

## WATER RESOURCES PROFILE SERIES

The Water Resources Profile Series synthesizes information on water resources, water quality, the water-related dimensions of climate change, and water governance and provides an overview of the most critical water resources challenges and stress factors within USAID Water for the World Act High Priority Countries. The profile includes: a summary of available surface and groundwater resources; analysis of surface and groundwater availability and quality challenges related to water and land use practices; discussion of climate change risks; and synthesis of governance issues affecting water resources management institutions and service providers.

## Afghanistan Water Resources Profile Overview

Water resources can be highly seasonal, and availability can vary significantly across Afghanistan. Water stress is moderate as approximately 55 percent of freshwater resources are withdrawn<sup>i</sup> and the annual per capita freshwater availability is slightly higher than the Falkenmark Water Stress Index<sup>ii</sup> threshold for water stress.

Snowmelt during the late spring and summer is key to replenishing water resources, particularly for major rivers in the east and northeast. Water is scarce in the deserts and steppes throughout the south and west. The Hindu Kush's glaciers are melting due to rising temperature caused by climate change. This is reducing a natural water storage mechanism that protects against drought in the Amu Darya and Kabul River Basins. Higher evaporation rates caused by warmer temperatures will significantly reduce water availability over the course of the century.

Surface water shortages during droughts are accentuated by over allocation, inadequate storage, and reservoir management challenges. Insufficient surface water storage and poor reservoir management constrain water availability for irrigation and contributes to food insecurity in the Helmand, Northern, and Harirud-Murghab River Basins. Additionally, surface water abstractions for irrigation are high relative to supply.

Natural and anthropogenic contaminants increasingly threaten the viability of water sources. While comprehensive water quality data are limited, untreated municipal wastewater contaminates surface water while and open pit mining exposes surface water to erosion, sedimentation, and toxic mine tailings.

Demand for groundwater often exceeds supply. Overexploitation of groundwater in the Harirud-Murghab and Helmand Basins is reducing water supply for irrigation and water table levels are declining in the Kabul and Kandahar metropolitan areas due to over-abstraction for domestic use.

Groundwater quality is poor due to naturally occurring heavy metals. Arsenic contamination is extensive in the Helmand and Kabul Basins. Poor sanitation systems in urban areas, especially around Kabul, have contaminated aquifers that are abstracted for drinking water.

Legal and institutional frameworks for transboundary basin management are limited and international disputes over transboundary river management impact opportunities for collaboration and financing of hydraulic infrastructure and basin conservation.

Limited surface and groundwater quality monitoring impedes implementation of evidence-based policies and strategies for water management.

<sup>i</sup>SDG 6.4.2 measures [water stress](#) as the percentage of freshwater withdrawals against total renewable freshwater resources. The water stress thresholds are: no stress <25%, low 25%-50%, medium 50%-75%, high 75%-100%, and critical >100%.

<sup>ii</sup>The [Falkenmark Water Stress Index](#) measures water scarcity as the amount of renewable freshwater that is available for each person each year. A country is said to be experiencing water stress when water availability is below 1,700 m<sup>3</sup> per person per year; below 1,000 m<sup>3</sup> is considered water scarcity; and below 500 m<sup>3</sup> is absolute or severe water scarcity.

# Water Resources Availability

## KEY TAKEAWAYS

- The Kabul and Amu Darya Basins are the most hydrologically productive basins. Most precipitation is in the form of winter snowfall, which replenishes water resources during the spring and summer.
- Groundwater is concentrated in broad alluvial fans following the courses of intermontane rivers and is accessible to most major urban areas.

This section summarizes key characteristics of surface and groundwater resources. Table 1 summarizes key water resources data and Figure 1 presents key surface water resources, wetlands, and dams.

## Surface Water Resources

Afghanistan manages its surface waters through five basins: Kabul, Helmand, Harirud-Murghab, Northern, and Amu Darya.<sup>6</sup> The Hindu Kush Mountains form the headwaters of all river basins. Most basins conclude their flows in low-lying deserts, wetlands, or inland lakes and seas. However, the Kabul River, which is a tributary of the Indus River, drains to the Arabian Sea. The Kabul and Amu Darya River Basins contain 83 percent of surface water.<sup>7,8</sup> The Amu Darya River Basin includes several small lakes, including the Chaqmaqin and Zorkul in the Wakhan Corridor and Lake Shiva in the north. The Amu Darya River is one of the longest and most important rivers in Central Asia, with Afghanistan contributing 15 percent of its total flow.<sup>8,9</sup> The Amu Darya River is also vital to regional agriculture and historically sustained the Aral Sea.<sup>10,11</sup> The Band-e Amir Lakes are located west of Kabul in the Kabul Basin. The Helmand River is the longest in Afghanistan and flows almost 800 miles before reaching the Hamun Wetlands along the border with Iran.<sup>13</sup> The Helmand Basin also contains brackish lakes and wetlands, including the Nawur and Abe Istada and Gowd-I Zerrah. The Harirud and Murghab Rivers (Harirud-Murghab Basin) flow into desert oases in Turkmenistan.<sup>8</sup>

## Groundwater Resources

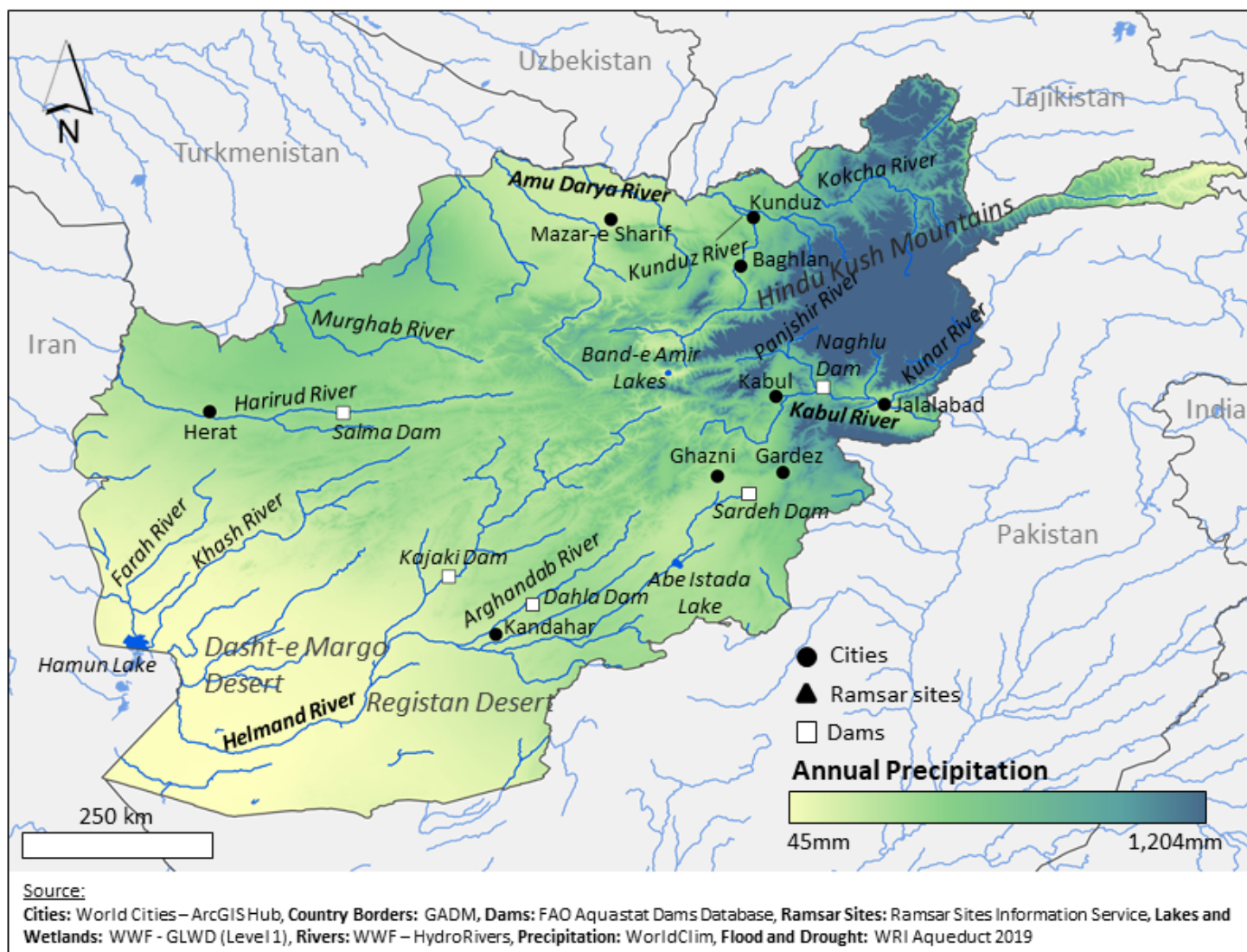
Groundwater availability and accessibility varies significantly across Afghanistan due to geologic and climate conditions. Most groundwater recharge is linked to infiltration along rivers.<sup>12</sup> Broadly, Afghanistan's aquifer systems can be grouped into three regions.<sup>13,14</sup> The Central Highlands (the Hindu Kush Mountain Range) contains the Kabul River Basin and has three connected aquifer systems (Kabul, Paghman, and Logar) with high water tables. Their layers are highly permeable and thickness can range between 20 and 70 meters.<sup>15</sup> There are over 5,000 mountain springs, mostly in the upper catchments of the Helmand River Basin, that supply surface water systems.<sup>3,16</sup> Groundwater in the Northern Plain (Northern River Basin around Mazar-e Sharif) is less accessible due to naturally high salinity. There are several important alluvial aquifers along the Balkh, Saripul, Shirin Tagab, and Qaysar River Valleys where recharge is higher. Aquifer characteristics such as thickness, depth to water table, and the presence of freshwater are highly variable around Mazar-i-Sharif, and municipal supply wells tend to be quite deep.<sup>12,17</sup> Aquifers in the Great Southern Plain (Dasht-e Margo and Registan Deserts in the southwest) are not well understood but groundwater is readily available along major watercourses.

TABLE 1. WATER RESOURCES DATA

	Year	Afghanistan	Central and South Asia Region (Median)
<u>Long-term average precipitation (mm/year)</u>	2017	327	691
<u>Total renewable freshwater resources (TRWR) (MCM/year)</u>	2017	65,330	65,330
<u>Falkenmark Index - TRWR per capita (m<sup>3</sup>/year)</u>	2017	1,839	2,529
<u>Total renewable surface water (MCM/year)</u>	2017	55,680	55,680
<u>Total renewable groundwater (MCM/year)</u>	2017	10,650	10,650
<u>Total freshwater withdrawal (TFWW) (MCM/year)</u>	2017	20,280	20,280
<u>Total dam capacity (MCM)</u>	2019	2,930	22,160
<u>Dependency ratio (%)</u>	2017	28.72	28.72
<u>Interannual variability</u>	2017	2.5	2.15
<u>Seasonal variability</u>	2017	2.5	3.15
<u>Environmental Flow Requirements (MCM/year)</u>	2017	28,290	36,310
<u>SDG 6.4.2 Water Stress (%)</u>	2017	54.75	83.60

Source: [FAO Aquastat](#)

**FIGURE 1: MAP OF WATER RESOURCES**



## Surface Water Outlook

### KEY TAKEAWAYS

- Surface water is primarily abstracted for irrigation along the Kunduz, Kabul, Harirod, and central reaches of the Helmand River. Irrigation methods tend to be inefficient and total abstractions are high relative to supply.
- Low reservoir storage capacity impedes irrigation and compounds water stress caused by high inter-seasonal and inter-annual variability.
- High abstractions on the Helmand River limit environmental flows needed to protect biodiversity in the transboundary Hamun Wetlands.
- Surface water quality is not well characterized, but fecal contamination appears to be widespread, while a burgeoning mining sector may expose surface water to chemical toxins and heavy metals.

**This section describes key sources of demand and uses of surface water, and associated challenges stemming from water availability and water quality challenges.**

**Surface water withdrawals for irrigation are high relative to water supply.** Nearly 98 percent of all freshwater abstractions are for irrigation and 85 percent of these withdrawals are from surface water.<sup>1</sup> Around

80 percent of irrigated agriculture depends on surface water.<sup>12,18</sup> Intensive irrigation, particularly of wheat, occurs along the Kunduz, Kabul, Harirod, and central reaches of the Helmand Rivers. Rainfed agriculture is

predominant in lowland regions throughout the Northern, Harirud-Murghab, and Amu Darya Basins.<sup>2</sup> Most irrigation systems are community-managed canals.<sup>16</sup> Irrigation efficiency in traditional and irrigation schemes is low (25-30 percent).<sup>4</sup> Surface water is not used extensively for urban or rural drinking water. Run-of-the-river hydropower plants are the primary source of local power and notably include the 100 MW capacity Naghlu Dam on the Kabul River.<sup>22</sup>

#### **Low storage capacity exacerbates differences between supply and demand during times of drought.**

Dams help regulate inter-seasonal and inter-annual variations in precipitation but current storage capacity is insufficient to protect against drought and food insecurity, particularly as rainfed agriculture is widespread. The Kajaki (1,200 MCM, Helmand River), Salma (633 MCM, Harirud River), Naghlu (550 MCM, Kabul River), Dahla (288 MCM, Arghandab River), and Sardeh Dams (259 MCM, Gardez/Sardeh Rivers) are the largest in Afghanistan<sup>1,28,29</sup> but overall per capita storage capacity is 2 to 50 times less than neighboring countries.<sup>1,2,27</sup> With the exception of the recently built Salma Dam, most dams are older and have reduced storage capacity from sedimentation.<sup>2,30</sup> The Dahla Dam is currently undergoing significant renovations after losing 43 percent of its original storage capacity due to sedimentation.<sup>31</sup>

**Drought, high surface water abstractions, and poor reservoir management have reduced environmental flows and impacted downstream wetlands.** The transboundary Hamun Wetlands, which are the largest in Afghanistan, have been degraded by drought and mismanagement of the Helmand River. Afghanistan is

not a member of the Ramsar Convention, but the Iranian portion of the wetlands have been designated as a Ramsar Site.<sup>32,33</sup> The Hamun Wetlands almost dried up in the early 2000s after years of drought, over-abstraction, and reduced outflows from the Kajaki Dam.

**Surface water quality is not monitored well and water quality studies are generally limited.** Most water quality studies are confined to the Kabul River Basin and are not comprehensive in scope. Chemical and microbial testing throughout the Kabul Basin indicate widespread fecal and E. Coli contamination. This is likely caused by limited sanitation systems and wastewater treatment, as well as livestock.<sup>34</sup> Uranium concentrations exceeding WHO guidelines for drinking water have also been detected in the Barik Ab River.<sup>34,35</sup>

**Mining will increase water quality risks from erosion and sedimentation, chemicals from ore processing, and heavy metals from mine tailings.** Afghanistan has vast reserves of natural gas and crude oil, and an estimated \$1 trillion reserve of mineral resources.<sup>36</sup> Afghanistan's Ministry of Mines and Petroleum has identified mining opportunities for gold, iron, copper, aluminum, gemstones, rare-earth minerals, and hydrocarbons in all river basins.<sup>36</sup> There are more than 1,400 informal large and small scale mining sites, namely around Kabul.<sup>37</sup> While the effects of these mines on surface water quality have not been studied extensively, open pit mines can increase erosion and sedimentation, and discharge mine tailings polluted with chemicals from ore processing and heavy metals into surface water resources.

## **Groundwater Outlook**

### **KEY TAKEAWAYS**

- Groundwater is most commonly used for irrigation, but most traditional irrigation systems are not viable as water sources dry up.
- Exploitation of the Kabul Aquifer is unsustainable. Almost half of shallow wells are expected to be seasonally dry within the next few decades.
- Geogenic contaminants are widespread, especially arsenic, and create longer term public health threats. Fecal contamination from poor sanitation and well infrastructure present more immediate health risks.

**This section describes key sources of demand and uses of groundwater, and associated challenges stemming from water availability and water quality challenges.**

#### **Over-abstraction of groundwater is making traditional agriculture and irrigation less viable for many farmers.**

Around 20 percent of all irrigation abstractions are from groundwater and irrigation is the largest source of groundwater withdrawals, usually through *karez*s<sup>iii</sup> and mountain springs, namely in the Helmand Basin.<sup>4,12</sup> Recent droughts and overexploitation have caused 60 to 70 percent of *karez*s to completely dry up. Increasing

water demand and climate change will further reduce their long-term viability.<sup>38</sup> Agricultural withdrawals also exceed aquifer recharge rates in the Kabul Basin and in the eastern Helmand Basin. Studies also suggest that water tables have declined up to 20 meters in Kandahar and Kabul over the past few decades.<sup>12,39</sup> Adoption of modern borehole technologies, such as solar powered wells, may be accelerating groundwater declines in the Helmand and

<sup>iii</sup>Subterranean hand dug canals, also known as qanats.



Farah Provinces where the water table has fallen 2-3 meters per year.<sup>40</sup>

**Declining groundwater tables impact drinking water availability.** Groundwater is the primary source of drinking and domestic water supply in most cities and rural areas. Many households in Kabul depend on shallow wells as municipal water is only distributed intermittently to 20 percent of the population.<sup>41</sup> It is estimated that there are over 120,000 shallow wells in Kabul<sup>2</sup> and over 40 percent are projected to be seasonally dry or completely dry by 2057 due to overexploitation.<sup>34</sup>

**High levels of salinity and geogenic contaminants, including fluoride, boron, and uranium are widespread. Arsenic is the most extensive and significant health risk.** Natural groundwater contaminants, including boron, lead, selenium, and uranium, have been detected in the Kabul Basin in excess of WHO guidelines for drinking water.<sup>34</sup> Dangerously high levels of arsenic have also been found in

groundwater in most basins.<sup>2,6</sup> Fluoride has been detected in the Harirud-Murghab and Northern Basins.<sup>6,43,44</sup> Close to 20 percent of nationally monitored wells have conductivity values above WHO guidelines, indicating high salinity.<sup>45</sup> Salinity is considered high in the Harirud-Murghab, Northern, and Helmand River Basins, particularly in Kandahar (Helmand Basin) and Mazar-e Sharif (Northern Basin).<sup>43</sup> Groundwater quality in the Amu Darya Basin and in some of the most mountainous interior provinces requires further analysis.

**Pathogenic contamination of groundwater is widespread and can be attributed to poor sanitation systems, particularly in urban areas.** One study found that more than 25 percent of monitored wells throughout Afghanistan showed signs of fecal contamination.<sup>45</sup> Fecal contamination is particularly severe in Kabul, where one-third of wastewater is estimated to infiltrate into the groundwater.<sup>6,15</sup> This pollutes the aquifer with fecal coliforms, E. Coli, and nitrates.

## Water Resources and Climate



### KEY TAKEAWAYS

- Climate change is increasing evaporation rates, decreasing precipitation, and reducing the long-term water balance so that current drought conditions may be the new normal by the end of the century.
- Afghanistan's glaciers are commonly found in the Kabul River and Amu Darya River Basins but are rapidly melting, reducing the base flow rate of rivers, and removing a natural buffer to drought.

**This section covers the climate variability and climate change, their impacts on water availability and water quality, and the risks they pose to local communities and their economies.**

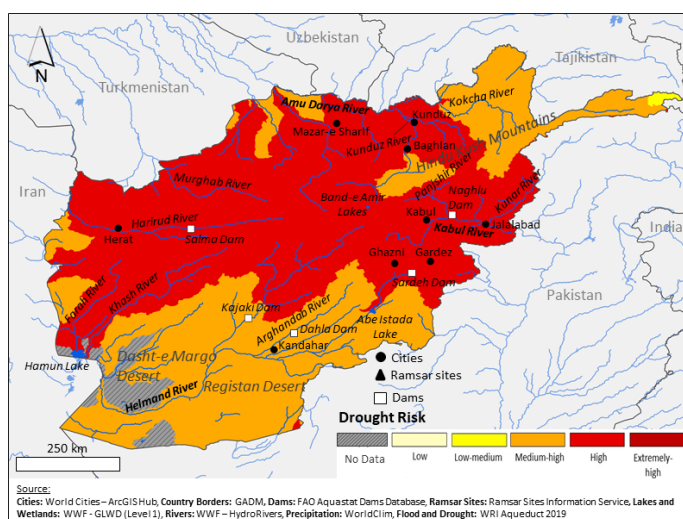
**Afghanistan's diverse landscapes and climates include sub-arctic mountains, semi-arid steppes, and lowland deserts, which have large regional and seasonal differences in water availability.** Afghanistan has low long-term average precipitation (327 mm/year)<sup>1</sup> and precipitation rates highest in the mountainous northeast (over 1,000 mm/year) and lowest in the southwestern deserts (less than 110 mm/year).<sup>2</sup> Over 80 percent of annual precipitation is snowfall received between January and March in the central and northeastern mountains.<sup>2,3</sup> Snow melts in the spring and summer contribute to peak river flows in June/July.<sup>4</sup> Snowpack and glaciers are a natural inter-annual and inter-seasonal water storage mechanism that sustains perennial watercourses and recharges aquifers.

**Climate change is increasing evaporation rates linked to higher temperature and increasing drought frequency.** Average temperature has increased by 0.6°C since the 1960s and global climate models project that temperatures will rise between 2.7-5.3°C by the end of the century.<sup>46,47</sup> Spring precipitation has decreased slightly

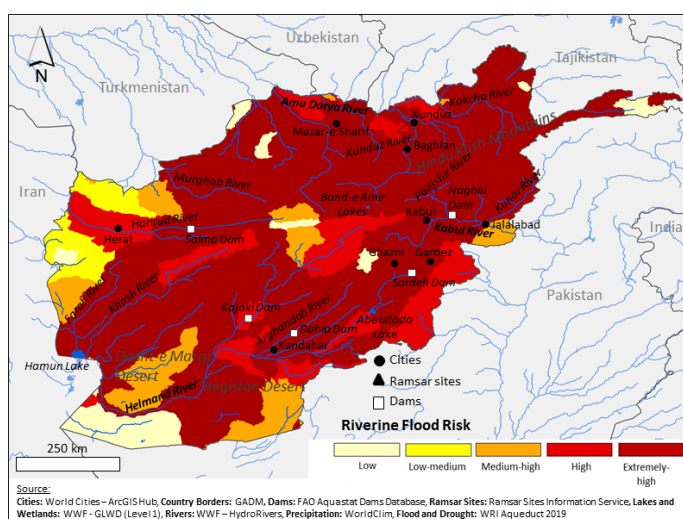
and may decline by as much as 20 percent,<sup>46,49</sup> while annual precipitation may decrease between 11 and 17 mm/year.<sup>47</sup> Projections indicate that evaporation rates will increase and that severe droughts will be 55 to 85 percent more frequent later this century. Hotter spring temperatures and drought will also accelerate snow melt and drive downstream flooding, while melting glaciers may increase the frequency of floods from glacial outburst events.<sup>48</sup> Rapid snowmelt flooding has been an issue for communities on the lower reaches of the Helmand Basin near Kandahar and may worsen as temperatures rise.<sup>48</sup>

**Glacial melt is impacting natural water storage that safeguards river flow rates during seasonal and longer-term drought.** Over 3,000 glaciers cover 2,700 km<sup>2</sup> primarily in the Amu Darya and upper Kabul Basins.<sup>50</sup> Glacial water constitutes a large portion of the water used for irrigation.<sup>50</sup> A recent study estimates that by 2100 at least half of the glacial mass in the Eastern Hindu Kush subregion, where most of Afghanistan's glaciers are found, will melt.<sup>51</sup>

**FIGURE 2: DROUGHT RISK**



**FIGURE 3. RIVERINE FLOOD RISK**



## Water Policy and Governance

### KEY TAKEAWAYS

- Key institutional and legal changes were implemented in 2020, including the formation of NWARA and the enactment of a new water law. Afghanistan lacks enforceable legal and institutional frameworks for transboundary basin management.
- National budgets prioritize hydraulic infrastructure while Integrated Water Resources Management (IWRM) governance mechanisms such as River Basin Councils and Agencies have not been systematically established.
- Surface and groundwater quality monitoring mandates for several governmental entities overlap and collected data is not comprehensive, consolidated, or shared among water sector actors.

This section provides an overview of key policies, institutions, and management challenges. Key laws, policies, and plans are summarized in Table 2 and the roles and responsibilities of select transboundary, national, and sub-national water management entities are summarized in Table 3.

**TABLE 2. KEY LAWS, POLICIES, AND PLANS**

Name	Year	Purpose
Water Affairs Management Law	2020	Replaces the 2009 Water Law. The law clarifies sectoral responsibilities, affirms the authority of the Supreme Council of Water, Land and Environment (SCoWLE), and formalizes key structures to resolve water disputes and harmonize water sector policies and implementation. Focuses on equitable, efficient, and sustainable water use.
Water Sector Strategy (2007-2013)	2007	The Water Sector Strategy, which is within the 2007-2013 Afghanistan National Development Strategy (ANDS), defined a timeline and roadmap for establishing IWRM institutions and achieving basin development outcomes.

### Limited funding and security challenges have impeded the development of key IWRM entities.

Water resources management is generally characterized as a top-down process led by the SCoWLE and is more focused on hydraulic development than conservation, water quality monitoring, water allocation, and source protection. The enactment of the Water Affairs Management Law and establishment of the NWARA in 2020 introduced sweeping changes to the legal and institutional framework for the water sector. Between

2007 and 2013, a portion of the national budget was allocated to establishing river basin organizations and capacity building initiatives.<sup>60</sup> The only operational RBCs are in the Amu Darya and Harirud-Murghab Basins.<sup>55</sup> There are over 90 WUAs in the Amu Darya Basin and a limited number in other basins, and only 350 out of 30,000 IAs have been established nationwide.<sup>55</sup> The Afghanistan National Peace and Development Framework (ANPDF) (2017-2021) re-allocated resources to other sector priorities, which effectively reduced funding for

**TABLE 3. WATER RESOURCES MANAGEMENT ENTITIES**

Mandate	Institution	Roles and Responsibilities
National	National Water Affairs Regulatory Authority (NWARA)	Established in 2020 by presidential decree, replacing the Ministry of Energy and Water (MEW). Lead ministry in charge of water resources management which manages data from regional meteorological, snow survey, and hydrometric stations. Develops and implements water policy and provides technical support and resources to national and sub-national actors. The Water Affairs Management Law empowers NWARA to determine water allocations every three years for drinking, irrigation, industry and commerce, environment, energy, and tourism.
	Supreme Council of Water, Land and Environment (SCoWLE)	Directs, coordinates, and integrates land, environment, and water resources development and planning, approves sectoral policies, and determines sectoral budgets. Chaired by the President of Afghanistan and composed of representatives from numerous line ministries.
	National Environmental Protection Agency (NEPA)	Responsible for monitoring surface water quality along with MEW and River Basin Agencies.
	Ministry of Mines and Petroleum	Responsible for monitoring and managing groundwater quality, groundwater availability and balance studies, and permitting for deep wells.
	Ministry of Public Health	Responsible for setting water quality standards based on use, including for drinking, domestic use, irrigation, and commercial use.
Sub-national	River Basin Agencies (RBAs), Sub-basin Agencies (SBAs)	Established by NWARA, these institutions are not consistently established in all basins. RBAs and SBAs develop basin management and water use plans in accordance with national water policy and in consultation with River Basin Councils (RBCs). Responsible for surface water quality monitoring.
	River Basin Councils (RBCs), Sub-Basin Councils (SBCs)	RBCs and SBCs consist of water users and government representatives from line ministries. Provide advice on water management strategy and water dispute resolutions, as well as advise and agreement on water allocation plans. Monitor water allocations and the protection of water rights.
	Water Users Associations (WUAs), Irrigation Associations (IAs)	WUAs are responsible for managing water use, distribution and operation and maintenance of main canals, and are registered with NWARA. IAs' responsibilities are similar to WUAs but these are registered with the Ministry of Agriculture, Irrigation and Livestock (MAIL). These entities are not consistently established in all river basins.

new basin-management entities while ongoing security challenges have impeded the operations of existing IWRM entities.<sup>55</sup> The 2020 Water Affairs Management Law assigned environmental planning to SCoWLE and established a Water Affairs Management Coordination Committee to harmonize sectoral planning and implementation. The structure and functions of this committee have yet to be defined.<sup>54</sup>

**Transboundary water governance is limited, which has limited potential investments in key infrastructure.** As an upstream country, Afghanistan has been reticent to establish water sharing treaties. However, in some cases this has deterred donor support in new infrastructure investments.<sup>56</sup> The 50 year old Helmand River Treaty between Iran and Afghanistan is Afghanistan's only transboundary water management treaty. However,

instability and conflict have hindered its implementation and there have been key disagreements over water allocation requirements.<sup>2,57-59</sup>

## Water Quality Monitoring

**Surface and groundwater quality are not systematically monitored.** The 2009 Water Law assigned surface water quality monitoring responsibilities to several entities, including the NEPA and RBAs, and groundwater quality monitoring to the Ministry of Mines and Petroleum.<sup>61</sup> In practice, water quality monitoring is not coordinated among these institutions and the 2020 Water Affairs Management Law did not clarify monitoring responsibilities.<sup>62</sup> A planned National Hydrological Database has the potential to increase analytical and data sharing capabilities.<sup>63</sup>

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