Water Indicators

Indicator	Value	Description	Source
Overall Basin Risk (score)	3.54	Overall Basin Risk (score)	
Overall Basin Risk (rank)	2	Overall Basin Risk (rank)	
Physical risk (score)	3.41	Physical risk (score)	
Physical risk (rank)	7	Physical risk (rank)	
Regulatory risk (score)	2.85	Regulatory risk (score)	
Regulatory risk (rank)	97	Regulatory risk (rank)	
Reputation risk (score)	4.61	Reputation risk (score)	
Reputation risk (rank)	1	Reputation risk (rank)	
1. Quantity - Scarcity (score)	3.14	1. Quantity - Scarcity (score)	
1. Quantity - Scarcity (rank)	37	1. Quantity - Scarcity (rank)	
2. Quantity - Flooding (score)	4.14	2. Quantity - Flooding (score)	
2. Quantity - Flooding (rank)	20	2. Quantity - Flooding (rank)	
3. Quality (score)	3.66	3. Quality (score)	
3. Quality (rank)	44	3. Quality (rank)	
4. Ecosystem Service Status (score)	3.04	4. Ecosystem Service Status (score)	
4. Ecosystem Service Status (rank)	50	4. Ecosystem Service Status (rank)	
5. Enabling Environment (Policy & Laws) (score)	3.00	5. Enabling Environment (Policy & Laws) (score)	
5. Enabling Environment (Policy & Laws) (rank)	54	5. Enabling Environment (Policy & Laws) (rank)	
6. Institutions and Governance (score)	2.50	6. Institutions and Governance (score)	
6. Institutions and Governance (rank)	130	6. Institutions and Governance (rank)	
7. Management Instruments (score)	2.71	7. Management Instruments (score)	
7. Management Instruments (rank)	107	7. Management Instruments (rank)	
8 - Infrastructure & Finance (score)	3.45	8 - Infrastructure & Finance (score)	
8 - Infrastructure & Finance (rank)	52	8 - Infrastructure & Finance (rank)	
9. Cultural Diversity (score)	5.00	9. Cultural importance (score)	
9. Cultural Diversity (rank)	1	9. Cultural importance (rank)	
10. Biodiversity Importance (score)	3.23	10. Biodiversity importance (score)	

Indicator	Value	Description	Source
10. Biodiversity Importance (rank)	112	10. Biodiversity importance (rank)	
11. Media Scrutiny (score)	5.00	11. Media Scrutiny (score)	
11. Media Scrutiny (rank)	1	11. Media Scrutiny (rank)	
12. Conflict (score)	4.34	12. Conflict (score)	
12. Conflict (rank)	1	12. Conflict (rank)	
1.0 - Aridity (score)	2.09	The aridity risk indicator is based on the Global Aridity Index (Global-Aridity) and Global Potential Evapo-Transpiration (Global-PET) Geospatial data sets by Trabucco and Zomer (2009). These data sets provide information about the potential availability of water in regions with low water demand, thus they are used in the Water Risk Filter 5.0 to better account for deserts and other arid areas in the risk assessment.	Trabucco, A., & Zomer, R. J. (2009). Global potential evapo-transpiration (Global-PET) and global aridity index (Global-Aridity) geo-database. CGIAR consortium for spatial information.
1.0 - Aridity (rank)	58	The aridity risk indicator is based on the Global Aridity Index (Global-Aridity) and Global Potential Evapo-Transpiration (Global-PET) Geospatial data sets by Trabucco and Zomer (2009). These data sets provide information about the potential availability of water in regions with low water demand, thus they are used in the Water Risk Filter 5.0 to better account for deserts and other arid areas in the risk assessment.	Trabucco, A., & Zomer, R. J. (2009). Global potential evapo-transpiration (Global-PET) and global aridity index (Global-Aridity) geo-database. CGIAR consortium for spatial information.
1.1 - Water Depletion (score)	3.38	The water depletion risk indicator is based on annual average monthly net water depletion from Brauman et al. (2016). Their analysis is based on model outputs from the newest version of the integrated water resources model WaterGAP3 which measures water depletion as the ratio of water consumption-to-availability.	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.
1.1 - Water Depletion (rank)	21	The water depletion risk indicator is based on annual average monthly net water depletion from Brauman et al. (2016). Their analysis is based on model outputs from the newest version of the integrated water resources model WaterGAP3 which measures water depletion as the ratio of water consumption-to-availability.	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.
1.2 - Baseline Water Stress (score)	3.62	World Resources Institute's Baseline Water Stress measures the ratio of total annual water withdrawals to total available annual renewable supply, accounting for upstream consumptive use. A higher percentage indicates more competition among users.	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.

Indicator	Value	Description	Source
1.2 - Baseline Water Stress (rank)	35	World Resources Institute’s Baseline Water Stress measures the ratio of total annual water withdrawals to total available annual renewable supply, accounting for upstream consumptive use. A higher percentage indicates more competition among users.	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.
1.3 - Blue Water Scarcity (score)	3.88	The blue water scarcity risk indicator is based on Mekonnen and Hoekstra (2016) global assessment of blue water scarcity on a monthly basis and at high spatial resolution (grid cells of 30 × 30 arc min resolution). Blue water scarcity is calculated as the ratio of the blue water footprint in a grid cell to the total blue water availability in the cell. The time period analyzed in this study ranges from 1996 to 2005.	Mekonnen, M. M., & Hoekstra, A. Y. (2016). Four billion people facing severe water scarcity. Science advances, 2(2), e1500323.
1.3 - Blue Water Scarcity (rank)	42	The blue water scarcity risk indicator is based on Mekonnen and Hoekstra (2016) global assessment of blue water scarcity on a monthly basis and at high spatial resolution (grid cells of 30 × 30 arc min resolution). Blue water scarcity is calculated as the ratio of the blue water footprint in a grid cell to the total blue water availability in the cell. The time period analyzed in this study ranges from 1996 to 2005.	Mekonnen, M. M., & Hoekstra, A. Y. (2016). Four billion people facing severe water scarcity. Science advances, 2(2), e1500323.
1.4 - Projected Change in Water Discharge (by ~2050) (score)	1.09	This risk indicator is based on multi-model simulation that applies both global climate and hydrological models from the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP). To estimate the change at 2°C of global warming above 1980-2010 levels, simulated annual water discharge was averaged over a 31-year period with 2°C mean warming. Results are expressed in terms of relative change (%) in probability between present day (1980-2010) conditions and 2°C scenarios by 2050.	Schewe, J., Heinke, J., Gerten, D., Haddeland, I., Arnell, N. W., Clark, D. B., ... & Gosling, S. N. (2014). Multimodel assessment of water scarcity under climate change. Proceedings of the National Academy of Sciences, 111(9), 3245-3250.
1.4 - Projected Change in Water Discharge (by ~2050) (rank)	154	This risk indicator is based on multi-model simulation that applies both global climate and hydrological models from the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP). To estimate the change at 2°C of global warming above 1980-2010 levels, simulated annual water discharge was averaged over a 31-year period with 2°C mean warming. Results are expressed in terms of relative change (%) in probability between present day (1980-2010) conditions and 2°C scenarios by 2050.	Schewe, J., Heinke, J., Gerten, D., Haddeland, I., Arnell, N. W., Clark, D. B., ... & Gosling, S. N. (2014). Multimodel assessment of water scarcity under climate change. Proceedings of the National Academy of Sciences, 111(9), 3245-3250.

Indicator	Value	Description	Source
1.5 - Drought Frequency Probability (score)	2.75	This risk indicator is based on the Standardized Precipitation and Evaporation Index (SPEI). Vicente-Serrano et al. (2010) developed this 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. The mathematical calculations used for SPEI are similar to the Standard Precipitation Index (SPI), but it has the advantage to include the role of evapotranspiration.	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.
1.5 - Drought Frequency Probability (rank)	81	This risk indicator is based on the Standardized Precipitation and Evaporation Index (SPEI). Vicente-Serrano et al. (2010) developed this 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. The mathematical calculations used for SPEI are similar to the Standard Precipitation Index (SPI), but it has the advantage to include the role of evapotranspiration.	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.
1.6 - Projected Change in Drought Occurrence (by ~2050) (score)	2.97	This risk indicator is based on multi-model simulation that applies both global climate and drought models from the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP) . A drought threshold for pre-industrial conditions was calculated based on time-series averages. Results are expressed in terms of relative change (%) in probability between pre-industrial and 2°C scenarios.	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.
1.6 - Projected Change in Drought Occurrence (by ~2050) (rank)	163	This risk indicator is based on multi-model simulation that applies both global climate and drought models from the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP) . A drought threshold for pre-industrial conditions was calculated based on time-series averages. Results are expressed in terms of relative change (%) in probability between pre-industrial and 2°C scenarios.	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.
2.1 - Estimated Flood Occurrence (score)	4.23	This risk indicator is based on the recurrence of floods within the 34-year time frame period of 1985 to 2019. The occurrence of floods within a given location was estimated using data from Flood Observatory, University of Colorado. The Flood Observatory use data derived from a wide variety of news, governmental, instrumental, and remote sensing source.	Brakenridge, G. R. (2019). Global active archive of large flood events. Dartmouth Flood Observatory, University of Colorado.
2.1 - Estimated Flood Occurrence (rank)	20	This risk indicator is based on the recurrence of floods within the 34-year time frame period of 1985 to 2019. The occurrence of floods within a given location was estimated using data from Flood Observatory, University of Colorado. The Flood Observatory use data derived from a wide variety of news, governmental, instrumental, and remote sensing source.	Brakenridge, G. R. (2019). Global active archive of large flood events. Dartmouth Flood Observatory, University of Colorado.

Indicator	Value	Description	Source
2.2 - Projected Change in Flood Occurrence (by ~2050) (score)	2.52	This risk indicator is based on multi-model simulation that applies both global climate and drought models from the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP). The magnitude of the flood event was defined based on 100-year return period for pre-industrial conditions. Results are expressed in terms of change (%) in probability between pre-industrial and 2°C scenarios.	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.
2.2 - Projected Change in Flood Occurrence (by ~2050) (rank)	78	This risk indicator is based on multi-model simulation that applies both global climate and drought models from the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP). The magnitude of the flood event was defined based on 100-year return period for pre-industrial conditions. Results are expressed in terms of change (%) in probability between pre-industrial and 2°C scenarios.	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.
3.1 - Surface Water Contamination Index (score)	3.66	The underlying data for this risk indicator is based on a broad suite of pollutants with well-documented direct or indirect negative effects on water security for both humans and freshwater biodiversity, compiled by Vörösmarty et al. (2010). The negative effects are specific to individual pollutants, ranging from impacts mediated by eutrophication such as algal blooms and oxygen depletion (e.g., caused by phosphorus and organic loading) to direct toxic effects (e.g., caused by pesticides, mercury). The overall Surface Water Contamination Index is calculated based on a range of key pollutants with different weightings according to the level of their negative effects on water security for both humans and freshwater biodiversity: soil salinization (8%), nitrogen (12%) and phosphorus (P, 13%) loading, mercury deposition (5%), pesticide loading (10%), sediment loading (17%), organic loading (as Biological Oxygen Demand, BOD; 15%), potential acidification (9%), and thermal alteration (11%).	Vörösmarty, C. J., McIntyre, P. B., Gessner, M. O., Dudgeon, D., Prusevich, A., Green, P., ... & Davies, P. M. (2010). Global threats to human water security and river biodiversity. Nature, 467(7315), 555.

Indicator	Value	Description	Source
3.1 - Surface Water Contamination Index (rank)	44	The underlying data for this risk indicator is based on a broad suite of pollutants with well-documented direct or indirect negative effects on water security for both humans and freshwater biodiversity, compiled by Vörösmarty et al. (2010). The negative effects are specific to individual pollutants, ranging from impacts mediated by eutrophication such as algal blooms and oxygen depletion (e.g., caused by phosphorus and organic loading) to direct toxic effects (e.g., caused by pesticides, mercury). The overall Surface Water Contamination Index is calculated based on a range of key pollutants with different weightings according to the level of their negative effects on water security for both humans and freshwater biodiversity: soil salinization (8%), nitrogen (12%) and phosphorus (P, 13%) loading, mercury deposition (5%), pesticide loading (10%), sediment loading (17%), organic loading (as Biological Oxygen Demand, BOD; 15%), potential acidification (9%), and thermal alteration (11%).	Vörösmarty, C. J., McIntyre, P. B., Gessner, M. O., Dudgeon, D., Prusevich, A., Green, P., ... & Davies, P. M. (2010). Global threats to human water security and river biodiversity. Nature, 467(7315), 555.
4.1 - Fragmentation Status of Rivers (score)	3.73	This risk indicator is based on the data set by Grill et al. (2019) mapping the world's free-flowing rivers. Grill et al. (2019) compiled 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). While only rivers with high levels of connectivity in their entire length are classified as free-flowing, rivers of CSI < 95% are considered as fragmented at a certain degree.	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.
4.1 - Fragmentation Status of Rivers (rank)	26	This risk indicator is based on the data set by Grill et al. (2019) mapping the world's free-flowing rivers. Grill et al. (2019) compiled 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). While only rivers with high levels of connectivity in their entire length are classified as free-flowing, rivers of CSI < 95% are considered as fragmented at a certain degree.	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.
4.2 - Catchment Ecosystem Services Degradation Level (tree cover loss) (score)	1.25	For this risk indicator, tree cover loss was applied as a proxy to represent catchment ecosystem services degradation since forests play an important role in terms of water regulation, supply and pollution control. The forest cover data is based on Hansen et al.'s global Landsat data at a 30-meter spatial resolution to characterize forest cover and change. The authors defined trees as vegetation taller than 5 meters in height, and forest cover loss as a stand-replacement disturbance, or a change from a forest to non-forest state, during the period 2000 – 2018.	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.

Indicator	Value	Description	Source
4.2 - Catchment Ecosystem Services Degradation Level (tree cover loss) (rank)	130	For this risk indicator, tree cover loss was applied as a proxy to represent catchment ecosystem services degradation since forests play an important role in terms of water regulation, supply and pollution control. The forest cover data is based on Hansen et al.'s global Landsat data at a 30-meter spatial resolution to characterize forest cover and change. The authors defined trees as vegetation taller than 5 meters in height, and forest cover loss as a stand-replacement disturbance, or a change from a forest to non-forest state, during the period 2000 – 2018.	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.
4.3 - Projected Impacts on Freshwater Biodiversity (score)	2.38	The study by Tedesco et al. (2013) to project changes [% increase or decrease] in extinction rate by ~2090 of freshwater fish due to water availability loss from climate change is used as a proxy to estimate the projected impacts on freshwater biodiversity.	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.
4.3 - Projected Impacts on Freshwater Biodiversity (rank)	98	The study by Tedesco et al. (2013) to project changes [% increase or decrease] in extinction rate by ~2090 of freshwater fish due to water availability loss from climate change is used as a proxy to estimate the projected impacts on freshwater biodiversity.	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.
5.1 - Freshwater Policy Status (SDG 6.5.1) (score)	3.00	This risk indicator is based on SDG 6.5.1. Degree of IWRM Implementation "National Water Resources Policy" indicator, which corresponds to one of the three national level indicators under the Enabling Environment category.	UN Environment (2018). Progress on integrated water resources management. Global baseline for SDG 6 Indicator 6.5.1: degree of IWRM implementation.
5.1 - Freshwater Policy Status (SDG 6.5.1) (rank)	34	This risk indicator is based on SDG 6.5.1. Degree of IWRM Implementation "National Water Resources Policy" indicator, which corresponds to one of the three national level indicators under the Enabling Environment category.	UN Environment (2018). Progress on integrated water resources management. Global baseline for SDG 6 Indicator 6.5.1: degree of IWRM implementation.
5.2 - Freshwater Law Status (SDG 6.5.1) (score)	3.00	This risk indicator is based on SDG 6.5.1. Degree of IWRM Implementation "National Water Resources Law(s)" indicator, which corresponds to one of the three national level indicators under the Enabling Environment category. 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.	UN Environment (2018). Progress on integrated water resources management. Global baseline for SDG 6 Indicator 6.5.1: degree of IWRM implementation.

Indicator	Value	Description	Source
5.2 - Freshwater Law Status (SDG 6.5.1) (rank)	39	This risk indicator is based on SDG 6.5.1. Degree of IWRM Implementation "National Water Resources Law(s)" indicator, which corresponds to one of the three national level indicators under the Enabling Environment category. 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.	UN Environment (2018). Progress on integrated water resources management. Global baseline for SDG 6 Indicator 6.5.1: degree of IWRM implementation.
5.3 - Implementation Status of Water Management Plans (SDG 6.5.1) (score)	3.00	This risk indicator is based on SDG 6.5.1. Degree of IWRM Implementation "National IWRM plans" indicator, which corresponds to one of the three national level indicators under the Enabling Environment category. 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.	UN Environment (2018). Progress on integrated water resources management. Global baseline for SDG 6 Indicator 6.5.1: degree of IWRM implementation.
5.3 - Implementation Status of Water Management Plans (SDG 6.5.1) (rank)	44	This risk indicator is based on SDG 6.5.1. Degree of IWRM Implementation "National IWRM plans" indicator, which corresponds to one of the three national level indicators under the Enabling Environment category. 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.	UN Environment (2018). Progress on integrated water resources management. Global baseline for SDG 6 Indicator 6.5.1: degree of IWRM implementation.
6.1 - Corruption Perceptions Index (score)	3.00	This risk Indicator is based on the latest Transparency International's data: the Corruption Perceptions Index 2018. This index aggregates data from a number of different sources that provide perceptions of business people and country experts on the level of corruption in the public sector.	Transparency International (2019). Corruption Perceptions Index 2018. Berlin: Transparency International.
6.1 - Corruption Perceptions Index (rank)	94	This risk Indicator is based on the latest Transparency International's data: the Corruption Perceptions Index 2018. This index aggregates data from a number of different sources that provide perceptions of business people and country experts on the level of corruption in the public sector.	Transparency International (2019). Corruption Perceptions Index 2018. Berlin: Transparency International.
6.2 - Freedom in the World Index (score)	1.00	This risk indicator is based on Freedom House (2019), 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 2019 edition involved more than 100 analysts and more than 30 advisers with global, regional, and issue-based expertise to covers developments in 195 countries and 14 territories from January 1, 2018, through December 31, 2018.	Freedom House (2019). Freedom in the world 2019. Washington, DC: Freedom House.

Indicator	Value	Description	Source
6.2 - Freedom in the World Index (rank)	132	This risk indicator is based on Freedom House (2019), 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 2019 edition involved more than 100 analysts and more than 30 advisers with global, regional, and issue-based expertise to covers developments in 195 countries and 14 territories from January 1, 2018, through December 31, 2018.	Freedom House (2019). Freedom in the world 2019. Washington, DC: Freedom House.
6.3 - Business Participation in Water Management (SDG 6.5.1) (score)	3.00	This risk indicator is based on SDG 6.5.1. Degree of IWRM Implementation “Business Participation in Water Resources Development, Management and Use” indicator, which corresponds to one of the six national level indicators under the Institutions and Participation category.	UN Environment (2018). Progress on integrated water resources management. Global baseline for SDG 6 Indicator 6.5.1: degree of IWRM implementation.
6.3 - Business Participation in Water Management (SDG 6.5.1) (rank)	45	This risk indicator is based on SDG 6.5.1. Degree of IWRM Implementation “Business Participation in Water Resources Development, Management and Use” indicator, which corresponds to one of the six national level indicators under the Institutions and Participation category.	UN Environment (2018). Progress on integrated water resources management. Global baseline for SDG 6 Indicator 6.5.1: degree of IWRM implementation.
7.1 - Management Instruments for Water Management (SDG 6.5.1) (score)	3.00	This risk indicator is based on SDG 6.5.1. Degree of IWRM Implementation “Sustainable and efficient water use management” indicator, 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.	UN Environment (2018). Progress on integrated water resources management. Global baseline for SDG 6 Indicator 6.5.1: degree of IWRM implementation.
7.1 - Management Instruments for Water Management (SDG 6.5.1) (rank)	23	This risk indicator is based on SDG 6.5.1. Degree of IWRM Implementation “Sustainable and efficient water use management” indicator, 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.	UN Environment (2018). Progress on integrated water resources management. Global baseline for SDG 6 Indicator 6.5.1: degree of IWRM implementation.

Indicator	Value	Description	Source
7.2 - Groundwater Monitoring Data Availability and Management (score)	1.00	This risk indicator is based on the data set by UN IGRAC (2019) to determine 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: 1) Status of country groundwater monitoring programme, 2) groundwater data availability for NGOs and 3) Public access to processed groundwater monitoring data.	UN IGRAC (2019). Global Groundwater Monitoring Network GGMN Portal. UN International Groundwater Resources Assessment Centre (IGRAC).
7.2 - Groundwater Monitoring Data Availability and Management (rank)	153	This risk indicator is based on the data set by UN IGRAC (2019) to determine 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: 1) Status of country groundwater monitoring programme, 2) groundwater data availability for NGOs and 3) Public access to processed groundwater monitoring data.	UN IGRAC (2019). Global Groundwater Monitoring Network GGMN Portal. UN International Groundwater Resources Assessment Centre (IGRAC).
7.3 - Density of Runoff Monitoring Stations (score)	3.07	The density of monitoring stations for water quantity was applied as proxy to develop this risk indicator. The Global Runoff Data Base was used to estimate the number of monitoring stations per 1000km2 of the main river system (data base access date: May 2018).	BfG (2019). Global Runoff Data Base. German Federal Institute of Hydrology (BfG).
7.3 - Density of Runoff Monitoring Stations (rank)	111	The density of monitoring stations for water quantity was applied as proxy to develop this risk indicator. The Global Runoff Data Base was used to estimate the number of monitoring stations per 1000km2 of the main river system (data base access date: May 2018).	BfG (2019). Global Runoff Data Base. German Federal Institute of Hydrology (BfG).
8.1 - Access to Safe Drinking Water (score)	2.00	This risk indicator is based on the Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (UNICEF/WHO) 2019 data. It provides estimates on the use of water, sanitation and hygiene by country for the period 2000-2017.	WHO & UNICEF (2019). Estimates on the use of water, sanitation and hygiene by country (2000-2017). Joint Monitoring Programme for Water Supply, Sanitation and Hygiene.
8.1 - Access to Safe Drinking Water (rank)	69	This risk indicator is based on the Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (UNICEF/WHO) 2019 data. It provides estimates on the use of water, sanitation and hygiene by country for the period 2000-2017.	WHO & UNICEF (2019). Estimates on the use of water, sanitation and hygiene by country (2000-2017). Joint Monitoring Programme for Water Supply, Sanitation and Hygiene.
8.2 - Access to Sanitation (score)	5.00	This risk indicator is based on the Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (UNICEF/WHO) 2019 data. It provides estimates on the use of water, sanitation and hygiene by country for the period 2000-2017.	WHO & UNICEF (2019). Estimates on the use of water, sanitation and hygiene by country (2000-2017). Joint Monitoring Programme for Water Supply, Sanitation and Hygiene.

Indicator	Value	Description	Source
8.2 - Access to Sanitation (rank)	1	This risk indicator is based on the Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (UNICEF/WHO) 2019 data. It provides estimates on the use of water, sanitation and hygiene by country for the period 2000-2017.	WHO & UNICEF (2019). Estimates on the use of water, sanitation and hygiene by country (2000-2017). Joint Monitoring Programme for Water Supply, Sanitation and Hygiene.
8.3 - Financing for Water Resource Development and Management (SDG 6.5.1) (score)	3.00	This risk indicator is based on the average 'Financing' score of UN SDG 6.5.1. Degree of IWRM Implementation database. UN SDG 6.5.1 database contains a category on financing which assesses different aspects related to budgeting and financing made available and used for water resources development and management from various sources.	UN Environment (2018). Progress on integrated water resources management. Global baseline for SDG 6 Indicator 6.5.1: degree of IWRM implementation.
8.3 - Financing for Water Resource Development and Management (SDG 6.5.1) (rank)	62	This risk indicator is based on the average 'Financing' score of UN SDG 6.5.1. Degree of IWRM Implementation database. UN SDG 6.5.1 database contains a category on financing which assesses different aspects related to budgeting and financing made available and used for water resources development and management from various sources.	UN Environment (2018). Progress on integrated water resources management. Global baseline for SDG 6 Indicator 6.5.1: degree of IWRM implementation.
9.1 - Cultural Diversity (score)	5.00	Water is a social and cultural good. The cultural diversity risk indicator was included in order to acknowledge that businesses face reputational risk due to the importance of freshwater for indigenous and traditional people in their daily life, religion and culture. This risk indicator is based on Oviedo and Larsen (2000) data set, which mapped the world's ethnolinguistic groups onto the WWF map of the world's ecoregions. This cross-mapping showed for the very first time the significant overlap that exists between the global geographic distribution of biodiversity and that of linguistic diversity.	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.
9.1 - Cultural Diversity (rank)	1	Water is a social and cultural good. The cultural diversity risk indicator was included in order to acknowledge that businesses face reputational risk due to the importance of freshwater for indigenous and traditional people in their daily life, religion and culture. This risk indicator is based on Oviedo and Larsen (2000) data set, which mapped the world's ethnolinguistic groups onto the WWF map of the world's ecoregions. This cross-mapping showed for the very first time the significant overlap that exists between the global geographic distribution of biodiversity and that of linguistic diversity.	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.
10.1 - Freshwater Endemism (score)	1.77	The underlying data set for this risk indicator comes from the Freshwater Ecoregions of the World (FEOW) 2015 data developed by WWF and TNC. Companies operating in basins with higher number of endemic fish species are exposed to higher reputational risks.	WWF & TNC (2015). Freshwater Ecoregions of the World.

Indicator	Value	Description	Source
10.1 - Freshwater Endemism (rank)	183	The underlying data set for this risk indicator comes from the Freshwater Ecoregions of the World (FEOW) 2015 data developed by WWF and TNC. Companies operating in basins with higher number of endemic fish species are exposed to higher reputational risks.	WWF & TNC (2015). Freshwater Ecoregions of the World.
10.2 - Freshwater Biodiversity Richness (score)	4.69	The underlying data set for this risk indicator comes from the Freshwater Ecoregions of the World (FEOW) 2015 data developed by WWF and TNC. Count of fish species is used as a representation of freshwater biodiversity richness. Companies operating in basins with higher number of fish species are exposed to higher reputational risks.	WWF & TNC (2015). Freshwater Ecoregions of the World.
10.2 - Freshwater Biodiversity Richness (rank)	37	The underlying data set for this risk indicator comes from the Freshwater Ecoregions of the World (FEOW) 2015 data developed by WWF and TNC. Count of fish species is used as a representation of freshwater biodiversity richness. Companies operating in basins with higher number of fish species are exposed to higher reputational risks.	WWF & TNC (2015). Freshwater Ecoregions of the World.
11.1 - National Media Coverage (score)	5.00	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., scarcity and pollution) is taken into account, as well as the importance of water for livelihoods (e.g., food and shelter).	WWF & Tecnoma (TYPSA Group)
11.1 - National Media Coverage (rank)	1	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., scarcity and pollution) is taken into account, as well as the importance of water for livelihoods (e.g., food and shelter).	WWF & Tecnoma (TYPSA Group)
11.2 - Global Media Coverage (score)	5.00	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.	WWF & Tecnoma (TYPSA Group)
11.2 - Global Media Coverage (rank)	1	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.	WWF & Tecnoma (TYPSA Group)

Country Overview - India

Indicator	Value	Description	Source
12.1 - Conflict News Events (RepRisk) (score)	5.00	This risk indicator is based on 2018 data collected by RepRisk 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.	RepRisk & WWF (2019). Due diligence database on ESG and business conduct risks. RepRisk.
12.1 - Conflict News Events (RepRisk) (rank)	1	This risk indicator is based on 2018 data collected by RepRisk 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.	RepRisk & WWF (2019). Due diligence database on ESG and business conduct risks. RepRisk.
12.2 - Hydro-political Risk (score)	3.67	This risk indicator is based on the assessment of hydro-political risk by Farinosi et al. (2018). More specifically, it is based on the results of spatial modelling by Farinosi et al. (2018) that determined the main parameters affecting water cross-border conflicts and calculated the likelihood of hydro-political issues.	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.
12.2 - Hydro-political Risk (rank)	14	This risk indicator is based on the assessment of hydro-political risk by Farinosi et al. (2018). More specifically, it is based on the results of spatial modelling by Farinosi et al. (2018) that determined the main parameters affecting water cross-border conflicts and calculated the likelihood of hydro-political issues.	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.
Population, total (#)	1324171354	Population, total	The World Bank 2018, Data , hompage accessed 20/04/2018
GDP (current US$)	2263792499341	GDP (current US$)	The World Bank 2018, Data , hompage accessed 20/04/2018
EPI 2018 score (0-100)	30.57	Environmental Performance Index	
WGI -Voice and Accountability (0-100)	14.29	Water Governance Indicator	Kaufmann, Daniel and Kraay, Aart and Mastruzzi, Massimo, The Worldwide Governance Indicators: Methodology and Analytical Issues (September 2010). World Bank Policy Research Working Paper No. 5430. Available at SSRN: https://ssrn.com/abstract=1682132

Indicator	Value	Description	Source
WGI -Political stability no violence (0-100)	58.62	Water Governance Indicator	Kaufmann, Daniel and Kraay, Aart and Mastruzzi, Massimo, The Worldwide Governance Indicators: Methodology and Analytical Issues (September 2010). World Bank Policy Research Working Paper No. 5430. Available at SSRN: https://ssrn.com/abstract=1682132
WGI - Government Effectiveness (0-100)	57.21	Water Governance Indicator	Kaufmann, Daniel and Kraay, Aart and Mastruzzi, Massimo, The Worldwide Governance Indicators: Methodology and Analytical Issues (September 2010). World Bank Policy Research Working Paper No. 5430. Available at SSRN: https://ssrn.com/abstract=1682132
WGI - Regulatory Quality (0-100)	41.35	Water Governance Indicator	Kaufmann, Daniel and Kraay, Aart and Mastruzzi, Massimo, The Worldwide Governance Indicators: Methodology and Analytical Issues (September 2010). World Bank Policy Research Working Paper No. 5430. Available at SSRN: https://ssrn.com/abstract=1682132
WGI - Rule of Law (0-100)	52.40	Water Governance Indicator	Kaufmann, Daniel and Kraay, Aart and Mastruzzi, Massimo, The Worldwide Governance Indicators: Methodology and Analytical Issues (September 2010). World Bank Policy Research Working Paper No. 5430. Available at SSRN: https://ssrn.com/abstract=1682132
WGI - Control of Corruption (0-100)	47.12	Water Governance Indicator	Kaufmann, Daniel and Kraay, Aart and Mastruzzi, Massimo, The Worldwide Governance Indicators: Methodology and Analytical Issues (September 2010). World Bank Policy Research Working Paper No. 5430. Available at SSRN: https://ssrn.com/abstract=1682132

Country Overview - India

Indicator	Value	Description	Source
WRI BWS all industries (0-5)	3.58	WRI Baseline Water Stress (BWS)	Gassert, F., P. Reig, T. Luo, and A. Maddocks. 2013. "Aqueduct country and river basin rankings: a weighted aggregation of spatially distinct hydrological indicators." Working paper. Washington, DC: World Resources Institute, December 2013. Available online at http://wri.org/publication/aqueduct-country-river-basin-rankings.
WRI BWS Ranking (1=very high)	40	WRI Baseline Water Stress (BWS)	Gassert, F., P. Reig, T. Luo, and A. Maddocks. 2013. "Aqueduct country and river basin rankings: a weighted aggregation of spatially distinct hydrological indicators." Working paper. Washington, DC: World Resources Institute, December 2013. Available online at http://wri.org/publication/aqueduct-country-river-basin-rankings.
Baseline Water Stress (BWS) - 2020 BAU (1=very high)	31	WRI country ranking	Luo, T., R. Young, and P. Reig. 2015. "Aqueduct projected water stress rankings." Technical note. Washington, DC: World Resources Institute, August 215. Available online at http://www.wri.org/publication/aqueduct-projected-water-stress-country-rankings.
Baseline Water Stress (BWS) - 2020 Optimistic (increasing rank describes lower risk)	35	WRI country ranking	Luo, T., R. Young, and P. Reig. 2015. "Aqueduct projected water stress rankings." Technical note. Washington, DC: World Resources Institute, August 215. Available online at http://www.wri.org/publication/aqueduct-projected-water-stress-country-rankings.
Baseline Water Stress (BWS) - 2020 Pessimistic (increasing rank describes lower risk)	32	WRI country ranking	Luo, T., R. Young, and P. Reig. 2015. "Aqueduct projected water stress rankings." Technical note. Washington, DC: World Resources Institute, August 215. Available online at http://www.wri.org/publication/aqueduct-projected-water-stress-country-rankings.

Water Risk Filter

Country Overview - India

Indicator	Value	Description	Source
Baseline Water Stress (BWS) - 2030 BAU (increasing rank describes lower risk)	37	WRI country ranking	Luo, T., R. Young, and P. Reig. 2015. "Aqueduct projected water stress rankings." Technical note. Washington, DC: World Resources Institute, August 215. Available online at http://www.wri.org/publication/aqueduct-projected-water-stress-country-rankings.
Baseline Water Stress (BWS) - 2030 Optimistic (increasing rank describes lower risk)	38	WRI country ranking	Luo, T., R. Young, and P. Reig. 2015. "Aqueduct projected water stress rankings." Technical note. Washington, DC: World Resources Institute, August 215. Available online at http://www.wri.org/publication/aqueduct-projected-water-stress-country-rankings.
Baseline Water Stress (BWS) - 2030 Pessimistic (increasing rank describes lower risk)	37	WRI country ranking	Luo, T., R. Young, and P. Reig. 2015. "Aqueduct projected water stress rankings." Technical note. Washington, DC: World Resources Institute, August 215. Available online at http://www.wri.org/publication/aqueduct-projected-water-stress-country-rankings.
Baseline Water Stress (BWS) - 2040 BAU (increasing rank describes lower risk)	40	WRI country ranking	Luo, T., R. Young, and P. Reig. 2015. "Aqueduct projected water stress rankings." Technical note. Washington, DC: World Resources Institute, August 215. Available online at http://www.wri.org/publication/aqueduct-projected-water-stress-country-rankings.
Baseline Water Stress (BWS) - 2040 Optimistic (increasing rank describes lower risk)	40	WRI country ranking	Luo, T., R. Young, and P. Reig. 2015. "Aqueduct projected water stress rankings." Technical note. Washington, DC: World Resources Institute, August 215. Available online at http://www.wri.org/publication/aqueduct-projected-water-stress-country-rankings.
Baseline Water Stress (BWS) - 2040 Pessimistic (increasing rank describes lower risk)	39	WRI country ranking	Luo, T., R. Young, and P. Reig. 2015. "Aqueduct projected water stress rankings." Technical note. Washington, DC: World Resources Institute, August 215. Available online at http://www.wri.org/publication/aqueduct-projected-water-stress-country-rankings.

Water Risk Filter

Country Overview - India

Indicator	Value	Description	Source
Total water footprint of national consumption (m3/a/cap)	1088.76	WFN Water Footprint Data	Mekonnen, M.M. and Hoekstra, A.Y. (2011) National water footprint accounts: The green, blue and grey water footprint of production and consumption, Value of Water Research Report Series No. 50, UNESCO-IHE, Delft, the Netherlands.http://www.waterfootprint.org/Reports/Report50-NationalWaterFootprints-Vol1.pdf
Ratio external / total water footprint (%)	2.53	WFN Water Footprint Data	Mekonnen, M.M. and Hoekstra, A.Y. (2011) National water footprint accounts: The green, blue and grey water footprint of production and consumption, Value of Water Research Report Series No. 50, UNESCO-IHE, Delft, the Netherlands.http://www.waterfootprint.org/Reports/Report50-NationalWaterFootprints-Vol1.pdf
Area equipped for full control irrigation: total (1000 ha)	70400.00	Aquastat - Irrigation	FAO. 2016. AQUASTAT website. Food and Agriculture Organization of the United Nations (FAO). Website accessed on 2018/04/13
Area equipped for irrigation: total (1000 ha)	70400.00	Aquastat - Irrigation	FAO. 2016. AQUASTAT website. Food and Agriculture Organization of the United Nations (FAO). Website accessed on 2018/04/13
% of the area equipped for irrigation actually irrigated (%)	93.90	Aquastat - Irrigation	FAO. 2016. AQUASTAT website. Food and Agriculture Organization of the United Nations (FAO). Website accessed on 2018/04/13
Electricity production from hydroelectric sources (% of total)	10.23	World Development Indicators	The World Bank 2018, Data , hompage accessed 20/04/2018
Total internal renewable water resources (IRWR) (10^9 m3/year)	1446.00	Aquastat - Water Ressources	FAO. 2016. AQUASTAT website. Food and Agriculture Organization of the United Nations (FAO). Website accessed on 2018/04/13
Total internal renewable water resources (IRWR) (10^9 m3/year)	464.90	Aquastat - Water Ressources	FAO. 2016. AQUASTAT website. Food and Agriculture Organization of the United Nations (FAO). Website accessed on 2018/04/13
Water resources: total external renewable (10^9 m3/year)	1446.00	Aquastat - Water Ressources	FAO. 2016. AQUASTAT website. Food and Agriculture Organization of the United Nations (FAO). Website accessed on 2018/04/13

Water Risk Filter

Country Overview - India

Indicator	Value	Description	Source
Total renewable water resources (10^9 m3/year)	1911.00	Aquastat - Water Ressources	FAO. 2016. AQUASTAT website. Food and Agriculture Organization of the United Nations (FAO). Website accessed on 2018/04/13
Dependency ratio (%)	30.52	Aquastat - Water Ressources	FAO. 2016. AQUASTAT website. Food and Agriculture Organization of the United Nations (FAO). Website accessed on 2018/04/13
Total renewable water resources per capita (m3/inhab/year)	1458.00	Aquastat - Water Ressources	FAO. 2016. AQUASTAT website. Food and Agriculture Organization of the United Nations (FAO). Website accessed on 2018/04/13
World happiness [0-8]	4.19	WorldHappinessReport.org	World Happiness Report, homepage accessed 20/04/2018

Country Aspects

1. PHYSICAL ASPECTS

1.1. WATER RESOURCES

1.1.1. WATER RESOURCES

India has an annual average precipitation of 1,170mm and about 80 per cent of the total area of the country experiences annual rainfall of 750mm or more. Due to the large spatial and temporal variability in the rainfall, water resources distribution in the country is highly varied in space and time.

The two main sources of water in India are rainfall and the snowmelt of glaciers in the Himalayas. Although snow and glaciers are poor producers of freshwater, they are good distributors as they yield at the time of need, in the hot season. Indeed, about 80 per cent of the flow of rivers in India occurs during the four to five months of the southwest monsoon season. Several important river systems originate in upstream countries and then flow to other countries: the Indus River originates in China and flows to Pakistan; the Ganges-Brahmaputra river system originates partly in China, Nepal and Bhutan, and flows to Bangladesh; some minor rivers drain into Myanmar and Bangladesh. However, there are no official records available regarding the quantum of annual flows into the country or out of the country.

The rivers of India can be classified into the following four groups:

-The Himalayan rivers (Ganges, Brahmaputra, Indus) are formed by melting snow and glaciers as well as rainfall and therefore have a continuous flow throughout the year. As these regions receive very heavy rainfall during the monsoon period, the rivers swell and cause frequent floods.

-The rivers of the Deccan plateau (with larger rivers such as the Mahanadi, Godavari, Krishna, Pennar and Cauvery draining into the bay of Bengal in the east, and the Narmadi and Tapi draining into the Arabian sea in the west), making up most of the southern-central part of the country, are rain-fed and fluctuate in volume, many of them being non-perennial.

-The coastal rivers, especially on the west coast south of the Tapi, are short in length with limited catchment areas, most of them being non-perennial.

-The rivers of the inland drainage basin in western Rajasthan in the northwestern part of the country towards the border with Pakistan are ephemeral, drain towards the salt lakes such as the Sambhar, or are lost in the sands.

For planning purposes, the country is divided into 20 river units, 14 of which are major river basins, while the remaining 99 river basins have been grouped into 6 river units. The spatial imbalance of distribution of water resources can be appreciated by the fact that the Ganges-Brahmaputra-Meghna basin covering 34 per cent of the country's area contributes about 62 per cent of the water resources. The west-flowing rivers towards the Indus covering 10 per cent of the area contribute 4 per cent of the water resources. The remaining 56 per cent of the area contributes 34 per cent to the runoff.

The water resources potential of the country is assessed as the natural runoff of the rivers and is estimated at 1,869.35km3, of which only 1,122km3 are considered as utilizable or exploitable in view of the constraints of topography, uneven distribution of the resource over space and time, the geological factors and the contemporary technological knowledge. These 1,122km3 comprise 690km3 from surface water and 432km3 from groundwater. The internal renewable water resources (IRWR) have been estimated at 1,238.13km3/year by deducting the inflow from neighbouring countries (210.2km3/year from Nepal, 347.02km3/year from China and 74km3/year from Bhutan) from the total estimated flow of 1,869.35km3/year. The overlap between surface water and groundwater is assumed to be 90 per cent.

Under the Indus Water Treaty (1960) between India and Pakistan, all the waters of the eastern tributaries of the Indus River originating in India, i.e. the Sutlej, Beas and Ravi rivers taken together, shall be available for the unrestricted use of India. All the waters, while flowing in Pakistan, of any tributary which in its natural course joins the main Sutlej or the main Ravi after these rivers have crossed into Pakistan shall be available for the unrestricted use of Pakistan. This flow reserved by treaty is estimated at 11.1km3/year, which gives a total of 1,858.25km3/year (=1,869.35 – 11.1) total actual renewable water resources.

An important part of the surface water resources leaves the country before it reaches the sea: 20km3/year to Myanmar, 181.37km3/year to Pakistan and 1,105.6km3/year to Bangladesh, of which 598.9km3 flows through the Brahmaputra, 343.93km3 through the Ganges and 162.77km3 through the northeastern rivers.

In 2004, wastewater production was estimated at 10.585km3 and treated wastewater was about 2.555km3.

No reliable statistics are available on the number of desalination plants, their capacities, technologies adopted and status in India. However, estimates indicate that there are more than 1,000 membrane-based desalination plants of various capacities ranging from 20m3/day to 10,000m3/day. There are a few thermal-based desalination plants also. In 1996, some 550,000m3 of seawater were desalinated in the Lakshadweep Islands, mainly through electro dialysis and Reverse Osmosis (RO). Solar stills are also installed on the peninsula, as in Gujarat in the northwest. A 6,300m3/day desalination plant is being set up at Kalpakkam, Chennai with a capacity of 4,500m3 from the Multi Stage Flash (MSF) method, using low pressure steam from Madras Atomic Power Station, and 1,800 m3/day from RO. While the plant with the RO method is under operation, the MSF-based plant is expected to be commissioned soon.

There are as many as 4,526 large dams and a large number of smaller dams and diversion structures in India. The total water storage capacity constructed up to 2002 was 212.78km3. Another 76.26km3 are estimated to be possible through dams under construction and 107.54km3 through dams under consideration. Seven dams have a reservoir capacity exceeding 8km3. They are the Nagarjuna Sagar dam on the Krishna River (11.56km3), the Rihand dam on the Rihand River (10.6km3), the Bhakra dam on the Sutlej River (9.62km3), the Srisailam dam on the Krishna River (8.72km3), the Hirakud dam on the Mahanadi River (8.1km3), the Pong (Beas) dam on the Beas River (8.57km3) and the Ukai dam on the Tapti River (8.5km3).

India controls the flow of the Ganges River through a dam completed in 1974 at Farraka, 18km from the border with Bangladesh. The Farakka Barrage is a diversion structure of small height not classified as a large dam.

India is endowed with rich hydropower potential, ranking fifth in the world. The gross hydropower potential was estimated at 148,700MW as installed capacity, or 84,000MW at 60 per cent power load factor. The Brahamaputra, Ganges and Indus basins contribute about 80 per cent of it. In addition to this, small, mini and micro hydropower schemes (with capacity less than 3MW) have been assessed to have almost 6,782MW of installed capacity.

1.1.2. WATER USE

It is estimated that in 2010 total water withdrawal was 761km3 of which 91 per cent, or 688km3, was for irrigation purposes. About 56km3 were for municipal use and 17km3 for industrial purposes.

In 2010, primary surface water withdrawal accounted for 396km3, primary groundwater withdrawal accounted for 251km3, and reused agricultural drainage water accounted for 113km3. In 1996, some 550,000m3 of seawater were desalinated.

In 1990, the total water withdrawal was estimated at 500km3, of which 92 per cent was for irrigation purposes. The primary surface water withdrawal was 362km3, while the amount coming from primary groundwater was estimated at 190km3.

1.2. WATER QUALITY, ECOSYSTEMS AND HUMAN HEALTH

Major environmental problems are deforestation; soil erosion; overgrazing; desertification; air pollution from industrial effluents and vehicle emissions; water pollution from raw sewage and runoff of agricultural pesticides; tap water is not potable throughout the country; and the huge and growing population is overstraining natural resources.

Water quality is a major issue in India. Although in their upper reaches most rivers are of good quality, the importance of water use for cities, agriculture and industries, and the lack of wastewater treatment plants in the middle and lower reaches of most rivers, cause a major degradation of surface water quality. Groundwater is also affected by municipal, industrial and agricultural pollutants. The overexploitation of groundwater can also lead to seawater intrusion. For example, there is an inland advance of the saline-freshwater interface in the Chingelput district of Tamil Nadu, where a well field along the Korttalaiyar River supplies water to the city of Madras.

In 1992, the Central Pollution Control Board completed water quality studies in all major river basins. The pollution control action plan of the Ganges River basin was formulated in 1984 and has been enforced by the Ganges Project Directorate, under the Central Ganges Authority, to oversee pollution control and the consequent cleaning of the Ganges River. The water quality in the middle stretch of the Ganges River, which had deteriorated to class C and D (the worst class is E, the best A), was restored to class B in 1990 after the implementation of the action plan. Similar programmes for other rivers have been developed as well as a national river action plan to clean the heavily polluted stretches of the major rivers of the country.

According to the National Commission on Floods, the area subject to flooding is estimated at about 400,000km2 (about 12 per cent of the area of the country). About 80 per cent of this area, or 320,000km2, could be provided with reasonable protection. Bihar is the worst flood-hit state. Hardly a year passes without severe flood damage. With the onset of the monsoon, rivers come down from the Himalayan hills in Nepal with enormous force, leading to rivers like the Ghagra, Kamla, Kosi, Bagmati, Gandak, Ganges, Falgu, Karmnasa and Mahanadi rising above the danger level. This results in severe floods in north Bihar. The Kosi River, popularly known as “the sorrow of Bihar”, has not yet matured enough to settle on a course, and has changed its course 15-16 times, the last time being as recent as August 2008. About 2.8 million people were said to have been marooned by these floods in Bihar.

The total area subject to waterlogging was estimated at 85,000km2 in 1985, including both rain-fed and irrigated areas. This is thought to be a substantial underestimate as precise data are lacking. It is estimated that about 24 per cent of irrigated command areas of major and medium irrigation projects is subject to waterlogging. Measures to counter waterlogging and salinity are being taken by constructing field channels and drains, and by encouraging the combined use of surface water and groundwater. Furthermore, it is estimated that out of the total irrigated area about 33,000km2 are affected by salinity.

Water-borne diseases have continued increasing over the years in spite of government efforts to combat them. States such as Punjab, Haryana, Andhra Pradesh and Uttar Pradesh are endemic for malaria on account of the high water table, waterlogging and seepage in the canal catchment area. There are also numerous cases of filariasis. In 1998 the population affected by water-related diseases was 44 million people.

Climate change may alter the distribution and quality of India’s water resources. Some of the impacts include more intense rains, changed spatial and temporal distribution of rainfall, higher runoff generation, low groundwater recharge, melting of glaciers, changes in evaporative demands and water use patterns in agricultural, domestic and industrial sectors, etc. These impacts have serious influences on agricultural production and food security, ecology, biodiversity, river flows, floods, droughts, water security, human and animal health, and sea levels.

2. GOVERNANCE ASPECTS

2.1. WATER INSTITUTIONS

Under the Indian Constitution, water is the responsibility of the states. Thus the federal states are primarily responsible for the planning, implementation, funding and management of water resources development. This responsibility in each state is borne by the Irrigation and Water

Supply Department. The Inter-State Water Disputes Act of 1956 provides a framework for the resolution of possible conflicts.

At central level, which is responsible for water management in the union territories and in charge of developing guidelines and a policy frame for all the states, there are three main institutions involved in water resources management:

1. The Ministry of Water Resources (MWR) is responsible for laying down policy guidelines and programmes for the development and regulation of the country's water resources. The ministry's technical arm, the Central Water Commission (CWC), provides general infrastructural, technical and research support for water resources development at state level. The CWC is also responsible for the assessment of water resources.
2. The Planning Commission is responsible for the allocation of financial resources required for various programmes and schemes of water resources development to the states as well as to the MWR. It is also actively involved in policy formulation related to water resources development at the national level.
3. 3. The Ministry of Agriculture promotes irrigated agriculture through its Department of Agriculture and Cooperation.

Further, the Indian National Committee of Irrigation and Drainage (INCID) coordinates with the International Commission on Irrigation and Drainage (ICID) and promotes research in the relevant areas. The Central Pollution Control Board (CPCB) is in charge of water quality monitoring, and the preparation and implementation of action plans to solve pollution problems.

In 1996, the Central Groundwater Authority was established to regulate and control groundwater development with a view to preserving and protecting the resource.

2.2. WATER MANAGEMENT

Water resources planning and management should be seen in a context of food grain availability. Food grain production increased in the 1950s and 1960s due to increases in the cultivated area, expansion in the irrigated area and the use of high yielding varieties (HYVs) from the mid-1960s onwards. Irrigation has also helped reduce inter-annual fluctuations in agricultural output and India's vulnerability to drought. One of the goals of Indian policy is now to find ways of maintaining the level of food grain availability per inhabitant in an increasing population. Total water demand is expected to equal water availability by 2025, but industrial and municipal water demand are expected to rise drastically at the expense of the agricultural sector, which will have to produce more with less water.

The centrally sponsored Command Area Development (CAD) Programme was launched in 1974-75. The main objectives of the Programme are improving the utilization of the area equipped for irrigation and optimizing agricultural production and productivity from irrigated agriculture. The Programme involves the implementation of on-farm development works like construction of field channels and field drains, reclamation of waterlogged areas, renovation and rehabilitation of minor irrigation tanks, and correction of irrigation water distribution system deficiencies. The programme also involves activities like adaptive trials, demonstrations, training of farmers, evaluation studies, etc. Warabandi, a rotation system of distribution of irrigation water in order to ensure equitable and timely supply of water to all the farm holdings of the command, is also a component of the programme. An amount of Rs 35.280 million was released to the states as central assistance under the programme from its inception until the end of March 2008. An area of about 180,700km2 was covered under the programme from its inception up to the end of March 2007. The CAD Programme has been restructured and renamed as the 'Command Area Development and Water Management (CADWM)' Programme since April 1 2004.

The main systems of irrigation water management (distribution) schemes practised in India are:

-The warabandi system in semi-arid and arid northwest India where irrigation water is strictly rationed in proportion to farm area and supplied on a predetermined rotational schedule. The distribution system is equipped with field channels and watercourses. Primarily designed to adapt to shortage in water supplies, farmers decide on crops according to the expected water supply.

-The shejpali system of western and parts of central and southern India where farmers obtain official sanction for proposed cropping patterns and are then entitled to irrigation supplies according to crop needs. The distribution system is equipped with field channels and watercourses. These systems were designed at a time when irrigation water was plentiful relative to demand.

-The localization system in parts of southern India, focussing on locational control of cropping patterns. Low-lying areas are zoned for 'wet' crops (primarily rice and sugarcane), while higher areas are limited to 'irrigated dry' (ID) crops with restricted water supplies. The distribution system is equipped with watercourses and field channels. Such systems break down as head-end farmers in ID zones take up cultivation of high water requiring crops and draw more water than their allocated quantity.

-The traditional field-to-field irrigation system which is used mainly for rice in some areas of eastern India and some parts of south India. Continuous irrigation flows are provided, passing from field to field, generally without watercourses or field channels. Operating rules have often evolved and been agreed through local tradition, and where water is abundant, yields can be good. However, crop choice and cropping patterns are limited.

A broad distinction can be made between supply-based systems (such as warabandi) that distribute water according to predetermined procedures and require the farmers to respond accordingly in terms of cropping patterns and areas, and demand-based systems (such as shejpali) that attempt to meet crop water needs. In supply-based systems, the role of the irrigation department tends to be simpler than under demand-based systems that require the department to respond to farmers' changing needs with more complex and flexible infrastructures and more intensive management. The average overall water use efficiency in canal irrigation systems is estimated at 38-40 per cent.

The National Water Policy 2002 emphasizes a participatory approach in water resources management. It has been recognized that participation of beneficiaries will help greatly for the optimal upkeep of the irrigation system and efficient utilization of irrigation water. The participation of farmers in irrigation management is formulated through the constitution of Water

Users' Associations (WUAs). The aims of the WUAs are to: i) promote and secure distribution of water among users; ii) ensure adequate maintenance of the irrigation systems; iii) improve efficiency and economic utilization of water; iv) optimize agricultural production; v) protect the environment; and vi) ensure ecological balance by involving the farmers and inculcating a sense of ownership of the irrigation systems in accordance with the water budget and operational plan. The WUAs are formed and work on the basis of executive instructions and guidelines laid down by each state government. There is no central legislation or legal instrument in this regard. However, the only state which has passed legislation exclusively for farmer participation in the management of irrigation systems is Andhra Pradesh. A total of 55,500 WUAs were constituted in India covering an area of 102,300km2.

The National Groundwater Recharge Master Plan (NGRMP) provides a nationwide assessment of the groundwater recharge potential and outlines the guiding principles for an artificial groundwater recharge programme. The plan estimates that through dedicated recharge structures in rural areas and rooftop water harvesting structures in urban areas a total of 36km3 can be added to groundwater recharge annually. The NGRMP follows two criteria for identifying recharge: availability of surplus water and availability of storage space in aquifers. The investments in the programme would therefore be driven by the potential available for groundwater recharge, and not by the need for recharge. Thus, the three states of Andhra Pradesh, Rajasthan, and Tamil Nadu, which together account for over half of India's threatened groundwater blocks, receive only 21 per cent of funds, whereas the states of the Ganges-Brahmaputra basin, which face no groundwater overdevelopment problems, receive 43 per cent of the funds. If implemented successfully, this recharge programme will be able to add a significant quantity of water to India's groundwater storage, but it will not provide much help in the areas that are most in need of help.

2.3. WATER POLICY AND LEGAL FRAMEWORK

India adopted a National Water Policy in 1987, which was revised in 2002, for the planning and development of water resources to be governed by national perspectives. It emphasizes the need for river basin-based planning of water use. Water allocation priority has been given to drinking water, followed by irrigation, hydropower, navigation and industrial or other uses. As water resources development is a state responsibility, all the states are required to develop their state water policy within the framework of the national water policy and, accordingly, set up a master plan for water resources development.

3. RELIGIOUS AND CULTURAL ASPECTS

Water in Hinduism has a special place because it is believed to have spiritually cleansing powers. To Hindus all water is sacred, especially rivers, and there are seven sacred rivers, namely the Ganges, Yamuna, Godavari, Sarasvati, Narmada, Sindhu and Kaveri. Although Hinduism encompasses so many different beliefs, among those that most Hindus do share is the importance of striving to attain purity and avoiding pollution. This relates to both physical cleanliness and spiritual well-being.

Pilgrimage is very important to Hindus. Holy places are usually located on the banks of rivers, coasts, seashores and mountains. Sites of convergence, between land and river or two, or even better three, rivers, carry special significance and are especially sacred. Sacred rivers are thought to be a great equalizer. In the Ganges the pure are made even more pure and the impure have their pollution removed if only temporarily. In sacred water distinctions of caste are supposed to count for nothing, as all sins fall away. Kumbhamela is a pilgrimage of Hindu devotees and is held every three years at four different places in turn – Hardwar, Nasik, Prayaga and Ujjain. These places are believed to be where drops of amrta – the nectar of immortality – fell to earth during a heavenly conflict.

The Ganges is the most important of the sacred rivers. Its waters are used in puja (worship) and if possible a sip is given to the dying. It is believed that those who bathe in the Ganges and those who leave some part of themselves (hair, bone etc) on the left bank will attain Svarga (the paradise of Indra). The river is said to flow from the toe of Vishnu to be spread into the world through the hair of Shiva.

Funeral grounds are always located near a river. Sometimes at the funeral a small hole is drilled in an earthen pot, which is then filled with water. As the son of the deceased walks around the burning funeral pyre with the pot, dripping water forms a limiting line to prevent the soul from escaping back into the earth as a ghost. When the heat of the pyre cracks the skull of the corpse, the mourners bathe in the river and return home. On the third day after the cremation the ashes are collected and on or after the tenth day they are cast into a holy river.

For Hindus, morning cleansing with water is a basic obligation. Tarpana is the point at which the worshipper makes a cup with his hands and pours the water back into the river reciting mantras. After sipping some water, he may then apply the distinguishing mark of his sampradaya (tradition), and say the morning prayer, samdhya. Sodhana is Hindu purification and is necessary for different reasons and at different levels. Physical purification is a part of daily ritual which may, in the case of sadhus (Hindu holy people who renounce the world seeking Brahman), be very elaborate. Sodhana is also necessary if caste rules have been broken, for example if someone drinks from the same vessel as a member of a lower caste, and before puja. Every temple has a pond near it and devotees are supposed to take a bath before entering the temple.

The story of the Great Flood of Manu appears in Hindu scriptures. This is the story of how all creation is submerged in a great deluge but Manu is rescued by a fish that he once saved from being eaten by a larger fish. The fish told him to build a large boat and to take into it seeds and animals. The fish then towed the boat to safety by anchoring it on the highest of the Himalayas. He stayed on the mountain (known as Manu's Descent) while the flood swept away all living creatures. Manu alone survived.

4. GEOPOLITICAL ASPECTS

The earlier-mentioned dam at Farraka, 18km from the border with Bangladesh, was a source of tension between the two countries, with Bangladesh asserting that the dam held back too much water during the dry season and released too much water during monsoon rains. A treaty was

signed in December 1996, under which Bangladesh is ensured a fair share of the flow reaching the dam during the dry season.
The Indus Water Treaty (1960) between India and Pakistan, described earlier, helped to resolve the issues between these two countries, although during the last few years Pakistan had objected against India's development of hydropower projects on the western rivers Chenab and Jhelum.
Similar arrangements exist between Nepal and India for the exploitation of the Kosi River (1954, 1966) and the Gandak River (1959).