Water Risk Filter

## Country Overview - Botswana

# Water Indicators

| Indicator | Value | Description | Source |
|---|---|---|---|
| Overall Basin Risk (score) | 2.58 | Overall Basin Risk (score) | |
| Overall Basin Risk (rank) | 111 | Overall Basin Risk (rank) | |
| Physical risk (score) | 2.57 | Physical risk (score) | |
| Physical risk (rank) | 100 | Physical risk (rank) | |
| Regulatory risk (score) | 2.92 | Regulatory risk (score) | |
| Regulatory risk (rank) | 79 | Regulatory risk (rank) | |
| Reputation risk (score) | 2.26 | Reputation risk (score) | |
| Reputation risk (rank) | 160 | Reputation risk (rank) | |
| 1. Quantity - Scarcity (score) | 2.98 | 1. Quantity - Scarcity (score) | |
| 1. Quantity - Scarcity (rank) | 44 | 1. Quantity - Scarcity (rank) | |
| 2. Quantity - Flooding (score) | 2.59 | 2. Quantity - Flooding (score) | |
| 2. Quantity - Flooding (rank) | 135 | 2. Quantity - Flooding (rank) | |
| 3. Quality (score) | 2.07 | 3. Quality (score) | |
| 3. Quality (rank) | 146 | 3. Quality (rank) | |
| 4. Ecosystem Service Status (score) | 1.68 | 4. Ecosystem Service Status (score) | |
| 4. Ecosystem Service Status (rank) | 160 | 4. Ecosystem Service Status (rank) | |
| 5. Enabling Environment (Policy & Laws) (score) | 3.55 | 5. Enabling Environment (Policy & Laws) (score) | |
| 5. Enabling Environment (Policy & Laws) (rank) | 28 | 5. Enabling Environment (Policy & Laws) (rank) | |
| 6. Institutions and Governance (score) | 2.25 | 6. Institutions and Governance (score) | |
| 6. Institutions and Governance (rank) | 152 | 6. Institutions and Governance (rank) | |
| 7. Management Instruments (score) | 2.88 | 7. Management Instruments (score) | |
| 7. Management Instruments (rank) | 92 | 7. Management Instruments (rank) | |
| 8 - Infrastructure & Finance (score) | 3.10 | 8 - Infrastructure & Finance (score) | |
| 8 - Infrastructure & Finance (rank) | 62 | 8 - Infrastructure & Finance (rank) | |
| 9. Cultural Diversity (score) | 2.00 | 9. Cultural importance (score) | |
| 9. Cultural Diversity (rank) | 112 | 9. Cultural importance (rank) | |
| 10. Biodiversity Importance (score) | 2.04 | 10. Biodiversity importance (score) | |

| Indicator | Value | Description | Source |
|---|---|---|---|
| 10. Biodiversity Importance (rank) | 181 | 10. Biodiversity importance (rank) | |
| 11. Media Scrutiny (score) | 2.00 | 11. Media Scrutiny (score) | |
| 11. Media Scrutiny (rank) | 188 | 11. Media Scrutiny (rank) | |
| 12. Conflict (score) | 2.85 | 12. Conflict (score) | |
| 12. Conflict (rank) | 62 | 12. Conflict (rank) | |
| 1.0 - Aridity (score) | 3.28 | 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) | 31 | 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) | 1.38 | The water depletion risk indicator is based on annual average monthly net water depletion from Brauman et al. (2016). Their analysis is based on model outputs from the newest version of the integrated water resources model WaterGAP3 which measures water depletion as the ratio of water consumption-to-availability. | Brauman, K. A., Richter, B. D., Postel, S., Malsy, M., & Flörke, M. (2016). Water depletion: An improved metric for incorporating seasonal and dry-year water scarcity into water risk assessments. Elem Sci Anth, 4. |
| 1.1 - Water Depletion (rank) | 111 | The water depletion risk indicator is based on annual average monthly net water depletion from Brauman et al. (2016). Their analysis is based on model outputs from the newest version of the integrated water resources model WaterGAP3 which measures water depletion as the ratio of water consumption-to-availability. | Brauman, K. A., Richter, B. D., Postel, S., Malsy, M., & Flörke, M. (2016). Water depletion: An improved metric for incorporating seasonal and dry-year water scarcity into water risk assessments. Elem Sci Anth, 4. |
| 1.2 - Baseline Water Stress (score) | 3.71 | 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) | 29 | 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) | 4.64 | 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) | 21 | 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) | 2.14 | 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) | 70 | This risk indicator is based on multi-model simulation that applies both global climate and hydrological models from the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP). To estimate the change at 2°C of global warming above 1980-2010 levels, simulated annual water discharge was averaged over a 31-year period with 2°C mean warming. Results are expressed in terms of relative change (%) in probability between present day (1980-2010) conditions and 2°C scenarios by 2050. | Schewe, J., Heinke, J., Gerten, D., Haddeland, I., Arnell, N. W., Clark, D. B., ... & Gosling, S. N. (2014). Multimodel assessment of water scarcity under climate change. Proceedings of the National Academy of Sciences, 111(9), 3245-3250. |

| Indicator | Value | Description | Source |
|---|---|---|---|
| 1.5 - Drought Frequency Probability (score) | 2.21 | 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. |
| 1.5 - Drought Frequency Probability (rank) | 113 | 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) | 3.16 | 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) | 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) . 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) | 2.59 | 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) | 135 | This risk indicator is based on the recurrence of floods within the 34-year time frame period of 1985 to 2019. The occurrence of floods within a given location was estimated using data from Flood Observatory, University of Colorado. The Flood Observatory use data derived from a wide variety of news, governmental, instrumental, and remote sensing source. | Brakenridge, G. R. (2019). Global active archive of large flood events. Dartmouth Flood Observatory, University of Colorado. |

| Indicator | Value | Description | Source |
|---|---|---|---|
| 2.2 - Projected Change in Flood Occurrence (by ~2050) (score) | 2.60 | 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) | 75 | 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) | 2.07 | 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).<br><br>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) | 146 | 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).<br><br>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) | 1.75 | 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) | 144 | This risk indicator is based on the data set by Grill et al. (2019) mapping the world's free-flowing rivers. Grill et al. (2019) compiled a geometric network of the global river system and associated attributes, such as hydro-geometric properties, as well as pressure indicators to calculate an integrated connectivity status index (CSI). While only rivers with high levels of connectivity in their entire length are classified as free-flowing, rivers of CSI < 95% are considered as fragmented at a certain degree. | Grill, G., Lehner, B., Thieme, M., Geenen, B., Tickner, D., Antonelli, F., ... & Macedo, H. E. (2019). Mapping the world's free-flowing rivers. Nature, 569(7755), 215. |
| 4.2 - Catchment Ecosystem Services Degradation Level (tree cover loss) (score) | 1.00 | 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.<br>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) | 179 | 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.<br>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) | 4.03 | 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) | 25 | 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) | 69 | 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) | 4.00 | 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.<br><br>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) | 25 | 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.<br><br>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.<br><br>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) | 86 | 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.<br><br>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) | 168 | 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) | 2.00 | 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) | 117 | 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) | 80 | 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.<br><br>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) | 78 | 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.<br><br>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 |
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| 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) | 93 | 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) | 2.21 | 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) | 163 | The density of monitoring stations for water quantity was applied as proxy to develop this risk indicator. The Global Runoff Data Base was used to estimate the number of monitoring stations per 1000km2 of the main river system (data base access date: May 2018). | BfG (2019). Global Runoff Data Base. German Federal Institute of Hydrology (BfG). |
| 8.1 - Access to Safe Drinking Water (score) | 2.00 | This risk indicator is based on the Joint Monitoring Programme for Water Supply, Sanitation and Hygiene (UNICEF/WHO) 2019 data. It provides estimates on the use of water, sanitation and hygiene by country for the period 2000-2017. | WHO & UNICEF (2019). Estimates on the use of water, sanitation and hygiene by country (2000-2017). Joint Monitoring Programme for Water Supply, Sanitation and Hygiene. |
| 8.1 - Access to Safe Drinking Water (rank) | 89 | 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) | 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. |

| Indicator | Value | Description | Source |
|---|---|---|---|
| 8.2 - Access to Sanitation (rank) | 62 | 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) | 4.00 | 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) | 41 | 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.<br>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) | 112 | 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.<br>This risk indicator is based on Oviedo and Larsen (2000) data set, which mapped the world's ethnolinguistic groups onto the WWF map of the world's ecoregions. This cross-mapping showed for the very first time the significant overlap that exists between the global geographic distribution of biodiversity and that of linguistic diversity. | Oviedo, G., Maffi, L., & Larsen, P. B. (2000). Indigenous and traditional peoples of the world and ecoregion conservation: An integrated approach to conserving the world's biological and cultural diversity. Gland: WWF (World Wide Fund for Nature) International. |
| 10.1 - Freshwater Endemism (score) | 1.52 | 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. |

## Country Overview - Botswana

| Indicator | Value | Description | Source |
|---|---|---|---|
| 10.1 - Freshwater Endemism (rank) | 186 | 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) | 2.56 | 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) | 132 | 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) | 2.00 | 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) | 189 | 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) | 118 | 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 - Botswana

| Indicator | Value | Description | Source |
|---|---|---|---|
| 12.1 - Conflict News Events (RepRisk) (score) | 3.00 | 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) | 87 | 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) | 2.69 | 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) | 66 | 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 (#) | 2250260 | Population, total | The World Bank 2018, Data , hompage accessed 20/04/2018 |
| GDP (current US$) | 15581137274 | GDP (current US$) | The World Bank 2018, Data , hompage accessed 20/04/2018 |
| EPI 2018 score (0-100) | 51.70 | Environmental Performance Index | |
| WGI -Voice and Accountability (0-100) | 90.00 | 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) | 59.11 | 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) | 70.67 | 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) | 70.19 | 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) | 70.67 | 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) | 80.29 | Water Governance Indicator | Kaufmann, Daniel and Kraay, Aart and Mastruzzi, Massimo, The Worldwide Governance Indicators: Methodology and Analytical Issues (September 2010). World Bank Policy Research Working Paper No. 5430. Available at SSRN: https://ssrn.com/abstract=1682132 |

| Indicator | Value | Description | Source |
|---|---|---|---|
| WRI BWS all industries (0-5) | 1.36 | 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) | 99 | 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) | 72 | 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) | 62 | 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) | 73 | 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. |

| Indicator | Value | Description | Source |
| --- | --- | --- | --- |
| Baseline Water Stress (BWS) - 2030 BAU (increasing rank describes lower risk) | 68 | 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) | 66 | 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) | 68 | 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) | 58 | 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) | 64 | 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) | 59 | 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 - Botswana

| Indicator | Value | Description | Source |
|---|---|---|---|
| Total water footprint of national consumption (m3/a/cap) | 2051.21 | 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 (%) | 38.05 | 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 |
| Area equipped for full control irrigation: total (1000 ha) | 1.44 | 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) | 1.44 | 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 (%) | 100.00 | 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) | 2.40 | 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) | 9.84 | 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) | 2.40 | 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 - Botswana

| Indicator | Value | Description | Source |
|---|---|---|---|
| Total renewable water resources (10^9 m3/year) | 12.24 | Aquastat - Water Ressources | FAO. 2016. AQUASTAT website. Food and Agriculture Organization of the United Nations (FAO). Website accessed on 2018/04/13 |
| Dependency ratio (%) | 80.39 | 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) | 5411.00 | 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] | 3.59 | WorldHappinessReport.org | World Happiness Report, homepage accessed 20/04/2018 |

# Country Aspects

## 1. PHYSICAL ASPECTS

## 1.1. WATER RESOURCES

### 1.1.1. WATER RESOURCES

Five major drainage basins exist in the country:
-the Limpopo basin occupies about 14 per cent of the country in the east;
-the Orange basin occupies about 12 per cent in the south;
-the Zambezi basin occupies about 2 per cent in the north;
-the Okavango basin, which is an endorheic basin, occupies about 9 per cent in the northwest;
-the South Interior, which also is an endorheic basin, occupies the remaining area (about 63 per cent) and includes the Kalahari Desert and the Makgadikgadi Pans.

Low rates of surface runoff and groundwater recharge are typical. Even during the wet season stream flow is not continuous, with internal rivers only flowing for 10-75 days a year. The Okavango Delta in the northwest is a large inland delta including about 6,000km2 of permanent swamp and between 7,000 and 12,000 km2 of seasonally inundated swampland. Together with the Chobe and Linyati rivers, it accounts for 95 per cent of all surface water in the country. An estimated 11km3 of water flows every year into the delta, but most of it is lost through evapotranspiration. There is a spillway from this area to the Chobe river in the Zambezi basin in periods of high floods.

Internal renewable surface water resources are estimated at 0.8km3/year. Most dams on rivers have been constructed for urban water supplies or for livestock watering. The major dams are constructed on the larger rivers and some have required international agreements. It is considered that most ‘good’ sites for larger dams have now been used or are reserved for large water supply dams (for urban and industrial water uses) that are expected to be constructed in the near future. The smaller dams on smaller rivers currently suffer from sedimentation and irregular stream flows, making planning for use by irrigation difficult. Many earth dams built for livestock watering and irrigation (over 240 since 1970) have also suffered from lack of maintenance and many are now not in use.

Groundwater resources are used throughout the country for livestock and municipal watering and for small areas of irrigation. These resources are geologically old and quality can be affected by salinity and concentrations of fluorides, nitrates and other elements. Current groundwater recharge rates are equivalent to about 1.7km3/year. Considering an overlap of about 0.1km3/year between surface water and groundwater, the total internal renewable water resources are 2.4km3/year. In most parts of Botswana groundwater abstraction effectively mines a limited resource. It is estimated that over 21,000 boreholes exist in the country, but many are not used and capped. Just over half of the registered boreholes in the country are owned by the government; the remainder are owned by private individuals. Although the amount of water potentially available is large, it is relatively expensive to exploit and is saline in many places. Aquifers also have to be protected carefully from contamination, mainly caused by faecal material from septic tanks and pit latrines.

Apart from the perennial rivers and wetlands in the north and the over-utilized Limpopo and its tributaries in the east, Botswana suffers from a lack of surface water and therefore development relies heavily on groundwater. Groundwater resources can be found almost everywhere in the region and are the main source for most of Botswana’s towns and smaller settlements, the livestock industry, its power stations and many mining developments. Rural and remote towns are often entirely dependent upon groundwater, except in cases such as Kasane on the lower Chobe-Zambezi River and Mohembo and Shakawe on the Okavango River (Plessis, A.J.E. and Rowntree K.M., 2003).

One of the factors related to the scarcity of water in Botswana is the rapidly increasing population, which is associated with a sharp increase in the demand for water. This may lead to water resource depletion if the rate of replenishment is lower than the rate of use. However, given the serious effect that HIV/AIDS is having on countries’ population growth rates in southern Africa, the earlier (outdated) estimates of population growth and accompanying water demand will be reduced significantly (Plessis, A.J.E. et al, 2003). According to a recent survey by the World Health Organisation (WHO), two thirds of infected adults (people aged 15-49 years) live in southern Africa. One in every four adults is infected in Botswana (UNAIDS, 2000).

Other factors influencing water availability and distribution in Botswana are the low and variable rainfall, high rates of evaporation, and the high cost of the exploitation of existing surface water resources. The semi-arid climatic conditions of the southern African region underpin the management strategies for both the groundwater and surface water resources (Plessis, A.J.E. et al, 2003).

In semi-arid regions such as Botswana, the variability in the rainfall is more important than the actual rainfall itself (Pallett, 1997). Over 90 per cent of the rainfall in Botswana occurs during the summer, from November to March, mainly in the form of scattered convective thunderstorms (Plessis, A.J.E. et al, 2003). Hailstorms are common at the beginning and end of the rainy season (FAO, 1995). The variability of rainfall, in terms of the amount and timing, and the length of the wet season lead to higher risks in, for example, the cultivation of crops. The temporal distribution of rainfall in Botswana is extremely variable but tends to be more reliable in the higher rainfall areas in the north of the country (Pallett, 1997).

Botswana is a particularly drought-prone country compared to the rest of the southern African region in terms of the frequency and duration of drought events. The number of drought occurrences affecting the southern Africa region has been steadily increasing. In the latter half of the twentieth century, between 1988 and 1992, over 15 drought events affected this region, compared to fewer than five such events between 1963 and 1967. Part of this trend can be tied to increased population growth and cultivation of marginal lands, while another part can be attributed to ENSO-related anomalies (Plessis, A.J.E. et al, 2003).

Water resources in Botswana are generated within the basins of the four major rivers: the Limpopo, Okavango, Orange and Zambezi rivers (Heyns, 1995). It is important to note that, apart from the Okavango river, all shared river systems flow away from Botswana and only a small area of these basins lie within the country. In contrast, the Okavango rises outside the country and much of its flow is generated outside the country. Water in Botswana is thus a common resource that must be shared between a number of the Southern African Development Community (SADC) states, such as Angola, Namibia, Zambia, Zimbabwe, South Africa and Mozambique (Plessis, A.J.E. et al, 2003).

The total mean annual surface runoff (MAR) from catchments originating within Botswana is about 1.2 x 109m3/yr-1 (FAO, 1995b). Most of the surface water resources are located in the sparsely populated districts of Ngamiland and Chobe in northern and northwestern Botswana where the perennial Chobe, Okavango, and Zambezi rivers are found (Plessis, A.J.E. et al, 2003). In the eastern part of the country, where more than 80 per cent of the population lives, all the rivers are ephemeral (Kgathi, 1999).

The concentration of population in towns and urban villages results in an increase in the local demand for water and, therefore, development in these areas relies heavily on groundwater (Plessis, A.J.E. et al, 2003). Although the total renewable groundwater resource of 1.7 x 109m3/yr-1 exceeds the internal surface water resource, local exploitation can lead to mining of groundwater resources (Pallett, 1997).

The development of surface water usage in Botswana is constrained by a number of factors such as its low and erratic run-off, lack of available dam sites, and high rates of evaporation. Approximately 35 per cent of the total water supply is from surface water; the remainder (65 per cent) is from groundwater. Surface water, however, accounts for 90 per cent of the total supply of water in urban areas such as Gaborone, Lobatse, Francistown and Selibe-Phikwe (Kgathi, 1999). It is estimated that approximately 19 per cent of the MAR is already stored in a number of dams that serve these towns (Plessis, A.J.E. et al, 2003).

Despite being a dry country, Botswana has two important wetland systems: the Okavango Delta and the Makgadikgadi Pans. Wetlands are crucial for local human populations as they provide natural resources (such as reeds and wood), grazing for livestock, and medicines, and boost the local economy through income generated by tourism. Wetlands also act as natural filters, trapping sediments and nutrients for life support. Although wetlands are limited to only a small portion of the total landscape, they are among the most threatened natural resources in many countries, especially arid ones such as Botswana. The Ramsar Convention attempts to slow down the loss of wetlands and promote sustainable use for the benefit of mankind, creating a framework for development of resources in an environmentally sensitive manner, with long-lasting benefits (Pallett, 1997). In 2000, the Okavango delta became the world's largest Ramsar site (6.8 m ha) (Plessis, A.J.E. et al, 2003).

## 1.1.2. WATER USE

Human settlements are consuming an ever-increasing share of water in Botswana. Of the 113 million m3 of water consumed in 1992, irrigation and livestock accounted for 47 per cent, municipalities 34 per cent and industries 20 per cent. In 2000, water withdrawals increased to 194 million m3, including 80 million m3 for irrigation, forestry, livestock and wildlife (41 per cent), 79 million m3 for urban use, villages, settlements and small industry (41 per cent) and 35 million m3 for mining and energy (18 per cent). By the year 2020, total water demands are expected to reach 336 million m3 annually and the municipal sector and small industry are expected to account for 52 per cent of total consumption.

Groundwater supplies two thirds of the water consumption. Rural areas depend on groundwater resources. Water from dams, rivers and other surface water sites currently contributes about one third to national water consumption. Four large dams supply some urban areas with water. A pipeline of 360km, from the dams of Letsibogo to the water plant of Mmamshia, is under construction, with the aim of supplying water to the capital city of Gaborone. A pilot project using wastewater for irrigation is being developed in Glen Valley, close to Gaborone.

As part of agricultural water supply, irrigation is key to the national strategy to increase food production in Botswana. Little or no land has a rainfed growing period of above 200 days and food demands cannot be met by low-input rainfed farming alone. Failures of large-scale irrigation systems over the whole of southern Africa suggest a need for the implementation of small-scale irrigation as an alternative. Responsibility for the planning and implementation of irrigation development rests with the Ministry of Agriculture. The Director of Water Affairs is the Registrar of the Water Apportionment Board and acts as Technical Adviser to the Board. The Water and Borehole Acts are administered by the Board and require individuals or groups to apply for a right to use irrigation water (FAO, 1995b).

Women, more than men, are often involved in small-scale irrigation development, and they face a large variety of social, economic and cultural obstacles to effective participation in irrigation development and management (Plessis, A.J.E. et al, 2003).

By international and regional standards, Botswana's per capita water consumption is low, at an estimated 95m3/year, compared to 144m3 and 412m3 for Namibia and South Africa respectively. Nonetheless, local and regional water shortages are increasing. A particular concern for Botswana is its heavy reliance on groundwater, estimated at 67 per cent of water consumption. The seriousness of water scarcity is judged differently. Despite the inadequacies in scarcity assessments, there is no doubt that water scarcity is increasing (Arntzen, J., Masike, S. and Kgathi, L., 2000).

Water use is unevenly distributed among residential user groups and economic sectors. Firstly, the poor tend to have the lowest consumption, as they rely on standpipes outside the yard or struggle to minimize their water bills from private connections. Secondly, agriculture is the largest water consumer, even though it creates much less value and formal employment than other sectors.

This apparent misallocation of water is common in the entire region (Arntzen, J. et al, 2000).

### 1.2. WATER QUALITY, ECOSYSTEMS AND HUMAN HEALTH

Water pollution is a growing problem that affects both surface water and groundwater. Groundwater becomes polluted primarily through pit latrines and livestock excrement.
The guidelines for drinking water quality are used as the basis for regulation and standard setting to ensure the safety of drinking water. The Botswana Bureau of Standards (BOBS) is the only organization in Botswana responsible for setting drinking water quality standards and guidelines and amendments of such (CSO, 2009).

## 2. GOVERNANCE ASPECTS

### 2.1. WATER INSTITUTIONS

The main institutions involved in water management are as follows.
•the Ministry of Minerals, Energy and Water Affairs (MMEWA) is responsible for national water policy. There are two water supply units under the Ministry, the Department of Water Affairs (DWA) and the Water Utilities Corporation (WUC), which are responsible for managing the country's water supply systems. The WUC is responsible for supplying water to all urban and mining centres. The DWA is the lead agency in water resources and provides support to the National Conservation Strategy Agency in the implementation of the National Conservation Strategy (Okavango). It is responsible for supplying water to the 17 major villages;
•in some situations, such as in the livestock and agricultural sector, water provision is the responsibility of the Ministry of Agriculture (MoA) and its Irrigation Section (IS), established in 1982 under the Department of Crop Production and Forestry within the Land Utilization Division. The MoA constructs small dams in farming areas used for livestock and assists syndicates (user groups);
•in the rural areas, the District Councils under the Ministry of Local Government, Lands and Housing (MLGLH) oversee the water supply to rural villages.
A number of institutions are involved in the activities of the water sector. The Ministry of Mineral Resources and Water Affairs (MMRWA) has overall responsibility for policies in the water sector. Groundwater protection and monitoring are the responsibilities of the Department of Water Affairs (DWA), supported by the Department of Geological Survey (DGS). The DWA is also responsible for the water supply to rural areas, for surface water development and planning, and for protection from pollution and aquatic weeds. The Water Utilities Corporation (WUC) is responsible for the water supply to six urban/mining sectors, except the Orapa diamond mine (whose water is supplied directly by the mining company) (Plessis, A.J.E. et al, 2003). The Ministry of Local Government, Lands and Housing (MLGLH) is responsible for the operation and maintenance of water schemes in medium-sized and small rural villages as well as wastewater management (Botswana Government, 1997 and Kgathi, 1999).

### 2.2. WATER MANAGEMENT

Until 1993, the MoA supplied water to farmers at no charge. Farmers were responsible for operating and maintaining the dams, which mainly involved building and maintaining fencing around the dams and keeping the spillways in good repair. In 1993, the ministry changed its policy and asked farmers to contribute 15 per cent of dam construction costs. The ministry also gives grants to syndicates to finance a portion of the costs of sinking boreholes for livestock watering. Syndicates operate and maintain the boreholes, but pay nothing for the water. They are required to obtain water rights from the Water Apportionment Board, which are free of charge.
National Development Plan 8 (NDP 8) consists of constructing of 30 small agricultural dams, maintaining and rehabilitating existing dams, assisting farmers in establishing small-scale irrigation schemes, and promoting the utilization of treated effluent for irrigated crop production. In order to implement NPD 8, the government earmarked the sum of US$3.1 million for the period 1997/98 – 2002/03.

### 2.3. WATER POLICY AND LEGAL FRAMEWORK

There are three main categories of land tenure: state land (25 per cent), freehold land (5 per cent) and tribal land (70 per cent). State land consists of national parks and game reserves, forest reserves, wildlife management areas, and urban areas. Freehold land is used mainly for cattle ranching. Tribal land, which is either communal or leasehold, constitutes most of the national territory. All Batswana, irrespective of sex, are entitled to use communal land for residential, commercial or agricultural purposes. Responsibility for the allocation and supervision of tribal land, once the responsibility of traditional chiefs, now rests with local Land Boards. The land cannot be sold and generally stays within the same family indefinitely, as long as it is used for the allocated purpose. The ownership of a borehole on tribal land, however, gives the owner de jure rights to the groundwater and de facto rights to the surrounding grazing land and woodland and veldt products.
The National Water Supply and Sanitation Plan was written in 1999. The main objective was to estimate water demand and availability and the development potential of the water resources. Related legislation comprises the Water Act, the Water Utilities Corporation Act, the Aquatic Weeds (Control) Act and Orders, the Boreholes Act, the Waterworks Act, the Town Councils (Public Sewers) Regulations and the Mines and Minerals Act.
According to Kgathi (1999), policies on water resources can be generally categorized as supply- or demand-oriented. The former are aimed at developing water resources in order to meet the projected demand; the latter are aimed at reducing the demand for water.
The government of Botswana is determined to create an enabling framework to facilitate the expected outputs of the division. Implementation of the recommendations of the recently completed Water Conservation and Water Demand Management in Botswana project is being undertaken and still continues. Some of these include the drafting of the National Water Conservation Policy and its related Strategy. Wide stakeholder and public consultation has

commenced and will continue to cover all districts and sub-districts in Botswana. This Policy is an integral part of the implementation of the reviewed Botswana National Water Master Plan (BNWMP) and National Development Plan 9 (NDP 9), and is a 'road map' to the better management of water resources in the country. In addition to this, the division has also drafted Regulations for the Supply of Drinking Water in Botswana, a document designed to mitigate misuse, wastage and mismanagement of drinking water supply in Botswana. (Botswana Government, 2011).

## 3. GEOPOLITICAL ASPECTS

Botswana is a landlocked country in the centre of southern Africa, between Zambia, Zimbabwe, South Africa and Namibia. Most of the rivers in Botswana (the Okavango, Limpopo, Zambezi and Orange) are shared with other countries. The Okavango River Basin Water Commission (OKACOM) was created in 1994 between Angola, Namibia and Botswana, the three countries sharing this basin, and the Zambezi Watercourse Commission was created in 2004 between the eight countries sharing the basin.

According to Plessis, A.J.E. et al (2003), the boundaries of twelve SADC states lie across fifteen major perennial and ephemeral river basins. At present there are approximately 21 agreements between different SADC countries concerning joint cooperation in various fields, including water resources of mutual interest. The commissions actively involved in the management of shared water resources in Botswana are as follows (Heyns, 1995; Pallett, 1997):

•agreement between Botswana, Mozambique, South Africa and Zimbabwe on the establishment of the Limpopo Basin Permanent Technical Committee (LBPTC), 15 June, 1986, Harare, Zimbabwe;

•agreement between the governments of Botswana and Namibia on the establishment of a Joint Permanent Water Commission (JPWC), 13 November, 1990, Windhoek, Namibia;

•agreement between Angola, Botswana and Namibia on the establishment of a Permanent Okavango River Basin Commission (OKACOM), 15 September, 1994, Windhoek, Namibia;

•agreement between Botswana and South Africa on the establishment of a Joint Permanent Technical Committee (JPTC), November 1983. In June 1989, the JPTC was replaced by a Joint Permanent Technical Commission on the Limpopo Basin and this, in turn, was replaced by another Water Commission in November 1995.

Apart from the four commissions established in Botswana, the country is actively involved with two other multinational agreements on water-related manners (Plessis, A.J.E. et al, 2003):

•the Southern African Regional Commission for the Conservation and Utilisation of the Soil (SARCCUS) between Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa and Swaziland, established in 1948;

•the Declaration, Treaty and Protocol on the establishment of the Southern African Development Community (SADC), signed on 17 August, 1992, Windhoek, Namibia;

•the SADC Protocol on Shared Watercourse Systems, signed by Botswana in August 1995 together with all but three of the SADC member states. This protocol has since been revised (in 2000) and has been ratified by all the member states except the Democratic Republic of the Congo.

The number of basins shared in the southern African region emphasises the need for international collaboration on river basin management, the equitable allocation of water, and cooperation on joint infrastructure development (Plessis, A.J.E. et al, 2003).

The usage of these potential renewable water resources is complicated by the frequent droughts and major floods. Management of Botswana's internal renewable surface and groundwater resources should be carried out in terms of their distribution within the SADC framework of shared watercourse systems (Plessis, A.J.E. et al, 2003).

## 4. SOURCES

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