Water Risk Filter

Country Overview - Pakistan

Water Indicators

Indicator	Value	Description	Source
Overall Basin Risk (score)	3.25	Overall Basin Risk (score)	
Overall Basin Risk (rank)	10	Overall Basin Risk (rank)	
Physical risk (score)	3.36	Physical risk (score)	
Physical risk (rank)	10	Physical risk (rank)	
Regulatory risk (score)	3.15	Regulatory risk (score)	
Regulatory risk (rank)	49	Regulatory risk (rank)	
Reputation risk (score)	3.04	Reputation risk (score)	
Reputation risk (rank)	48	Reputation risk (rank)	
1. Quantity - Scarcity (score)	3.28	1. Quantity - Scarcity (score)	
1. Quantity - Scarcity (rank)	33	1. Quantity - Scarcity (rank)	
2. Quantity - Flooding (score)	3.94	2. Quantity - Flooding (score)	
2. Quantity - Flooding (rank)	36	2. Quantity - Flooding (rank)	
3. Quality (score)	3.50	3. Quality (score)	
3. Quality (rank)	52	3. Quality (rank)	
4. Ecosystem Service Status (score)	2.63	4. Ecosystem Service Status (score)	
4. Ecosystem Service Status (rank)	76	4. Ecosystem Service Status (rank)	
5. Enabling Environment (Policy & Laws) (score)	2.70	5. Enabling Environment (Policy & Laws) (score)	
5. Enabling Environment (Policy & Laws) (rank)	105	5. Enabling Environment (Policy & Laws) (rank)	
6. Institutions and Governance (score)	3.50	6. Institutions and Governance (score)	
6. Institutions and Governance (rank)	46	6. Institutions and Governance (rank)	
7. Management Instruments (score)	3.10	7. Management Instruments (score)	
7. Management Instruments (rank)	63	7. Management Instruments (rank)	
8 - Infrastructure & Finance (score)	3.45	8 - Infrastructure & Finance (score)	
8 - Infrastructure & Finance (rank)	53	8 - Infrastructure & Finance (rank)	
9. Cultural Diversity (score)	2.00	9. Cultural importance (score)	
9. Cultural Diversity (rank)	94	9. Cultural importance (rank)	
10. Biodiversity Importance (score)	3.30	10. Biodiversity importance (score)	

Water Risk Filter

Country Overview - Pakistan

Indicator	Value	Description	Source
10. Biodiversity Importance (rank)	108	10. Biodiversity importance (rank)	
11. Media Scrutiny (score)	3.00	11. Media Scrutiny (score)	
11. Media Scrutiny (rank)	65	11. Media Scrutiny (rank)	
12. Conflict (score)	3.57	12. Conflict (score)	
12. Conflict (rank)	11	12. Conflict (rank)	
1.0 - Aridity (score)	3.59	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)	26	The aridity risk indicator is based on the Global Aridity Index (Global-Aridity) and Global Potential Evapo-Transpiration (Global-PET) Geospatial data sets by Trabucco and Zomer (2009). These data sets provide information about the potential availability of water in regions with low water demand, thus they are used in the Water Risk Filter 5.0 to better account for deserts and other arid areas in the risk assessment.	Trabucco, A., & Zomer, R. J. (2009). Global potential evapo-transpiration (Global-PET) and global aridity index (Global-Aridity) geo-database. CGIAR consortium for spatial information.
1.1 - Water Depletion (score)	3.40	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)	20	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)	3.41	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)	42	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)	4.48	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)	28	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)	1.53	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)	131	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)	2.20	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)	115	This risk indicator is based on the Standardized Precipitation and Evaporation Index (SPEI). Vicente-Serrano et al. (2010) developed this multi-scalar drought index applying both precipitation and temperature data to detect, monitor and analyze different drought types and impacts in the context of global warming. The mathematical calculations used for SPEI are similar to the Standard Precipitation Index (SPI), but it has the advantage to include the role of evapotranspiration.	Vicente-Serrano, S. M., Beguería, S., & López-Moreno, J. I. (2010). A multiscalar drought index sensitive to global warming: the standardized precipitation evapotranspiration index. Journal of climate, 23(7), 1696-1718.
1.6 - Projected Change in Drought Occurrence (by ~2050) (score)	3.00	This risk indicator is based on multi-model simulation that applies both global climate and drought models from the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP) . A drought threshold for pre-industrial conditions was calculated based on time-series averages. Results are expressed in terms of relative change (%) in probability between pre-industrial and 2°C scenarios.	Frieler, K., Lange, S., Piontek, F., Reyer, C. P., Schewe, J., Warszawski, L., ... & Geiger, T. (2017). Assessing the impacts of 1.5 C global warming–simulation protocol of the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP2b). Geoscientific Model Development.
1.6 - Projected Change in Drought Occurrence (by ~2050) (rank)	69	This risk indicator is based on multi-model simulation that applies both global climate and drought models from the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP) . A drought threshold for pre-industrial conditions was calculated based on time-series averages. Results are expressed in terms of relative change (%) in probability between pre-industrial and 2°C scenarios.	Frieler, K., Lange, S., Piontek, F., Reyer, C. P., Schewe, J., Warszawski, L., ... & Geiger, T. (2017). Assessing the impacts of 1.5 C global warming–simulation protocol of the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP2b). Geoscientific Model Development.
2.1 - Estimated Flood Occurrence (score)	4.04	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)	28	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)	2.14	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)	108	This risk indicator is based on multi-model simulation that applies both global climate and drought models from the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP). The magnitude of the flood event was defined based on 100-year return period for pre-industrial conditions. Results are expressed in terms of change (%) in probability between pre-industrial and 2°C scenarios.	Frieler, K., Lange, S., Piontek, F., Reyer, C. P., Schewe, J., Warszawski, L., ... & Geiger, T. (2017). Assessing the impacts of 1.5 C global warming–simulation protocol of the Inter-Sectoral Impact Model Intercomparison Project (ISIMIP2b). Geoscientific Model Development.
3.1 - Surface Water Contamination Index (score)	3.50	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)	52	The underlying data for this risk indicator is based on a broad suite of pollutants with well-documented direct or indirect negative effects on water security for both humans and freshwater biodiversity, compiled by Vörösmarty et al. (2010). The negative effects are specific to individual pollutants, ranging from impacts mediated by eutrophication such as algal blooms and oxygen depletion (e.g., caused by phosphorus and organic loading) to direct toxic effects (e.g., caused by pesticides, mercury). The overall Surface Water Contamination Index is calculated based on a range of key pollutants with different weightings according to the level of their negative effects on water security for both humans and freshwater biodiversity: soil salinization (8%), nitrogen (12%) and phosphorus (P, 13%) loading, mercury deposition (5%), pesticide loading (10%), sediment loading (17%), organic loading (as Biological Oxygen Demand, BOD; 15%), potential acidification (9%), and thermal alteration (11%).	Vörösmarty, C. J., McIntyre, P. B., Gessner, M. O., Dudgeon, D., Prusevich, A., Green, P., ... & Davies, P. M. (2010). Global threats to human water security and river biodiversity. Nature, 467(7315), 555.
4.1 - Fragmentation Status of Rivers (score)	3.13	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)	49	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. 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)	155	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)	3.75	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)	41	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)	4.00	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)	9	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)	2.00	This risk indicator is based on SDG 6.5.1. Degree of IWRM Implementation "National Water Resources Law(s)" indicator, which corresponds to one of the three national level indicators under the Enabling Environment category. For SDG 6.5.1, enabling environment depicts the conditions that help to support the implementation of IWRM, which includes legal and strategic planning tools for IWRM.	UN Environment (2018). Progress on integrated water resources management. Global baseline for SDG 6 Indicator 6.5.1: degree of IWRM implementation.

Indicator	Value	Description	Source
5.2 - Freshwater Law Status (SDG 6.5.1) (rank)	109	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)	2.00	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)	126	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)	4.00	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)	20	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)	4.00	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)	43	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)	2.00	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)	114	This risk indicator is based on SDG 6.5.1. Degree of IWRM Implementation "Business Participation in Water Resources Development, Management and Use" indicator, which corresponds to one of the six national level indicators under the Institutions and Participation category.	UN Environment (2018). Progress on integrated water resources management. Global baseline for SDG 6 Indicator 6.5.1: degree of IWRM implementation.
7.1 - Management Instruments for Water Management (SDG 6.5.1) (score)	3.00	This risk indicator is based on SDG 6.5.1. Degree of IWRM Implementation "Sustainable and efficient water use management" indicator, which corresponds to one of the five national level indicators under the Management Instruments category. For SDG 6.5.1, management instruments refer to the tools and activities that enable decision-makers and users to make rational and informed choices between alternative actions.	UN Environment (2018). Progress on integrated water resources management. Global baseline for SDG 6 Indicator 6.5.1: degree of IWRM implementation.
7.1 - Management Instruments for Water Management (SDG 6.5.1) (rank)	28	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)	31	This risk indicator is based on the data set by UN IGRAC (2019) to determine the level of availability of groundwater monitoring data at country level as groundwater management decisions rely strongly on data availability. The level of groundwater monitoring data availability for groundwater management is determined according to a combination of three criteria developed by WWF and IGRAC: 1) Status of country groundwater monitoring programme, 2) groundwater data availability for NGOs and 3) Public access to processed groundwater monitoring data.	UN IGRAC (2019). Global Groundwater Monitoring Network GGMN Portal. UN International Groundwater Resources Assessment Centre (IGRAC).
7.3 - Density of Runoff Monitoring Stations (score)	3.65	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)	76	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)	71	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)	7	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)	66	This risk indicator is based on the average 'Financing' score of UN SDG 6.5.1. Degree of IWRM Implementation database. UN SDG 6.5.1 database contains a category on financing which assesses different aspects related to budgeting and financing made available and used for water resources development and management from various sources.	UN Environment (2018). Progress on integrated water resources management. Global baseline for SDG 6 Indicator 6.5.1: degree of IWRM implementation.
9.1 - Cultural Diversity (score)	2.00	Water is a social and cultural good. The cultural diversity risk indicator was included in order to acknowledge that businesses face reputational risk due to the importance of freshwater for indigenous and traditional people in their daily life, religion and culture. This risk indicator is based on Oviedo and Larsen (2000) data set, which mapped the world's ethnolinguistic groups onto the WWF map of the world's ecoregions. This cross-mapping showed for the very first time the significant overlap that exists between the global geographic distribution of biodiversity and that of linguistic diversity.	Oviedo, G., Maffi, L., & Larsen, P. B. (2000). Indigenous and traditional peoples of the world and ecoregion conservation: An integrated approach to conserving the world's biological and cultural diversity. Gland: WWF (World Wide Fund for Nature) International.
9.1 - Cultural Diversity (rank)	94	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)	2.09	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)	172	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)	4.51	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)	40	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)	68	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)	3.00	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)	21	This risk indicator is based on joint qualitative research by WWF and Tecnoma (Typsa Group). It indicates how aware people are of water-related issues due to global media coverage. Familiarity to and media coverage of the region and regional water-related disasters are taken into account.	WWF & Tecnoma (TYPSA Group)

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Indicator	Value	Description	Source
12.1 - Conflict News Events (RepRisk) (score)	4.00	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)	8	This risk indicator is based on 2018 data collected by RepRisk on counts and registers of documented negative incidents, criticism and controversies that can affect a company's reputational risk. These negative news events are labelled per country and industry class.	RepRisk & WWF (2019). Due diligence database on ESG and business conduct risks. RepRisk.
12.2 - Hydro-political Risk (score)	3.13	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)	23	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 (#)	193203476	Population, total	The World Bank 2018, Data , hompage accessed 20/04/2018
GDP (current US$)	278913371202	GDP (current US$)	The World Bank 2018, Data , hompage accessed 20/04/2018
EPI 2018 score (0-100)	37.50	Environmental Performance Index	
WGI -Voice and Accountability (0-100)	1.43	Water Governance Indicator	Kaufmann, Daniel and Kraay, Aart and Mastruzzi, Massimo, The Worldwide Governance Indicators: Methodology and Analytical Issues (September 2010). World Bank Policy Research Working Paper No. 5430. Available at SSRN: https://ssrn.com/abstract=1682132

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Indicator	Value	Description	Source
WGI -Political stability no violence (0-100)	28.57	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
WGI - Government Effectiveness (0-100)	28.85	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)	27.40	Water Governance Indicator	Kaufmann, Daniel and Kraay, Aart and Mastruzzi, Massimo, The Worldwide Governance Indicators: Methodology and Analytical Issues (September 2010). World Bank Policy Research Working Paper No. 5430. Available at SSRN: https://ssrn.com/abstract=1682132
WGI - Rule of Law (0-100)	20.19	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 - Control of Corruption (0-100)	19.23	Water Governance Indicator	Kaufmann, Daniel and Kraay, Aart and Mastruzzi, Massimo, The Worldwide Governance Indicators: Methodology and Analytical Issues (September 2010). World Bank Policy Research Working Paper No. 5430. Available at SSRN: https://ssrn.com/abstract=1682132

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Indicator	Value	Description	Source
WRI BWS all industries (0-5)	4.31	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)	31	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)	18	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)	19	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)	18	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 - Pakistan

Indicator	Value	Description	Source
Baseline Water Stress (BWS) - 2030 BAU (increasing rank describes lower risk)	20	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)	19	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)	20	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)	23	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)	20	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)	24	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 - Pakistan

Indicator	Value	Description	Source
Total water footprint of national consumption (m3/a/cap)	1331.29	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 (%)	16.29	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)	19270.00	Aquastat - Irrigation	FAO. 2016. AQUASTAT website. Food and Agriculture Organization of the United Nations (FAO). Website accessed on 2018/04/13
Area equipped for irrigation: total (1000 ha)	19990.00	Aquastat - Irrigation	FAO. 2016. AQUASTAT website. Food and Agriculture Organization of the United Nations (FAO). Website accessed on 2018/04/13
% of the area equipped for irrigation actually irrigated (%)	0.00	Aquastat - Irrigation	FAO. 2016. AQUASTAT website. Food and Agriculture Organization of the United Nations (FAO). Website accessed on 2018/04/13
Electricity production from hydroelectric sources (% of total)	29.84	World Development Indicators	The World Bank 2018, Data , hompage accessed 20/04/2018
Total internal renewable water resources (IRWR) (10^9 m3/year)	55.00	Aquastat - Water Ressources	FAO. 2016. AQUASTAT website. Food and Agriculture Organization of the United Nations (FAO). Website accessed on 2018/04/13
Total internal renewable water resources (IRWR) (10^9 m3/year)	191.80	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)	55.00	Aquastat - Water Ressources	FAO. 2016. AQUASTAT website. Food and Agriculture Organization of the United Nations (FAO). Website accessed on 2018/04/13

Water Risk Filter

Country Overview - Pakistan

Indicator	Value	Description	Source
Total renewable water resources (10^9 m3/year)	246.80	Aquastat - Water Ressources	FAO. 2016. AQUASTAT website. Food and Agriculture Organization of the United Nations (FAO). Website accessed on 2018/04/13
Dependency ratio (%)	77.71	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)	1306.00	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]	5.47	WorldHappinessReport.org	World Happiness Report, homepage accessed 20/04/2018

Country Aspects

1. PHYSICAL ASPECTS

1.1. WATER RESOURCES

1.1.1. WATER RESOURCES

Pakistan can be divided into three hydrological units:

-The Indus basin covering more than 566,000km2 or 71% of the territory, comprising the whole of the provinces of Punjab, Sindh and North West Frontier Province (NWFP) and the eastern part of Balochistan. The Indus River has two main tributaries, the Kabul on the right bank and the Panjnad on the left bank. The Panjnad is the flow resulting from five main rivers (literally Punjab means "five waters"): the Jhelum and Chenab, known as the western rivers, and the Ravi, Beas and Sutlej, known as the eastern rivers.

-The Karan desert in the west of Balochistan in the west of the country. This is an endorheic basin (a closed drainage basin that retains water) covering 15% of the territory. The Mashkel and Marjen rivers are the principal source of water in the basin. Marjen River is a minor tributary to the Mashkel River. The water is discharged in the Hamun-i-Mashkel lake in the southwest, at the border with Iran.

The arid Makran coast along the Arabian Sea covering 14% of the territory in its southwestern part (Balochistan province). The Hob, Porali, Hingol and Dasht are the principal rivers of this coastal zone.

The river basins outside the Indus Basin Irrigation System (IBIS), the Makran coast and the Karan closed basin, are "flashy" in nature and do not have a perennial supply. They account for a total flow less than 5km3 per year.

The long-term average annual precipitation for Pakistan is 494 mm, representing 393,273km3. Taking into account the overlap between surface water and groundwater, the internal renewable water resources are estimated at 55km3/yr, which equals the total amount of groundwater resources. Some of the groundwater drains directly into the sea, while the rest feeds the base flow of the river system which is estimated at 47.4km3/yr.

Glacier melt, snowmelt, rainfall and runoff constitute the river flows. The Indus basin has a total drainage area of 1.06 million km2, of which 56% lies in Pakistan, and the other 44% in China, Afghanistan and India. Because of the importance of irrigation in the Indus plain, the water balance of the Indus basin has been carefully studied, which is not the case for the other basins. Therefore most of the results refer only to the Indus basin. The mean annual inflow into the country through the western rivers (the Indus, including the Kabul tributary, the Jhelum and the Chenab) amounted to 170.27km3. The mean annual natural inflow into the country through the eastern rivers (the Ravi, the Beas and the Sutlej) is estimated at 11.1km3, but this is reserved for India, according to the 1960 Indus Water Treaty.

Given the seasonal nature of the Himalayan runoff, roughly 85% of the annual flows are in summer, 15% in winter.

The Indus Basin has a large groundwater aquifer covering a gross command area of 162,000km2.

In 2005, total dam capacity was estimated at 23.36km3. Currently, there are 3 large hydropower dams and 50 smaller dams (but with a height of more than 15m) in the country. Eleven smaller dams are under construction. The designed live storage capacity of the three large hydropower dams in the Indus basin is 22.98km3 comprised as follows: Tarbela 11.96km3; Raised Mangla 10.15km3, which includes recent increase of 3.58km3 and Chashma 0.87km3. The current live storage capacity of these three large hydropower dams is 17.89km3, representing an overall loss of storage of 22% (WB, 2005). The designed live storage capacity of the 50 small dams is 0.383km3. There are more than 1,600 mini-dams (with a height of less than 15m), which were constructed for small-scale irrigation purposes, but their capacity is very low as a mini-dam is normally constructed for an individual farmer. The hydropower potential in Pakistan is over 100,000 MW with identified sites of 59000 MW. Currently, studies under way include Diamer Basha, Bunji and Kohala amongst many others (Hydro Potential In Pakistan, WAPDA, 2011). The Indus River and its tributaries are the main source of water. Its main gorge, between the Skardu and Tarbela, has a potential of almost 30,000MW.

1.1.2. WATER USE

In 2008, total water withdrawal was estimated at 183.4km3, of which surface water withdrawal accounts for 121.8km3 (66.4%) and groundwater withdrawal accounts for 61.6 km3 (33.6%). This refers mainly to the Indus Basin Irrigation System (IBIS), the withdrawal outside the IBIS being extremely small. Water withdrawal by agriculture was estimated at 172.4km3, or 94% of the total water withdrawal and municipal and industrial withdrawals at 9.7km3 and 1.4 km3, respectively.

Most summer rains are not available for crop production or recharge to groundwater because of rapid runoff of torrential showers.

Water conveyance efficiency of the Indus Basin irrigation system is around 55.3 %; which is based on the canal conveyance efficiency of 79% and watercourse conveyance efficiency of 70%. Field application efficiency is around 75%. Thus the overall irrigation efficiency is around 41.5%.

In some areas, development appears to have reached the point where groundwater is being mined. Most urban and rural water is supplied from groundwater. Over 50% of the village water supply is obtained through hand pumps installed by private households. In saline groundwater areas, irrigation canals are the main source of municipal water.

Groundwater is pumped using electricity and diesel fuels. There are currently one million tubewells in the country, of which 87% are operated by diesel. Power failures, extended load shedding and poor supply of electricity are the major reasons for slow growth of electric tubewells compared to the diesel-operated tubewells.

Information on the use of treated wastewater and desalinated water is not available; it is however a small fraction of the total. Sewage water from urban areas is used by farmers in the peri-urban areas for raising fodder and vegetables. Farmers are also known to be reusing drainage water during periods of water scarcity for supplementing canal water supplies, but figures are not available.

1.2. WATER QUALITY, ECOSYSTEMS AND HUMAN HEALTH

Pakistan is faced with a growing population, water scarcity, system losses, distribution inequalities, loss of ecosystems, and the generation of effluents beyond its system capacity. The country is struggling to meet incremental demand for more irrigation water and to fulfil environmental flow requirements to deal with the disposal of salts and pollutants, and to meet urban, domestic and industrial needs.

Estimates from the Human Development Report (2010) show that Pakistan has a population of 184.8 million, of which at least 22.6% are below the poverty line, 10% do not have access to safe drinking water and 55% have no sanitation. According to the World Bank, Pakistan became a water-stressed country (1700 cubic meters per capita per year) around the year 2000.

According to a government source, Pakistan reached 1700 m3 in 1992 and became a water-short country, and then went down to 1500 m3 in 2002. Water scarcity (1000 m3 per capita per year of renewable supply) is expected in about 2035. However, a United Nations Development Programme source gives Pakistan's current water availability as 1090 m3 per capita per year. This is because the terms "water shortage" and "water scarcity" are often used interchangeably, while both use the 1000 m3 per capita measurement as a benchmark, "shortage" is an absolute term and scarcity is a relative concept.

Indiscriminate and unplanned disposal of effluents (including agricultural drainage water, municipal and industrial wastewater) into rivers, canals and drains is causing deterioration of water quality in the downstream parts. In 1995 around 12.435 km3/yr of untreated water were being discharged into water bodies. It was estimated that 0.484 and 0.345km3/yr of sewage was produced in Karachi and Lahore metropolitan areas respectively and most of it was discharged untreated into water bodies. The polluted water is also being used for drinking in downstream areas, causing numerous water borne diseases. In 2000, total wastewater produced was estimated at 12.33km3 while treated wastewater was estimated at 0.145km3.

Quality of groundwater (salinity) varies widely, ranging from less than 1000ppm (57,500km2) to more than 3000ppm (42,800km2). There are also quality concerns in terms of sodium adsorption ratio and residual sodium carbonate. Use of pesticides and nitrogenous fertilizers is now seriously affecting shallow groundwater and entry of effluents into rivers and canals is also causing the quality of freshwater to deteriorate. Almost all shallow freshwater is now polluted with agricultural pollutants and sewage.

Investments in drainage have been significant during the last two decades, though water logging still affects large tracts of land. Soil salinity also constrains farmers and affect agricultural production. These problems are further exacerbated by the use of poor quality groundwater. In fresh groundwater areas, excessive pumping by tube wells leads to mining and redistribution of groundwater quality. Currently, the waterlogged and saline areas are around 70,000km2. During the late 1990s most of the SCARP (Salinity Control and Reclamation Project) tube wells were abandoned and farmers were provided support to install shallow tube wells.

Major environmental problems are:

-water pollution from raw sewage, industrial wastes and agricultural runoff

-limited natural fresh water resources (most of the population does not have access to drinkable water)

-deforestation

-soil erosion

-desertification

Climate change is also expected to have significant impacts on agriculture. Potential impacts include vulnerability of crops to heat stress, possible shifts in spatial boundaries of crops, changes in productivity potentials, changes in water availability and use, and changes in land use systems. Even a fractional rise in temperature could have serious adverse effects, such as considerable increase in growing degree days (GDD, which is a measure of heat accumulation used to predict the date that a flower will bloom or a crop reach maturity). This could not only affect the growth, maturity and productivity of crops, but would also require additional amounts of irrigation water to compensate for the heat stress.

The quality of shallow and deep groundwater has adverse impacts on human and animal health. Around 25% of all illnesses diagnosed at public hospitals and dispensaries and 40% of all deaths are gastro-enteric. 60% of infants' deaths are due to infections and parasitic diseases, most of which are waterborne. The most common conditions are diarrhoea, dysentery, typhoid fever, hepatitis, kidney stones, skin disease and malaria.

2. GOVERNANCE ASPECTS

2.1. WATER INSTITUTIONS

Water is a federal concern, responsibility for which is divided between the following federal institutions:

-The Ministry of Water and Power is responsible for the development of water projects including hydropower dams, main canals and inter-provincial works. The Ministry is supported by the Office of the Chief Engineering Advisor, the Chairman of the Federal Flood Commission and the Chairman of the Indus River System Authority (IRSA).

-The IRSA is responsible for the distribution of water among the provinces and assists provinces to share shortages as per the Apportionment Accord of 1991.

-The Water and Power Development Authority (WAPDA), created in 1958 as a semi-autonomous body, is the functional arm of the Ministry of Water and Power and is responsible for the development of hydropower and water development projects. It is the only institution responsible for the execution of all water and power schemes (including irrigation and drainage). It is also responsible for operation and maintenance of Pakistan's large multipurpose dams, the main hubs of freshwater reserves, and for the dissemination of water flow data to relevant authorities.

-The Federal Flood Commission's main function is to coordinate the planning, development and management of flood protection infrastructure.

-The Ministry of Food and Agriculture is responsible for water management at the watercourse command level and farm level irrigation and water productivity. The Ministry is supported by the Federal Water Management Cell, which coordinates the national projects and provides services to the provinces for planning, evaluation and monitoring of mega projects. This Cell also provides support to the provincial Departments of Agriculture through the provincial On-Farm Water Management (OFWM) Directorate Generals. These OFWMs implement the programmes and projects related to water management in agriculture and are involved in organizing water users' associations at the watercourse level and their federations at the distributary canal command level.

-The Pakistan Meteorological Department (PMD) is both a scientific and service organization that functions under the tutelage of the Ministry of Defence. In addition to providing data on meteorology, the department is also concerned with Agro meteorology, Hydrology, Astronomy and Astrophysics (including solar physics), Seismology, Geomagnetism, Atmospheric Electricity and studies of the Ionosphere and Cosmic Rays. Pakistan Meteorological Department shoulders the responsibility to investigate the factors responsible for global warming, climate change its impact assessment and adaptation strategies in various sectors of human activities.

-The Pakistan Agricultural Research Council (PARC) is a national apex research organization and responsible for the conduct of research in agriculture, land, water, energy, environment and livestock.

-The Water Resources Research Institute of the National Agricultural Research Centre of PARC is a major institution dealing with research related to water for agriculture. Recently, the federal government has transferred the "High Efficiency Irrigation Project", which is a mega project, to PARC under the directive of the Prime Minister of Pakistan.

-Pakistan Council of Research in Water Resources is an organization under the federal Ministry of Science and Technology. The Council is also involved in some of the areas of water research related to agriculture, but has no formal linkages with the Department of Agriculture in the provinces. Its activities are related to water for domestic use, water quality and control of desertification.

Irrigation and drainage are provincial subjects. The Provincial Irrigation and Drainage Authorities (PIDAs) are the custodians of the irrigation networks and act in association with the Area Water Boards (AWB). These carry out the operations and maintenance (O&M) and the distribution of water within the province, and also design and develop new irrigation and drainage schemes. The experiment of PIDAs is still in its infancy and Provincial Irrigation Departments (PIDs) are still active as the responsibility and authority is not yet transferred to the AWBs.

The Farmers' Organizations (FOs) were registered during the early 20th century. In the Institutional Reforms in water sector, the Provincial Irrigation and Drainage Authority Acts provide the authority to the PIDAs to form and register the FOs at the distributary canal level. The FOs have been established in the selected AWBs in provinces; they have the responsibility to collect the water fee.

In addition to the FOs, the first Water Users' Associations (WUA) were created in 1981 under the World Bank supported "On-Farm Water Management Programme". These were formed at the watercourse level, with a primary objective of rehabilitating the watercourses. Currently, around 80,000 WUAs have been formed and they have participated in the rehabilitation and lining of watercourses.

Environment institutions have been established within most of the organizations in addition to the federal and provincial Environmental Protection Agencies (EPAs) to address issues related to field level activities. The regulatory and legal aspects of pollution control are being implemented by the EPAs.

2.2. WATER MANAGEMENT

The government of Pakistan has undertaken a "National Project on the Improvement of Watercourses" to improve 88,000 watercourses, where 70% is contributed jointly by the federal and provincial governments and 30% by farmers. The federal government is also funding a "National Programme for Water Conservation for Productivity Enhancement using High Efficiency Irrigation System" since 2007. Service and Supply Companies have been registered from the private sector to provide installation of sprinkler and drip irrigation systems on a turn-key basis. Recently, this project has been transferred to PARC due to the extremely slow progress being made.

The public sector operates the irrigation systems above the moghas (turnout). Each season, the Water and Power Development Authority (WAPDA) of the Federal Government estimates water availability for the following season. The Provincial Irrigation Departments (PID) informs the WAPDA of provincial water demands at specific locations. The WAPDA releases water from the reservoirs to meet demands as closely as possible. The limited reservoir capacity of the systems does not allow the full regulation of rivers for irrigation.

Groundwater is providing flexibility to farmers to irrigate their fields at times of peak demand when there is scarcity of water due to fixed rotation and the continuous flow irrigation system, which is quite rigid. The water distribution system is based on a rotation schedule; although water is supplied to farmers on fixed rotation in a time equitable manner, there is inequity due to inefficiency in the conveyance of water.

In 1991 an agreement was reached between the provinces on the apportionment of the Indus water to replace a much older agreement. The new agreement has released the provincial canal systems from the need to be in operation all the time so as to protect or establish future rights. Now that the supplies have been apportioned, including the formula for sharing any surplus river flows, the provincial systems are free to move toward more efficient water use.

2.3. WATER POLICY AND LEGAL FRAMEWORK

The 1967 Land Reform Act established a register of rights which is a cadastral register for land and water rights.

The Pakistan Water Strategy was prepared during 2001 and is the basic document for water development and management in the country. There is also no formal Agriculture Policy, although policy decisions have been made on a case to case basis. The only approved Integrated Water Resources Management Policy is for Balochistan province.

The Draft National Water Policy (DNWP) has been in the process of approval since 2005. The principles adopted are:

-development of water resources to meet national development goals;

-decentralized planning and development of water resources at the basin level;

-handover water services to autonomous and accountable public and private agencies;

-engage society for sustainable use of water resources; ensure stakeholders participation through consultations;

-capacity building of institutions for effective monitoring, evaluation, research and learning.

The main strategies proposed by the DNWP are focused on:

-gaining approval of the DNWP and proposed action plan;

-institutional and legislative reforms and strengthening;

-make investments as per national water priorities;

-increase the autonomy and accountability of water services providers;

-development of incentives, regulations and awareness for sustainable use of water;

-international coordination for shared water resources; dissemination of water information;

-stakeholders consultations and partnerships;

-and institutional capacity building, monitoring and learning.

The DNWP also proposes a long list of policies for each adopted principle and proposed strategy.

3. GEOPOLITICAL ASPECTS

Under the Indus Water Treaty (1960) between India and Pakistan:

1.All water of the eastern rivers, i.e. the Sutlej, Beas and Ravi rivers taken together, shall be available for the unrestricted use of India.

2.The three western rivers (Indus, Jhelum, Chenab) and all water while flowing in Pakistan of any tributary, which in its natural course joins the Sutlej main or the Ravi main after these rivers have crossed into Pakistan, shall be available for the unrestricted use of Pakistan.

This flow reserved by treaty is estimated at 11.1km3/yr. As well, there is a development potential to compensate for the perpetual loss of the eastern waters. This Treaty helped to resolve the issues between the two countries and allowed Pakistan to have a large investment in the Indus Basin Project (IBP) during the 1960s to construct a network of canals and barrages to divert waters of the western rivers to the command of the eastern rivers, as replacement works. However, in the last few years Pakistan has objected to India's development of hydropower projects on the western rivers, Chenab and Jhelum.

A couple of years ago, India and Pakistan were in dispute over the Baglihar Dam issue. India claimed entitlement to construct plants on the three western rivers (allocated to Pakistan for unrestricted use) for generation of hydropower if it did not construct spillways with submerged gates. Pakistan thought the Baglihar Dam had three spillways on the Chenab and objected. Pakistan viewed the difference as largely a legal one, involving interpretation of the Treaty, while India viewed it mainly as an engineering one, regarding hydropower plants. The most recent issue regarding the Wullar Barrage/Tulbul Navigation Project between Pakistan and India highlight the limitations of the Indus Waters Treaty. The Wullar Barrage has been contentious for 24 years. It was proposed to be built on River Neelum and has a storage capacity of 0.3 MAF. India claims that Tulbul/Wullar barrage is not a storage project and will only be used for navigation purposes. Pakistan is reluctant because it does not want to agree to any development project which would result in India gaining control over water from the Jhelum river.

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