Water Risk Filter

Country Overview - Brunei Darussalam

Water Indicators

Indicator	Value	Description	Source
Overall Basin Risk (score)	2.30	Overall Basin Risk (score)	
Overall Basin Risk (rank)	163	Overall Basin Risk (rank)	
Physical risk (score)	2.03	Physical risk (score)	
Physical risk (rank)	166	Physical risk (rank)	
Regulatory risk (score)	2.90	Regulatory risk (score)	
Regulatory risk (rank)	89	Regulatory risk (rank)	
Reputation risk (score)	2.51	Reputation risk (score)	
Reputation risk (rank)	111	Reputation risk (rank)	
1. Quantity - Scarcity (score)	1.49	1. Quantity - Scarcity (score)	
1. Quantity - Scarcity (rank)	164	1. Quantity - Scarcity (rank)	
2. Quantity - Flooding (score)	3.92	2. Quantity - Flooding (score)	
2. Quantity - Flooding (rank)	40	2. Quantity - Flooding (rank)	
3. Quality (score)	1.00	3. Quality (score)	
3. Quality (rank)	189	3. Quality (rank)	
4. Ecosystem Service Status (score)	2.49	4. Ecosystem Service Status (score)	
4. Ecosystem Service Status (rank)	94	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)	92	5. Enabling Environment (Policy & Laws) (rank)	
6. Institutions and Governance (score)	3.00	6. Institutions and Governance (score)	
6. Institutions and Governance (rank)	108	6. Institutions and Governance (rank)	
7. Management Instruments (score)	3.15	7. Management Instruments (score)	
7. Management Instruments (rank)	55	7. Management Instruments (rank)	
8 - Infrastructure & Finance (score)	2.10	8 - Infrastructure & Finance (score)	
8 - Infrastructure & Finance (rank)	102	8 - Infrastructure & Finance (rank)	
9. Cultural Diversity (score)	2.00	9. Cultural importance (score)	
9. Cultural Diversity (rank)	119	9. Cultural importance (rank)	
10. Biodiversity Importance (score)	4.50	10. Biodiversity importance (score)	

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Indicator	Value	Description	Source
10. Biodiversity Importance (rank)	25	10. Biodiversity importance (rank)	
11. Media Scrutiny (score)	2.55	11. Media Scrutiny (score)	
11. Media Scrutiny (rank)	140	11. Media Scrutiny (rank)	
12. Conflict (score)	2.00	12. Conflict (score)	
12. Conflict (rank)	157	12. Conflict (rank)	
1.0 - Aridity (score)	1.00	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)	169	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)	2.93	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)	59	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)	1.00	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.

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Indicator	Value	Description	Source
1.2 - Baseline Water Stress (rank)	183	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)	1.00	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)	182	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)	1.00	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)	190	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.

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Indicator	Value	Description	Source
1.5 - Drought Frequency Probability (score)	1.00	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)	192	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)	3.00	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)	141	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)	3.97	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)	47	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)	3.00	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)	45	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)	1.00	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)	189	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)	1.97	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)	129	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)	4.23	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)	10	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)	1.00	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)	190	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)	94	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)	100	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)	112	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)	2.00	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)	178	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)	5.00	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)	38	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)	100	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)	105	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.

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Indicator	Value	Description	Source
7.2 - Groundwater Monitoring Data Availability and Management (score)	3.00	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)	127	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)	4.00	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)	51	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)	1.00	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)	170	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)	3.00	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.

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Indicator	Value	Description	Source
8.2 - Access to Sanitation (rank)	94	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)	137	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)	2.00	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)	119	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)	5.00	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)	19	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)	4.00	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)	62	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)	3.00	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)	163	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)	2.00	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)	140	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)

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Indicator	Value	Description	Source
12.1 - Conflict News Events (RepRisk) (score)	2.00	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)	144	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)	1.99	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)	135	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 (#)	423196	Population, total	The World Bank 2018, Data , hompage accessed 20/04/2018
GDP (current US$)	11400653732	GDP (current US$)	The World Bank 2018, Data , hompage accessed 20/04/2018
EPI 2018 score (0-100)	63.57	Environmental Performance Index	
WGI -Voice and Accountability (0-100)	93.81	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)	23.15	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)	81.25	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)	71.15	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)	73.08	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)	72.60	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

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Indicator	Value	Description	Source
WRI BWS all industries (0-5)	0.01	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)	172	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)	155	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)	155	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)	155	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.

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Indicator	Value	Description	Source
Baseline Water Stress (BWS) - 2030 BAU (increasing rank describes lower risk)	158	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)	158	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)	157	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)	157	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)	160	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)	151	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

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Indicator	Value	Description	Source
Total water footprint of national consumption (m3/a/cap)	3420.61	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 (%)	99.25	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)	0.00	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)	0.00	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 (%)	0.00	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)	0.00	World Development Indicators	The World Bank 2018, Data , hompage accessed 20/04/2018
Total internal renewable water resources (IRWR) (10^9 m3/year)	0.00	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)	0.00	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)	0.00	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

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Indicator	Value	Description	Source
Total renewable water resources (10^9 m3/year)	0.00	Aquastat - Water Ressources	FAO. 2016. AQUASTAT website. Food and Agriculture Organization of the United Nations (FAO). Website accessed on 2018/04/13
Dependency ratio (%)	0.00	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)	0.00	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]	0.00	WorldHappinessReport.org	World Happiness Report, homepage accessed 20/04/2018

Country Aspects

1. PHYSICAL ASPECTS

1.1. WATER RESOURCES

1.1.1. WATER RESOURCES

There are four main river basins in Brunei Darussalam: Temburong, Belait, Tutong and Brunei.
The Temburong, the smallest of the rivers, drains a catchment area of about 430km2.
The Belait is the largest basin, with an area of 2,700km2. The lower catchment comprises an extensive area of peat swamp forest. The river narrows at the town of Kuala Belait and a sandbar restricts the discharge of water to the South China Sea. Some areas in the upper catchment have been cleared for agriculture.
The Tutong basin, which is about 1,300km2 in area, has a complex estuary system formed between two sand spits. Subject to fairly high tidal influence, its lower catchment is mainly floodplain. The upper catchment is jungle with patches of agriculture. The basin also encompasses Brunei's largest lake, the Tasek Merimbun.
The Brunei river flows into Brunei Bay. The upper reaches of the river are a major fresh water source, particularly for the western part of the country.
By analogy with the whole island, the runoff coefficient is estimated at 1.5m/year corresponding to a surface flow of 8.5km3. Limited reserves of groundwater have been identified in the Liang and Seria areas of the Belait district and in the Berakas area of the Brunei-Muara district. The estimated safe yield is 17.3 million m3/year. Also by analogy with the whole island, the total groundwater resources are estimated at 0.1km3/year, all being drained by the rivers. Internal renewable water resources are estimated at 8.5km3.
Brunei Darussalam has two dams with a total storage capacity of just over 45 million m3. The Tasek reservoir used for water supply has a total capacity of 13,000m3 and a catchment area of 2.8km2. The Benutan dam, an impounded reservoir used to regulate the Tutong river, has a total storage capacity of 45 million m3 and a catchment area of 28.6km2.
There is no hydropower dam, though one suitable site has been located within the National Forest Reserve of Temburong.
Despite adequate rainfall, developing and maintaining sufficient water resources is difficult. The low-lying coastal plains mean that river water is generally brackish for a considerable distance inland, and the catchments in the coastal zones are inadequate for any major supply scheme (WPRO, 2006).
Groundwater is also difficult to exploit due to the impermeability of the underlying rock strata (WPRO, 2006).
The majority of water resources are derived from the three main river basins, the Tutong, the Belait and the Temburong, which although generally adequate can be adversely affected by extended periods of dry weather, and the construction of dams and storage reservoirs is needed to ensure reliable supply during these dry periods (WPRO, 2006).
The extraction of raw water from any water source for the purpose of treatment for drinking water supply must be approved by the Water Services Department under the provisions of the Water Supply Act (1968). Normal treatment of raw surface waters is by dosing with lime or chalk to adjust the pH followed by flocculation and sedimentation using alum, and where necessary by the addition of polymer to speed up coagulation. The water is then filtered through rapid sand filters, before secondary pH adjustment with lime and disinfection with chlorine. Where required, sodium aluminate is used for the removal of colour (WPRO, 2006).
There are four main urban water supply systems. The Brunei-Muara-Tutong System provides a water supply for two thirds of the country's population, using raw water extracted from the Tutong river through three treatment works. During periods of dry weather, additional water is sourced from the Benutan Silver Jubilee and Tasek Dams. The Temburong and Belait Coastal Systems supply water from their respective rivers and, in the case of the Belait river, a barrage has been provided to prevent contamination of the water source by seawater. The Labi System also serves the Belait District by extraction of raw water from the Rampayoh river. Almost the entire population is now served by a reticulated drinking water system with 24-hour continuous supply through pipelines that follow the road networks. The remainder, who are in remote or difficult-to-access areas, are provided with drinking water through basic rural water supply systems (WPRO, 2006).
However, Brunei Darussalam reported that in 2006 its estimated population of 350,000 was almost entirely urbanised (99.9 per cent), with all having access to improved drinking water through household connections (WPRO, 2006).

1.1.2. WATER USE

In 1994, the total water withdrawal was estimated at 92 million m3. Urban water supply is entirely from surface water. The major use of water in industrial processes is for the liquefied natural gas industry, which abstracts and treats its own water from the Belait river. Other industrial uses are on a smaller scale, for timber/sawmills, dairy farms, soft-drink manufacture and workshops, which account for an estimated 25 per cent of overall water demand.
Initially, groundwater abstraction was undertaken in the 1950s for use by the oil and gas industries. This has been replaced by surface water resources. Groundwater abstraction, which accounts for 0.5 per cent of the total water supply, is currently limited to the local bottled water industry.
The chemical and physical qualities of natural raw water are highly dependent on the volume of water in the system from rainfall. Generally the water in the low-lying peat swamp area has low

turbidity, but is acidic, low in calcium and can be highly coloured (WPRO, 2006).

The low population densities of the catchment areas mean that pollution is not yet considered a major threat to raw surface water supplies, and potential sources of pollution are controlled under the Water Supply Act (WPRO, 2006).

There are currently no major industries within catchment areas, and the small amount of agriculture that is carried out is controlled by the Agriculture Department of the Ministry of Industry and Primary Resources. Agricultural runoff and domestic waste discharges are sufficiently low to be adequately diluted and dispersed by the rivers, and new developments within catchment areas are carefully controlled to ensure that they pose no threat to the water supply system. All solid wastes are collected and disposed of in landfills. At present, the only real threat to water supply systems comes from seawater intrusion into estuaries and the low-lying reaches of rivers, but this has been addressed by the construction of barrages (WPRO, 2006).

Although there is collaboration and exchange of information between the Ministries of Health and Development regarding water quality analysis, there is no over-arching national committee established specifically for monitoring and surveillance. Such a committee would oversee the establishment of National Standards for Drinking Water Quality, establish Water Quality Management Programmes appropriate for each agency, and review and update legislation and strengthen authority to enforce compliance and actions. This committee would also facilitate enhanced collaboration between all agencies involved in water supply to improve information exchange (WPRO, 2006).

There is also a need for sufficient numbers of trained staff to ensure that programmes are conducted efficiently and effectively, and for the provision of regular training or refresher courses appropriate to the tasks being carried out (WPRO, 2006).

1.2. WATER QUALITY, ECOSYSTEMS AND HUMAN HEALTH

Brunei Darussalam has excellent facilities for the treatment of drinking water at six government treatment plants situated throughout the country. In addition, Brunei Shell Petroleum (BSP) and Brunei Shell's Liquefied Natural Gas (LNG) manage two other facilities privately. There are also bottled water factories using advanced technology to produce purified water.

Monitoring of treated water at treatment plants, storage points and end-points is carried out daily by the Departments of Water Services and of Public Works, and by the Ministry of Development. In addition, the Department of Health Services also audits the quality of water at treatment plants and end-points.

Brunei Darussalam was declared malaria-free by WHO in 1987. Seventeen new cases were reported in 2003 but they were all imported cases. Malaria vigilance activities continue to be maintained and implemented by the Department of Health Services. Water- and sanitation-related diseases such as diarrhoeal diseases, hepatitis, cholera and typhoid occur in Brunei Darussalam (WHO, 2004).

Safe drinking water is available at the turn of the tap and is presently enjoyed by more than 90 per cent of the population. Total water usage for the period under review reached 66,157 million L, an increase of 66,157 million L. The Water Services Department, Public Works, is directly responsible for the supply of potable water and management of fresh water resources. It manages several water treatment plants with a total capacity of more than 195 million L/day and has a modern laboratory to make sure that the quality of treated water meets safe drinking standards (Johannesburg Summit, 2002).

Communicable disease is no longer considered a major threat to the health of the population of Brunei Darussalam, and the revenue from the oil and gas industry allows the government to provide the nation with one of Asia's best healthcare systems. This includes three major hospitals and numerous health clinics throughout the country. Malaria has been eradicated, cholera is virtually nonexistent, and waterborne diseases attributable to the drinking water system are rare (WPRO, 2006).

Surveillance and reporting of disease outbreaks is the responsibility of the Disease Control Unit (DCU) of the Department of Public Health Services, which also carries out epidemiological investigations, research and analysis and produces recommendations and responses to outbreaks through its Communicable Disease Surveillance System. It is also responsible for developing health-related action plans, standards and guidelines (WPRO, 2006).

Currently there are two main water quality monitoring programmes conducted by the Environmental Health Services (EHS) of the Ministry of Health and the Department of Water Services (DWS) of the Ministry of Development, which work closely together and exchange data and information (WPRO, 2006).

The EHS conducts routine monitoring and surveillance of water quality and waste disposal to control and prevent environment-related diseases and health risks and maintain a safe and healthy environment. Samples collected by EHS from each of the four districts are sent to one of the Department of Laboratory Services' 10 laboratories for analysis. Chemical analyses are carried out on raw and potable water for both government and non-government agencies, while the Microbiology Laboratory provides microbiological analysis of water samples (WPRO, 2006).

The DWS is directly responsible for the management of water resources and the supply of drinking water. It operates and maintains water supply systems including intakes, treatment works, pumping stations, reservoirs and pipelines, and conducts routine chemical and microbiological testing of raw water inputs and monitors the quality of treated supply to consumers. The DWS is expanding its water supply systems to meet the increased demand for drinking water, through the protection of existing resources and the development of new resources. Water samples are sent to its Tasek laboratory, which performs all physical, chemical and microbiological testing. Each treatment plant also has its own laboratory, which conducts testing to ensure the correct operation of the plants and the quality of treated water. These laboratories also test raw water quality from reservoirs and surface waters used in the treatment plant (WPRO, 2006).

The Pollution Control Unit of the Ministry of Health also conducts sampling through its local Health Inspectorate, and together with the DWS ensures that drinking water conforms to WHO Drinking Water Guidelines. The Ministry is also considering a national effluent discharge standard (WPRO, 2006).

The present quality requirements for public water supply in Brunei Darussalam follow the World Health Organization's (WHO) Drinking Water Guidelines (1993). Both chemical and microbiological testing is conducted to ensure that water supply conforms to these values (WPRO, 2006).

2. GOVERNANCE ASPECTS

2.1. WATER INSTITUTIONS

The main institutions related to water management are:
•the Ministry of Industry and Primary Resources (MIPR), which is responsible for facilitating and developing industries and primary resources for local markets and export;
•the Department of Agriculture of the MIPR, which is responsible for irrigation and drainage as well as water and electricity supplies. It actively promotes development of various agricultural commodities and facilitates outsourcing of raw materials and food supply;
•the Technical Services Division of the MIPR, which is responsible for coordination and facilitation of agricultural infrastructure development in Agricultural Development Area (ADA) land and Department of Agriculture premises. Its responsibilities include mechanical and agricultural engineering support, the development and maintenance of agricultural infrastructure such as buildings, access roads and irrigation and drainage systems, and the supply of electrical and domestic water requirements;
•the Departments of Water Services and of Public Works and the Ministry of Development, which are responsible for monitoring treated water at treatment plants, storage points and end-points;
•the Department of Health Services, which audits the quality of water at treatment plants and end-points.
The Department of Drainage and Sewerage is Brunei's authority for the planning, construction, maintenance and operation of land drainage and waterborne systems. It formulates policies and strategies to safeguard the infrastructure and environment through its activities (Muhammad, H., 2005).
Formerly known as the Drainage and Irrigation Section, the Drainage Section is the main authority for matters relating to flood mitigation, flood control, land drainage, rivers, streams and coastal protection works. Its main functions are (Muhammad, H., 2005):
•planning, designing and implementing drainage schemes to prevent flooding;
•advising on the provision of flood control measures and drainage;
•improving rivers and waterways;
•maintaining and safeguarding the national drainage network;
•advising and coordinating with the Department of Agriculture in matters concerning irrigation and water resources;
•planning and implementing projects for the protection of the coasts.
The objectives of the Sewerage Section are (Muhammad, H., 2005):
•to plan and design the public sewerage system;
•to operate and maintain the sewerage system and sewage treatment plants to ensure effluent quality;
•to develop controls at all sewerage systems and sewage plants to ensure that effluent qualities are complied with;
•to monitor water quality at sewage outfalls and receiving waters from rapid runoff.
The Project Section works directly under the control of the Director of Drainage and Sewerage and provides technical support for the implementation of large development projects. The objectives of this section are (Muhammad, H., 2005):
•to investigate, collect data and prepare reports on the Drainage and Sewerage system;
•to assess developmental projects for their feasibility;
•to monitor consultants in the design and implementation of large-scale projects;
•to check the designs submitted;
•to visit and co-ordinate site meetings.

2.2. WATER MANAGEMENT

Efforts are being made to diversify the economy, moving away from a heavy dependence on oil and gas and towards a more independent agriculture sector. The first of the government's four major objectives in agriculture is to enhance domestic production of rice, vegetables, poultry and livestock. The government is trying to stimulate greater interest in agriculture through the establishment of model farms and by providing training, advice and support.
The government has been supportive towards the development of agro-industries in providing various kinds of agricultural infrastructure. In this context, the Department of Agriculture has invested heavily in farm roads, irrigation and drainage infrastructure, as well as water and electricity supplies, in order to help entrepreneurs to develop their farmlands. The Department is also actively involved in facilitating inflow of technology and provides various kinds of technical services in an effort to boost the productivity and quality of domestic agriculture.
Management of the Brunei rivers does not currently include provision for dealing with future potential oil industry pollutants or for the dumping of solid waste in the rivers (Muhammad, H., 2005).
The potential and major source of sea pollution is from offshore and on-shore oil exploration and production. Under normal conditions, oil seepage from the ocean floor may take place, but the ocean system is capable of absorbing it. However, the potential of pollution is real in cases of accidents. Two such accidents happened in 1981 and 1984, when oil blow-outs resulted in the contamination of shoreline and some rivers of Brunei (Muhammad, H., 2005).
Another major environmental problem is the appearance since 1971 of the red tide phenomenon brought about by the dinoflagellate pyrodinium bahamense var sompressum species along Brunei's coast and rivers. This species produces a highly poisonous toxin that is not dangerous to shellfish but is to humans if the shellfish are eaten. There were two major outbreaks in 1980 and 1989, and since the 90s the phenomenon has been an annual event of varying intensity (Muhammad, H., 2005).
A more serious water pollution problem is that which is found in the Brunei river, which is home to

nearly 100,000 people. These people live in houses on the water called Kampung Air ('Water Village'). Their garbage and kitchen, toilet and bathroom refuse are dumped straight into the river water. Organic waste discharged into the Brunei river per household per day amounts to 2.83kg, or 2.85 million kg for the whole settlement per year (Muhammad, H., 2005).

2.3. WATER POLICY AND LEGAL FRAMEWORK

The Water Services Department, Public Works, is directly responsible for the supply of potable water and management of fresh water resources. It manages several water treatment plants with a total capacity of more than 195 million L per day and has a modern laboratory to ensure that the quality of treated water meets safe drinking standards. A Water Resources Management Working Group was established by the National Committee on Environment in 1994 with the following objectives (Johannesburg Summit 2002):

•the establishment of environmental quality objectives and corresponding standards and monitoring requirements for the water resources of Brunei Darussalam;

•the establishment of a plan of action to mitigate adverse effects on Brunei Darussalam's water resources (present or future) with particular emphasis on the following critical activities:

-raw sewerage discharge from settlements;
-silt from land clearance;
-oily waste from workshops and filling stations;
-livestock and chemical wastes from agricultural development;
-discharges from industrial development;
-domestic discharges;

•the establishment of a harmonized legal framework for water resource management.

None of the laws of Brunei Darussalam on water quality and pollution specifically addresses the protection of water quality. Further, legally enforceable discharge standards are yet to be made under these laws. Currently, internationally accepted standards are used as references, e.g. WHO and ASEAN member countries. Recommendations have been made for effluent/discharge standards, which need to be reviewed, together with classification of waters based on present and future uses (BD Gov, 1995).

3. GEOPOLITICAL ASPECTS

Brunei Darussalam lies in southeast Asia, on the northwest coast of the island shared with Indonesian Borneo and the Sabah and Sarawak states of Malaysia. It is bordered on the landward side by Sarawak. The country consists of two enclaves separated from each other by the valley of the Limbang river in Sarawak.

Brunei Darussalam belongs to the Association of Southeast Asian Nations (ASEAN), established on 8 August, 1967. The others member states of the Association are Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand and Viet Nam. The ASEAN Secretariat is based in Jakarta, Indonesia (ASEAN Secretariat, 2009).

The Roadmap For An ASEAN Community 2009-2015 stresses the need for ASEAN member states to promote sustainability of water resources to ensure equitable accessibility and sufficient water quantity of acceptable quality to meet the needs of their people. The ASEAN Strategic Plan of Action on Water Resources Management will continue to be implemented. ASEAN is also on track to reduce by half the number of people without sustainable access to safe drinking water by 2010, and to promote integrated river basin management by 2015. The ASEAN Marine Water Quality Criteria and the ASEAN Criteria for National Protected Areas will form the basis for sustaining coastal and marine water quality and for establishing a regional network of representative marine protected areas to conserve critical habitats. Several AMS have taken the lead in establishing the Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security to protect the region's rich marine biological resources (ASEAN Secretariat, 2009).

Brunei Darussalam also belongs to the Southeast Asia Technical Advisory Committee (SEATAC) of the Global Water Partnership (World Water Council, 2000). The other countries involved are Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand and Viet Nam (David, 2004).

The vision of SEATAC is to ensure access of all inhabitants of southeast Asia to safe, adequate and affordable water, to provide sufficient water to ensure food security, to spur and sustain the economies of the region, to protect the water environment, to preserve flow regimes, biodiversity and cultural heritage, and to eliminate water-related health hazards (David, 2004).

The framework or strategy for action includes managing water resources efficiently and effectively, moving towards integrated river basin management, translating awareness into political will and capacities, and moving towards adequate and affordable water services.

Managing water resources efficiently and effectively is likely to entail: a comprehensive review of policy and legislation so as to remove policy distortions and foster a policy environment in support of the vision; the integration and coordination of fragmented activities and responsibilities for water resources management; the treatment of water as an economic good; the development and adoption of appropriate technologies; and the enhancement of institutional capacity (David, 2004).

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