 - Institutions & Governance	6.1 - Corruption Perceptions Index	50%
		6.2 - Freedom in the World Index	25%
		6.3 - Private Sector Participation in Water Management (SDG 6.5.1)	25%
	7 - Management Instruments	7.1 - Management Instruments for Water Management (SDG 6.5.1)	70%
		7.2 - Groundwater Monitoring Data Availability and Management	15%
		7.3 - Density of Runoff Monitoring Stations	15%
	8 - Infrastructure & Finance	8.1 - Access to Safe Drinking Water	45%
		8.2 - Access to Sanitation	45%
		8.3 - Financing for Water Resource Development and Management (SDG 6.5.1)	10%
Reputational Risk	9 - Cultural Importance	9.1 - Cultural Diversity	100%
	10 - Biodiversity Importance	10.1 - Freshwater Endemism	50%
		10.2 – Freshwater Biodiversity Richness	50%
	11 - Media Scrutiny	11.1 – National Media Coverage	55%
		11.2 – Global Media Coverage	45%
	12 - Conflict	12.1 - Conflict News Events	50%
		12.3 - Hydro-political Likelihood	50%

Table 2. Industry-specific weightings in the basin risk assessment.

		Risk type	Risk category				Risk type	Risk category				Risk type	Risk category			
#	Industry	Physical Risk	1. Water Scarcity	2. Flooding	3. Water Quality	4. Ecosystem Services Status	Regulatory Risk	5. Enabling Environment	6. Institutions & Governance	7. Management Instruments	8 - Infrastructure & Finance	Reputational Risk	9. Cultural Importance	10. Biodiversity Importance	11. Media Scrutiny	12. Conflict
1	Agriculture (animal products)	75%	55%	15%	20%	10%	20%	30%	30%	25%	15%	5%	20%	10%	50%	20%
2	Agriculture (plant products)	70%	70%	10%	5%	15%	20%	30%	30%	25%	15%	10%	20%	10%	50%	20%
3	Appliances & General Goods Manufacturing	60%	35%	25%	20%	20%	20%	30%	30%	25%	15%	20%	20%	10%	50%	20%
4	Automotive, Electrical Equipment & Machinery Production	65%	40%	20%	30%	10%	15%	30%	30%	25%	15%	20%	20%	10%	40%	30%
5	Chemicals & Other Materials Production	60%	35%	20%	30%	15%	15%	30%	30%	25%	15%	25%	10%	10%	40%	40%
6	Construction Materials	55%	55%	25%	5%	15%	20%	30%	30%	25%	15%	25%	20%	10%	50%	20%
7	Electric Energy Production - Geothermal or Combustion (Biomass, Coal, Gas, Nuclear, Oil)	60%	65%	10%	15%	10%	20%	30%	30%	25%	15%	20%	15%	10%	40%	35%
8	Electric Energy Production - Hydropower	65%	50%	25%	10%	15%	20%	30%	30%	25%	15%	15%	20%	10%	30%	40%
9	Electric Energy Production - Solar, Wind	35%	55%	20%	5%	20%	35%	30%	30%	25%	15%	30%	10%	20%	30%	50%
10	Electronics & Semiconductor Manufacturing	65%	45%	15%	30%	10%	15%	30%	30%	25%	15%	20%	20%	10%	40%	30%
11	Fishing and aquaculture	50%	45%	5%	30%	20%	30%	30%	30%	25%	15%	20%	20%	10%	30%	40%
12	Food & Beverage Production	70%	70%	10%	15%	5%	10%	30%	30%	25%	15%	20%	10%	5%	40%	45%
13	Food Retailing	40%	50%	20%	20%	10%	25%	30%	30%	25%	15%	35%	10%	10%	50%	30%
14	General or Speciality Retailing	45%	50%	20%	20%	10%	20%	30%	30%	25%	15%	35%	15%	10%	55%	20%
15	Health Care, Pharmaceuticals and Biotechnology	65%	40%	20%	25%	15%	25%	30%	30%	25%	15%	10%	30%	10%	50%	10%
16	Hospitality Services	55%	30%	25%	20%	25%	15%	30%	30%	25%	15%	30%	20%	10%	40%	30%
17	Land development & Construction	60%	49%	20%	17%	14%	20%	30%	30%	25%	15%	20%	16%	11%	43%	30%
18	Metals & Mining	70%	60%	25%	5%	10%	5%	30%	30%	25%	15%	25%	5%	15%	40%	40%
19	Oil, Gas & Consumable Fuels	70%	65%	20%	5%	10%	5%	30%	30%	25%	15%	25%	5%	15%	40%	40%
20	Offices & professional services (e.g., Consulting, Software, Real Estate, Financial Institutions)	40%	35%	35%	15%	15%	40%	30%	30%	25%	15%	20%	15%	5%	60%	20%
21	Paper & Forest Product Production	70%	55%	10%	20%	15%	10%	30%	30%	25%	15%	20%	10%	10%	45%	35%
22	Textiles, Apparel & Luxury Good Production	65%	50%	15%	20%	15%	15%	30%	30%	25%	15%	20%	20%	10%	50%	20%
23	Transportation Services	65%	40%	35%	5%	20%	20%	30%	30%	25%	15%	15%	20%	10%	40%	30%
24	Water utilities / Water Service Providers	70%	40%	20%	25%	15%	25%	30%	30%	25%	15%	5%	20%	15%	40%	25%
25	Telecommunication services (including wireless)	50%	50%	25%	10%	15%	30%	30%	30%	25%	15%	20%	20%	10%	40%	30%
26	Other (cross-sector average)	60%	49%	20%	17%	14%	20%	30%	30%	25%	15%	20%	16%	11%	43%	30%

D. APPENDIX 2. Weightings in the Operational Risk Assessment

Table 1. Industry-specific weightings for each operational risk indicator for full version questionnaire.

Risk type	Risk category	Short version	Risk indicator	Weightings
Physical Risk	Water Scarcity	Yes	O1 - Form of water consumption	10%
		Yes	O2 - Importance of water in operations	15%
			O3 - Historical issues with shared water challenges	20%
			O4 - Total water withdrawn (approximate)	25%
			O5 - Total water discharged (approximate)	25%
			O6 - Water-intensive energy source dependence	5%
	Water Quality		O7 - Total wastewater discharged into environment	10%
		Yes	O8 - Treatment requirements - before use	30%
		Yes	O9 - Treatment requirements - prior to discharge	25%
			O10 - Toxic chemicals used or stored on site	15%
		Yes	O11 - Ability to impact downstream water quality	20%
Regulatory Risk	Enabling Environment	Yes	O12 - Regulatory scrutiny facing site	30%
			O13 - Planned regulatory changes	70%
	Institutions & Governance	Yes	O14 - Quality standards compliance	50%
			O15 - Historical penalties or fines	20%
			O16 - Presence and participation in basin stakeholder water user platform	30%
Reputational Risk	Media Scrutiny		O17 - Local media exposure	70%
			O18 - Global media exposure	30%
	Conflict	Yes	O19 - Relative water use of site within basin (User/Polluter)	30%
		Yes	O20 - Local brand recognition	30%
		Yes	O21 - Water stewardship maturity	15%
			O22 - Involvement in water disputes with others	25%

Table 2. Industry-specific weightings for the full version questionnaire.

		Risk type	Risk category		Risk type	Risk category		Risk type	Risk category	
#	Industry	Physical Risk	Water Scarcity	Water Quality	Regulatory Risk	Enabling Environment	Institutions & Governance	Reputational Risk	Media Scrutiny	Conflict
1	Agriculture (animal products)	75%	73%	27%	20%	50%	50%	5%	35%	65%
2	Agriculture (plant products)	60%	93%	7%	25%	50%	50%	15%	35%	65%
3	Appliances & General Goods Manufacturing	60%	64%	36%	20%	50%	50%	20%	35%	65%
4	Automotive, Electrical Equipment & Machinery Production	65%	57%	43%	15%	50%	50%	20%	35%	65%
5	Chemicals & Other Materials Production	60%	54%	46%	15%	50%	50%	25%	35%	65%
6	Construction Materials	50%	92%	8%	20%	50%	50%	30%	35%	65%
7	Electric Energy Production - Geothermal or Combustion (Biomass, Coal, Gas, Nuclear, Oil)	60%	81%	19%	20%	50%	50%	20%	35%	65%
8	Electric Energy Production - Hydropower	65%	83%	17%	20%	50%	50%	15%	35%	65%
9	Electric Energy Production - Solar, Wind	35%	92%	8%	35%	50%	50%	30%	35%	65%
10	Electronics & Semiconductor Manufacturing	65%	60%	40%	15%	50%	50%	20%	35%	65%
11	Fishing and aquaculture	50%	60%	40%	30%	50%	50%	20%	35%	65%
12	Food & Beverage Production	70%	82%	18%	10%	50%	50%	20%	35%	65%
13	Food Retailing	40%	71%	29%	25%	50%	50%	35%	35%	65%
14	General or Speciality Retailing	45%	71%	29%	20%	50%	50%	35%	35%	65%
15	Health Care, Pharmaceuticals and Biotechnology	65%	62%	38%	25%	50%	50%	10%	35%	65%
16	Hospitality Services	55%	60%	40%	15%	50%	50%	30%	35%	65%
17	Land development & Construction	50%	60%	40%	15%	50%	50%	35%	35%	65%
18	Metals & Mining	65%	92%	8%	5%	50%	50%	30%	35%	65%
19	Oil, Gas & Consumable Fuels	65%	93%	7%	5%	50%	50%	30%	35%	65%
20	Offices & professional services (e.g., Consulting, Software, Real Estate, Financial Institutions)	40%	70%	30%	40%	50%	50%	20%	35%	65%
21	Paper & Forest Product Production	65%	73%	27%	15%	50%	50%	20%	35%	65%
22	Textiles, Apparel & Luxury Good Production	55%	71%	29%	30%	50%	50%	15%	35%	65%
23	Transportation Services	65%	89%	11%	20%	50%	50%	15%	35%	65%
24	Water utilities / Water Service Providers	70%	62%	38%	25%	50%	50%	5%	35%	65%
25	Telecommunication services (including wireless)	50%	90%	10%	30%	50%	50%	20%	35%	65%
26	Other (cross-sector average)	50%	60%	40%	15%	50%	50%	35%	35%	65%

Table 3. Industry-specific weightings for operational risk indicators for short version questionnaire.

Risk type	Risk category	Short version	Risk indicator	Weightings
Physical Risk	Water Scarcity	Yes	O1 - Form of water consumption	45%
		Yes	O2 - Importance of water in operations	55%
	Water Quality	Yes	O8 - Treatment requirements - before use	40%
		Yes	O9 - Treatment requirements - prior to discharge	30%
		Yes	O11 - Ability to impact downstream water quality	30%
Regulatory Risk	Enabling Environment	Yes	O12 - Regulatory scrutiny facing facility	100%
	Institutions & Governance	Yes	O14 - Quality standards compliance	100%
Reputational Risk	Conflict	Yes	O19 - Relative water use of site within basin (User/Polluter)	40%
		Yes	O20 - Local brand recognition	40%
		Yes	O21 - Water stewardship maturity	20%

Table 4. Industry-specific weightings for short version questionnaire.

		Risk type	Risk category		Risk type	Risk category		Risk type	Risk category	
#	Industry	Physical Risk	Water Scarcity	Water Quality	Regulatory Risk	Enabling Environment	Institutions & Governance	Reputational Risk	Media Scrutiny	Conflict
1	Agriculture (animal products)	75%	73%	27%	20%	50%	50%	5%	0%	100%
2	Agriculture (plant products)	60%	93%	7%	25%	50%	50%	15%	0%	100%
3	Appliances & General Goods Manufacturing	60%	64%	36%	20%	50%	50%	20%	0%	100%
4	Automotive, Electrical Equipment & Machinery Production	65%	57%	43%	15%	50%	50%	20%	0%	100%
5	Chemicals & Other Materials Production	60%	54%	46%	15%	50%	50%	25%	0%	100%
6	Construction Materials	50%	92%	8%	20%	50%	50%	30%	0%	100%
7	Electric Energy Production - Geothermal or Combustion (Biomass, Coal, Gas, Nuclear, Oil)	60%	81%	19%	20%	50%	50%	20%	0%	100%
8	Electric Energy Production - Hydropower	65%	83%	17%	20%	50%	50%	15%	0%	100%
9	Electric Energy Production - Solar, Wind	35%	92%	8%	35%	50%	50%	30%	0%	100%
10	Electronics & Semiconductor Manufacturing	65%	60%	40%	15%	50%	50%	20%	0%	100%
11	Fishing and aquaculture	50%	60%	40%	30%	50%	50%	20%	0%	100%
12	Food & Beverage Production	70%	82%	18%	10%	50%	50%	20%	0%	100%
13	Food Retailing	40%	71%	29%	25%	50%	50%	35%	0%	100%
14	General or Speciality Retailing	45%	71%	29%	20%	50%	50%	35%	0%	100%
15	Health Care, Pharmaceuticals and Biotechnology	65%	62%	38%	25%	50%	50%	10%	0%	100%
16	Hospitality Services	55%	60%	40%	15%	50%	50%	30%	0%	100%
17	Land development & Construction	50%	60%	40%	15%	50%	50%	35%	0%	100%
18	Metals & Mining	65%	92%	8%	5%	50%	50%	30%	0%	100%
19	Oil, Gas & Consumable Fuels	65%	93%	7%	5%	50%	50%	30%	0%	100%
20	Offices & professional services (e.g., Consulting, Software, Real Estate, Financial Institutions)	40%	70%	30%	40%	50%	50%	20%	0%	100%
21	Paper & Forest Product Production	65%	73%	27%	15%	50%	50%	20%	0%	100%
22	Textiles, Apparel & Luxury Good Production	55%	71%	29%	30%	50%	50%	15%	0%	100%
23	Transportation Services	65%	89%	11%	20%	50%	50%	15%	0%	100%
24	Water utilities / Water Service Providers	70%	62%	38%	25%	50%	50%	5%	0%	100%
25	Telecommunication services (including wireless)	50%	90%	10%	30%	50%	50%	20%	0%	100%
26	Other (cross-sector average)	50%	60%	40%	15%	50%	50%	35%	0%	100%