Water Risk Filter

Country Overview - Benin

Water Indicators

Indicator	Value	Description	Source
Overall Basin Risk (score)	2.51	Overall Basin Risk (score)	
Overall Basin Risk (rank)	127	Overall Basin Risk (rank)	
Physical risk (score)	2.80	Physical risk (score)	
Physical risk (rank)	75	Physical risk (rank)	
Regulatory risk (score)	2.11	Regulatory risk (score)	
Regulatory risk (rank)	148	Regulatory risk (rank)	
Reputation risk (score)	2.03	Reputation risk (score)	
Reputation risk (rank)	183	Reputation risk (rank)	
1. Quantity - Scarcity (score)	2.57	1. Quantity - Scarcity (score)	
1. Quantity - Scarcity (rank)	63	1. Quantity - Scarcity (rank)	
2. Quantity - Flooding (score)	3.66	2. Quantity - Flooding (score)	
2. Quantity - Flooding (rank)	66	2. Quantity - Flooding (rank)	
3. Quality (score)	2.98	3. Quality (score)	
3. Quality (rank)	109	3. Quality (rank)	
4. Ecosystem Service Status (score)	2.13	4. Ecosystem Service Status (score)	
4. Ecosystem Service Status (rank)	114	4. Ecosystem Service Status (rank)	
5. Enabling Environment (Policy & Laws) (score)	1.00	5. Enabling Environment (Policy & Laws) (score)	
5. Enabling Environment (Policy & Laws) (rank)	184	5. Enabling Environment (Policy & Laws) (rank)	
6. Institutions and Governance (score)	2.00	6. Institutions and Governance (score)	
6. Institutions and Governance (rank)	166	6. Institutions and Governance (rank)	
7. Management Instruments (score)	2.21	7. Management Instruments (score)	
7. Management Instruments (rank)	138	7. Management Instruments (rank)	
8 - Infrastructure & Finance (score)	4.35	8 - Infrastructure & Finance (score)	
8 - Infrastructure & Finance (rank)	39	8 - Infrastructure & Finance (rank)	
9. Cultural Diversity (score)	1.00	9. Cultural importance (score)	
9. Cultural Diversity (rank)	171	9. Cultural importance (rank)	
10. Biodiversity Importance (score)	3.62	10. Biodiversity importance (score)	

Indicator	Value	Description	Source
10. Biodiversity Importance (rank)	77	10. Biodiversity importance (rank)	
11. Media Scrutiny (score)	2.10	11. Media Scrutiny (score)	
11. Media Scrutiny (rank)	166	11. Media Scrutiny (rank)	
12. Conflict (score)	1.88	12. Conflict (score)	
12. Conflict (rank)	166	12. Conflict (rank)	
1.0 - Aridity (score)	2.24	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)	54	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)	1.10	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)	137	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)	1.38	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)	125	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)	3.48	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)	56	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)	1.58	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)	126	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)	4.41	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)	21	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)	3.89	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)	20	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)	3.77	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)	65	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)	1.59	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)	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). 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)	2.98	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)	109	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)	1.71	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)	146	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)	2.98	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)	47	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)	3.74	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)	42	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)	1.00	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)	179	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)	1.00	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.

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Indicator	Value	Description	Source
5.2 - Freshwater Law Status (SDG 6.5.1) (rank)	171	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)	1.00	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)	183	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)	137	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)	159	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)	1.00	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)	173	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)	2.00	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)	142	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)	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)	104	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)	2.40	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)	147	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)	4.00	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)	36	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)	38	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)	123	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)	1.00	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)	171	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)	2.67	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)	151	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)	4.56	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)	39	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)	138	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)	1.00	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)	172	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)

Water Risk Filter

Country Overview - Benin

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)	138	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)	1.76	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)	151	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 (#)	10872298	Population, total	The World Bank 2018, Data , hompage accessed 20/04/2018
GDP (current US$)	8583031398	GDP (current US$)	The World Bank 2018, Data , hompage accessed 20/04/2018
EPI 2018 score (0-100)	38.17	Environmental Performance Index	
WGI -Voice and Accountability (0-100)	48.57	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

Water Risk Filter

Country Overview - Benin

Indicator	Value	Description	Source
WGI -Political stability no violence (0-100)	63.05	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)	33.17	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)	30.29	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
WGI - Rule of Law (0-100)	29.33	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)	36.54	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 - Benin

Indicator	Value	Description	Source
WRI BWS all industries (0-5)	0.00	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)	176	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)	152	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)	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.
Baseline Water Stress (BWS) - 2020 Pessimistic (increasing rank describes lower risk)	152	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 - Benin

Indicator	Value	Description	Source
Baseline Water Stress (BWS) - 2030 BAU (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.
Baseline Water Stress (BWS) - 2030 Optimistic (increasing rank describes lower risk)	152	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)	154	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)	156	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)	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 Pessimistic (increasing rank describes lower risk)	156	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.

Country Overview - Benin

Indicator	Value	Description	Source
Total water footprint of national consumption (m3/a/cap)	1136.05	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 (%)	8.76	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
Area equipped for full control irrigation: total (1000 ha)	23.04	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)	23.04	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 (%)	74.65	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)	10.30	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)	16.09	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)	10.30	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 - Benin

Indicator	Value	Description	Source
Total renewable water resources (10^9 m3/year)	26.39	Aquastat - Water Ressources	FAO. 2016. AQUASTAT website. Food and Agriculture Organization of the United Nations (FAO). Website accessed on 2018/04/13
Dependency ratio (%)	60.97	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)	2426.00	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]	4.14	WorldHappinessReport.org	World Happiness Report, homepage accessed 20/04/2018

Country Aspects

1. PHYSICAL ASPECTS

1.1. WATER RESOURCES

1.1.1. WATER RESOURCES

The internal renewable water resources are estimated to be 10.3km3/year and total renewable resources, including water entering the country, 26.4km3/year. The total water surface and the capacity of groundwater recharge is estimated to be 13,106km3 (excluding the Niger but including water from upstream countries for some other stations) and 1,870km3 of water per year, respectively.

The wetlands of Benin are primarily concentrated in the south and account for about 2,505km2 as follows:

-20km2 of inland water bodies;

-2,050km2 of flood plains and lowlands;

-35km2 of water bodies, including reservoirs. In 1999, there were 226 micro-dams storing 10,000 to 150,000m3 of water. The total volume of water stored in these works is estimated to be 40 million m3 (24 million m3 for the dam in the sugar-producing region in Savé);

-400km2 of river-lagoon complex.

Rich biodiversity sanctuaries, the wetlands of Benin are being overexploited and species threatened with extinction due to human activities (construction, garbage dumps, etc) and the development of fresh water hyacinth (calamote).

According to GWP PNE-Benin (2010), the country receives an annual average of 700mm in the north and 1,300mm in the north; rainfall can reach 1,400mm in the southeast. Benin is drained by a dense hydrographical network made up of seasonal flow rivers. The renewable water resources of the country are estimated at about 15 billion m3 of water per year, including approximately 2 billion and 13 billion m3 of groundwater and surface water respectively, unequally distributed in terms of regions and seasons.

The country is still at a stage where catchments and water uses are not controlled and do not fall under any enforced regulation. The country currently uses less than 3 per cent of its renewable water resources, meaning that 97 per cent is lost through evaporation and spring runoff. According to forecasts made in 2000 (Benin Report, Water Vision 2025), Benin only needs about 40 per cent of its renewable water resources to meet its development needs to 2025, excluding the non-evaluated needs of the industrial sector. These forecasts, however, do not take into account the impacts of climate change on water resources and the increasingly pressing need for the population to adapt. In addition, the chronic lack of reliable and useful water data and the current mode of GDP calculation make it almost impossible to estimate the real contribution of water to growth and economic development in Benin (GWP PNE-Benin, 2010).

However, the irreplaceable role that water plays in the development of the country was partly taken into account in the 2007-2009 Strategic Document for Growth and Poverty Alleviation (DSCRP), in which it was identified as one of the priorities of the Beninese government. It is true to say that better water resources management is key to growth and economic development in Benin (GWP PNE-Benin, 2010).

1.1.2. WATER USE

Water resources in Benin are rarely used. Asessment of a sample of 100 million m3 of water used for agriculture, livestock and domestic purposes in the year 2001 on the basis of commonly used consumption assumptions and data collected from the Benin Electricity and Water Company (SBEE) provided the following usage breakdown:

•irrigation: 45 million m3

•livestock watering: 14 million m3

•drinking water: 41 million m3, including:

•urban population: 25 million m3

•rural population: 16 million m3

For 2025, 1,068 billion m3 of total withdrawal is expected for agriculture, livestock and domestic purposes:

•agriculture and livestock (450km2, 3,291 million head of cattle): 653 million m3

•household uses: 415 million m3

1.2. WATER QUALITY, ECOSYSTEMS AND HUMAN HEALTH

Benin has enough good-quality water to meet its needs. However, the risk of bacteriological, chemical and biological water contamination exists in areas of very high concentrations of people and in cotton production regions. Unfortunately, there exists no operational monitoring mechanism to measure progress. Irrigation, because of its very low level of development, has had no measurable impact yet on the water quality.

Although the country does not exploit more than 32 per cent of its arable land, unsuitable farming practices (extensive agriculture and slash and burn, application of chemical fertilizers, use of steep slopes and plowing parallel to the lines of steepest slope) have caused accelerated erosion and consequent siltation of water bodies.

From the perspective of the irrigation impacts on health, a relatively high prevalence of diseases linked to water (malaria, bilharzia, diarrhoea and swelling of the feet) is reported in riparian areas of development.

According to USAID (2010), the lack of safe drinking water is a major problem confronting Benin's residents, particularly in rural areas, where, according to the 2006 Demographic and Health Survey

(DHS), 43 per cent do not have access to improved water sources (Institut National de la Statistique et de l'Analyse Économique et al. 2007). The 2006 DHS also showed that 94 per cent of the population did nothing to treat drinking water to prevent diarrhoea. Of those who did treat, 50 per cent used eau de javel (household bleach, which is not manufactured to food-grade standards and is not of a consistent concentration that allows for proper dosing for water treatment) and 33 per cent used other, often inadequate treatments (such as straining through a cloth).

According to the Ministry of Health's 2005 Annual Report and data from the National Health Management Information System (Système National d'Information et de Gestion Sanitaires, or SNIGS), the principal reasons for health-facility visits for children under five were: malaria (41 per cent); respiratory infections (20 per cent); diarrhoea and gastrointestinal problems (15 per cent); and anaemia (7 per cent). The World Health Organization estimates that 13 per cent of deaths in children under five in Benin are caused by diarrhoea. High diarrhoea-related death rates can be attributed to poor hygiene and sanitation practices and poor-quality drinking water – both of which contribute to the spread of water-related diseases (USAID, 2010).

2. GOVERNANCE ASPECTS

2.1. WATER INSTITUTIONS

The country has opted for the integrated management of water resources. Three departments are responsible for this management and should work together to achieve sustainable development:

•the Ministry of Mines, Energy and Water (MMEH), which monitors the quantitative evolution of water resources and their use for drinking water and energy production through the Directorate of Water, the Department of Energy and the Benin Electricity and Water (SBEE);

•the Ministry of Agriculture, Livestock and Fisheries (MAEP), implemented through the Directorate of Agricultural Engineering (DGR), the Department of Livestock of the Directorate of Fisheries, Forestry and Natural Resources (DFRN), and Regional Action Centres for Rural Development (CARD). The Department (with its delegations in villages) is responsible for agricultural and pastoral water, soil and water conservation, aquaculture, and forest and reforestation management;

•the Ministry of Environment, Housing and Urban Development (MEHU), which works with the Department of Environment (DE), the Department of Planning (DAT), the Agency for Benin Environment (ABE) and the National Commission on Sustainable Development.

There are currently overlapping responsibilities between the three ministries. Similarly, the fight against pollution involves several different entities within the MMEH, the Ministry of Public Health, MEHU, and the Ministry of Interior, Security and Decentralisation.

The main actor in the promotion of irrigation and drainage in Benin is the public sector, which through the MAEP has mobilized most of the funding for the implementation of existing development plans and those planned for the short and medium term. The situation differs from previous development, which was achieved through donations and grants; today, external resources consist mainly of loans.

The private sector remains weak with regard to the development of irrigation, due to lack of incentives. Private developers, however, have the financial support of certain projects to promote agriculture and self-employment. In addition, the country has recently adopted a national programme to promote private irrigation; its implementation in the medium term will facilitate the gradual withdrawal of the state and its replacement with a dynamic and operational private sector.

According to GWP PNE-Benin (2010), from an institutional perspective, the water sector in Benin is characterized by a multiple decision-making centres, a sector-based management framework and a lack of collaboration and dialogue between stakeholders. Management is thus sector-based, fragmented and compartmentalized, with no cross-sectoral coordination, resulting in high economic, social and ecological costs.

2.2. WATER MANAGEMENT

There currently exists no organization of water management in agriculture. Facilities are made available without charge, and users are independently responsible for management; this approach, however, does not generally ensure the maintenance of networks and equipment. Private irrigators, meanwhile, maintain their facilities adequately but do not keep proper accounts and are not subject to taxation.

Under the auspices of the Directorate of Water, water users' associations (WUAs) have been created for the management of water points in the former communes (future districts). Their federation at the departmental level and the extension of their activities to the management of water resources has so far been gradual. The ultimate goal is to find a participatory mechanism for the creation of basin and sub-basin agencies.

Benin has made slow but steady progress in developing its water supply and sanitation (WSS) sector since the 1990s. Particularly in rural areas, international donors and the government have succeeded in significantly expanding coverage under a clear development framework. The national utility responsible for urban areas, however, has not defined strategies to improve and expand coverage and as a result has been slow to improve its performance and WSS coverage in urban and peri-urban areas (USAID, 2008).

Benin's WSS sector will need to develop clear national strategies related to WSS management capacity in order to achieve the Millennium Development Goals (MDGs). The most prominent areas requiring improvement include:

•the management capacity of both the newly created municipalities with authority over WSS service and the National Water Society of Benin (SONEB);

•the planning and management of service provider finances;

•WSS monitoring and evaluation (M&E).

The MDGs are reachable if sector financing and management capacity continue to follow current trends. Stronger M&E processes will better link WSS sector improvements to poverty reduction strategies, especially as better linkages between sanitation and health are embedded within broader poverty reduction strategies (USAID, 2008).

According to UNHCR (2009), corruption has limited access to safe water for more than half of

Benin's population. Over the past 20 years, donors have given US$87 million to water sector reform in Benin, more than half of which has come from the Japanese government.
In 2007 Benin's Water Ministry reported the existence of more than 13,000 water sources – from wells to community faucets – of which 13 per cent were malfunctioning. According to SONEB's Klican, 52 per cent of urban residents have access to water (UNHCR, 2009).
In 1998 Benin's government adopted Integrated Water Resources Management (IWRM) as a priority approach for sustainable management of its water resources. The decision was a consequence of the findings of a report on Benin's strategy for water resources management. The report, validated in February 1998, recommended the adoption of IWRM to improve water resources management in the country.
Despite important actions implemented between 1998 and 2002, the framework for water resources management in Benin was not in favour of good water governance. Following the 2002 World Summit on Sustainable Development (WSSD) resolution for countries to develop and implement national IWRM action plans as a means to achieve the water-related Millennium Development Goals, Benin's government initiated a programme to develop a national IWRM plan. This was part of the Partnership for Africa's Water Development (PAWDII) programme, supported by the Netherlands Development Cooperation with facilitation by the Global Water Partnership (GWP PNE-Benin, 2010).
Under the leadership of the Benin government, the Benin Water Partnership mobilized stakeholders from government and non-government organisations and civil society to define a 'road map' and vision of the planning process towards better water resources management (GWP PNE-Benin, 2010).
Following various workshops and studies, a drafting committee made up of national experts, supported by national and international consultants, was set up. Thematic workshops were organized to refine the results of water situation analysis studies. The water resources challenges were prioritized using Water Resources Issues Assessment Methodology (WRIAM) and priority was given to the main technical problems in terms of assessing, managing and using water resources at basin and national level. Weaknesses of the water resources management framework were also assessed and analysed. The content of the national IWRM action plan was developed. 54 Actions were defined for immediate and long-term implementation. A draft IWRM action plan was validated by stakeholders during six regional workshops. The IWRM action plan was finalized in March 2010 (GWP PNE-Benin, 2010).
The main outcomes of Benin's planning process include (GWP PNE-Benin, 2010):
•enhancement of political will for IWRM planning process;
•establishment of a national water law validated by all stakeholders and adopted in July 2009 by the government;
•development of a new water law and its transmission to parliament for review and adoption;
•development of a draft national IWRM action plan;
•beginning of the process of IWRM integration in Benin's education system;
•establishment and strengthening of CWP-Benin and its positioning as a key facilitating platform for promoting, understanding and implementing IWRM in Benin;
•building capacity of various stakeholders for the implementation of a national IWRM action plan.
The main lessons learned from Benin's IWRM process are as follows (GWP PNE-Benin, 2010):
•a common agreement is needed on the perception and understanding of IWRM principles and the IWRM planning 'road map' and methodology. This requires special attention and sufficient time to resolve difficulties;
•any law or regulatory framework developed without appropriate involvement of civil society has limited chances of success in practice;
•a clear and unreserved political commitment is an essential prerequisite for the success of the IWRM planning process;
•the involvement of, and support from, technical and financial partners in the IWRM planning process ensures some level of financial sustainability and increases the prospects of immediate implementation.
The recommendations resulting from the process are (GWP PNE-Benin, 2010):
•commitment from the government and technical and financial partners to the IWRM process by on-going advocacy action should be maintained;
•IWRM experiences and principles should be integrated into the education system;
•investment in capacity building, training courses and specialization of qualified staff in IWRM and its related sub-sectors should be increased;
•a new IWRM institutional framework, including monitoring and evaluation structures with sufficient means for regular assessment of the IWRM action plan's implementation, should be established.
From a political and legal perspective, the IWRM process enabled Benin to develop a national water policy, which was validated by key stakeholders in January 2008 and adopted by the government in July 2009. A draft water law was validated by stakeholders in April 2005 and submitted to parliament for adoption in July 2007. This new water law is the only water-specific regulation that considers the different reforms carried out in the sector in the context of decentralization. It replaces the obsolete 1987 water law.

2.3. WATER POLICY AND LEGAL FRAMEWORK

While the policy and strategic approaches of irrigation schemes have been defined, they are not yet expressed in a single document. They aim to create the necessary conditions for modern, intensive and competitive agriculture, capable of ensuring the food security of the country and forming the basis of its economy, and integrated and sustainable natural resources management. Strengthening food security and agricultural diversification, and increasing productivity and conservation of the country's ecological heritage are the key objectives that may influence the management of water resources; these are set out in the Master Plan for Agricultural and Rural Development and the Letter of Representation of the rural development policy.
Two strategic studies have been conducted, one on the management of water resources in 1996, and the other on the wetlands in 2001. Regarding the latter, negotiations with stakeholders

continue.
The following laws provide the legislative, legal and regulatory framework for the country:
-the legal regime governing the forests of Benin (Act No. 93-009 of 2 July, 1993);
-the framework law on the environment (Law No. 98-030 of 12 February, 1999);
-a water code and a code of public health from before independence (outdated, but now being updated);
-a proposed land code recently developed and validated by all stakeholders in 2001 but not yet passed by the legislature.
The country joined a number of international conventions relating to water and the environment, namely the Ramsar Convention (1971), the Convention on Biological Diversity (1992), the Framework Convention on Climate Change (1992), and the Convention on the fight against desertification (1994). The country has two official RAMSAR sites: the west lagoon complex and the east lagoon complex.
Efforts to decentralize authority over WSS functions for the newly created municipalities continues successfully in Benin's rural areas. In contrast, Benin's urban areas receive WSS service from one semi-autonomous public utility, known as SONEB.
Sanitation services differ markedly from water supply services in both institutional arrangements and coverage of services. The Hygiene and Basic Sanitation Authority (DHAB) provides sanitation services directly to institutions such as schools, hospitals, SONEB and the Ministry of Environment, Housing and Urbanism. Consequently, support for better management of sanitation and hygiene functions requires substantial attention at all levels of government, particularly to establish clear lines of authority and define institutional roles and responsiblities as decentralization processes progress (USAID, 2008).
Benin is currently revising its national water policy, which includes a strategy for sanitation and hygiene, promotes IWRM and creates a regulatory agency with oversight over WSS service provider delivery standards. Estimates for sector financial planning indicate that more than sufficient investments for water supply improvements will be available, but significant donor assistance is needed in the sanitation subsector (USAID, 2008).
To improve and expand Benin's urban WSS service (especially in peri-urban areas), a cohesive strategy is needed to integrate the expansion of sanitation coverage with water supply services. SONEB needs support to improve management, given its poor capacity. Overall operations and management reforms in areas such as billing and financial planning are necessary preconditions for the utility to work toward expanding coverage. If SONEB can successfully make the transition from its reliance on government subsidies, it will be in a better position to more sustainably expand services to poorer urban and peri-urban areas (USAID, 2008).
Another concern is that funding to train and retain staff has been historically weak due to poor systems of accountability and the practice of limiting skilled personnel to short-term contracts. As a result, SONEB does not have the human resources necessary to fully implement SONEB's commerical plan and financing strategy (USAID, 2008).
In contrast to the limited successes in the urban WSS sub-sector, Benin's rural sub-sector is making great strides through the Assistance Programme for the Development of the Water Supply and Sanitation framework (PADEAR) and its transparent M&E system used on both government and donor-assisted projects. Consequently, development of rural water supply institutions and service is gaining momentum through effective performance and the inclusion of the private sector in water supply development such as borehole drilling. Furthermore, the government has adopted a medium-term goal-oriented water budgeting approach that has donors aligning their own contributions with government projects. However, continued improvements may not be sustainable as new municipalities, created through Benin's decentralization policies, begin to come to grips with with the requirement to co-finance capital improvement projects and operate and maintain systems without the ability to train and retain the necessary technical staff. Sanitation coverage still remains low in rural areas, but may improve as budgetary reforms increase the timeliness of WSS budgetary allocations from the national government to the rural service providers (USAID, 2008).

3. GEOPOLITICAL ASPECTS

Benin shares its major river basins (Niger, Mono, Volta) with its neighbouring countries. It is a member of the Niger Basin Authority (NBA), and oversees the development of these water resources in common with Togo and Niger. It also participates in ongoing discussions on the prevention of conflicts related to the operation and management of shared water resources.
Benin shares the Niger river basin with several countries, including Mali, Guinea, Nigeria, Niger, Cameroon and Chad. All of these nations have a vested interest in the vital resources provided by these waterways.
Recognising the need for cooperation, two bodies have emerged to manage the growing problems faced by the people who rely on shared water sources for survival. Both the NBA and the Lake Chad Basin Commission work towards promoting the healthy development of Lake Chad and the Niger river so that all countries can benefit (IRIN 2006).
In conjunction with international bodies, many projects have been implemented to try to alleviate some of the stresses that have been placed on these two crucial resources. The Niger Basin Initiative was launched in July, bringing together the World Wildlife Fund, the NBA, Wetlands International and the Nigerien Conservation Foundation in a two-year project to ensure that environmental concerns are considered when developing the basin (IRIN, 2006).
The catchments of several right-bank tributaries of the Middle Niger river are situated in northern Benin, occupying 2.5 per cent of the total area of the basin (37,500km2). Benin is densely populated, with an average of 65 inhabitants per km2. More than 1.95 million people live in the Niger Basin in Benin. The land within the basin is used primarily for grazing and livestock, although there are areas, once used for groundnut farming, that are now used for cotton farming.
Cotton farming in this area now contributes one-third of national production. The main city is Kandi, and Malanville is the river port. The railway from Cotonou reaches only to Parakou, in the centre of the country, thus limiting access for commerce to Kandi. The Mekrou river, a tributary of the Niger, crosses the 'W' International Park, an extensive protected sanctuary for flora and fauna

shared by Benin, Burkina Faso and Niger (Andersen et al, 2005).

The basin is a unique and complex river system with an extensive network of tributaries. Because of climatic variations, the annual river flood does not occur at the same time in different parts of the basin. There are usually high flows from the headwaters in Guinea, a decrease in flow caused by evaporation and expansion in the floodplain of the Inland Delta, and an increase in flow from tributary input through the Middle and Lower reaches as the river enters the Niger Delta. In the Upper Niger, the high-water discharges generally occur in September, and the low-water season is generally April–May. The Inland Delta has an estimated storage capacity of 70km3 but has a high rate of loss caused by evaporation over the thousands of square kilometers of its floodplain. This loss is estimated at about 44 per cent of the inflow. The peak flow period that arrives in September is delayed as it spreads out, exiting the Inland Delta three months later. A phase of receding water extends into February.

In the Middle Niger, at Niamey, the maximum flows are usually twofold: a first wet seasonal peak flow and the upstream peak flow that arrives during the dry season. The first high-water discharge, known as the white flood (because of the light sediment content of the water), occurs soon after the rainy season in September. A second rise, known as the black flood, begins in December with the arrival of inflow from upstream. May and June are the low-water months in the Middle Niger.

On the Benue, there is only one high-water season, because of the Benue's more southerly climatic location; this normally occurs from May to October, which is earlier than on the Middle Niger. The Lower Niger below its confluence with the Benue consequently has a high-water period that begins in May or June and a low-water period that is at least a month shorter than on the Middle Niger, because the rains in the south start earlier. In terms of water quality, an increase in siltation is linked to erosion, deforestation, and soil depletion (Andersen et al, 2005).

A better understanding of the Niger River Basin will assist decision makers in basin management. It is a premise of river basin management that managing the river as a system yields optimal benefits. In the case of the Niger river, this could mean increased water, food, power, transport, and so on (Andersen et al, 2005).

Optimized management of any river is difficult, primarily because of the need to recognize so many different interests. Management of an international river is particularly difficult, but much can still be done to move toward optimized management (Andersen et al, 2005).

Once cooperative investments have been made in the development of the water resources, trust and cooperation will grow between the countries and many other benefits will accrue, including those 'beyond the river', such as communication investments, increases in trade, improved flows of labour, and so on, thereby leading to better regional integration of the countries of the basin. Specific investment opportunities identified by the countries include: enhanced food and energy production; transportation; environmental management, such as investments in land productivity and measures against desertification; flood and drought management; and investments in livestock, fisheries, and tourism (Andersen et al, 2005).

The NBA Summit of Heads of State has set the organization on a renewed path, through the Shared Vision process and SDAP. If the NBA is to succeed in revitalizing itself so that it can drive regional development of the river, several criteria for success will be required of the institution, its stakeholders and the donor community. These success criteria are necessary to ensure that the re-engagement and renewal that are currently taking place within the NBA will take hold (Andersen et al, 2005).

Institutionally, the NBA will need to earn and recapture legitimacy, relevance and support from its constituency. National engagement from governments and other key stakeholders – in the form of a strong champion and an adequate coordination mechanism for river basin management – is critical to moving development forward.

For national water resources management and development aspirations to be fulfilled by the shared water resources, a broad national constituency must have ownership of the agenda (Andersen et al, 2005).

The degree to which the NBA can recapture both legitimacy and relevance will largely determine whether the institution will meet the expectations of its constituency. This is all the more important because NBA financial sustainability, which is key to its renewal and survival, will be secure only after the constituency sees the relevance and benefits from the institution (Andersen et al, 2005).

The Niger Basin Summit of Heads of State has embarked on a Shared Vision process. This is a bold commitment, moving from a past of unilateral actions on the river toward enhanced coordination, collaboration and joint action. The process is an expression of the political commitment of the heads of state to a cooperative agenda. The Shared Vision will guide the formulation of the SDAP, which will identify and define the development opportunities in which the basin countries can jointly participate. The Shared Vision and the SDAP will form a platform for mobilizing resources from the NBA countries and from the donor communities for investments to implement the SDAP (Andersen et al, 2005).

To succeed in moving this process forward, the NBA will need to continue toward greater transparency, inclusivity, and engagement of the communities and stakeholders who live with and on the river. Issues such as escalating populations, conflict and war, and environmental stresses will continue to put increased pressure on the river and its resources. Although the NBA cannot address all these issues, the organization can be an important platform for awareness of transboundary impacts of socioeconomic pressures on natural resources. The subsidiarity principle will help the NBA, as part of the SDAP, to identify areas where the institution will have a comparative advantage over well-established national and local agencies, which are also charged with working on these matters (Andersen et al, 2005).

The path ahead is clearly difficult. As the countries move forward, the key ingredients for success include continued strong political leadership, staying the course of the reform process, maintaining a dynamic and enabled staff, and sustaining a financially viable institution, to move beyond unilateral planning, to facilitate hydrodiplomacy, and to engage donors to commit to their side of the compact (Andersen et al, 2005).

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