

## Toward sustainable water resources management: critical assessment on the implementation of integrated water resources management and water–energy–food nexus in Afghanistan

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### ABSTRACT

Afghanistan has abundant water resources; however, the current state of affairs is dismal because of the lack of integrated water resources management (IWRM) practices and prolonged war and conflict in the country. Therefore, there is a need for a systematic approach to water management, which can be materialized by integrating IWRM and the water–energy–food (WEF) nexus approach to maintain a critical balance of available water resources and their various uses at the national level. This study provides a comprehensive assessment of Afghanistan’s water resource management, including the current state, challenges, opportunities, and way forward. The identified challenges are categorized as social and environmental issues, engineering and technical and regulatory, policy and government role. These challenges are inter-connected and a novel framework toward the implementation of IWRM and the WEF nexus in Afghanistan is proposed. This framework can be used by the relevant stakeholders to prepare a roadmap for sustainable management of water resources. Such integrative approaches will enhance Afghanistan’s water, food, and energy security and significantly contribute to its economic development. Moving forward, the Afghanistan government must play a crucial role with regards to the efficient management of the country’s water resources in an integrated manner as suggested in this paper.

**Key words:** Afghanistan water resources, Integrated water resource management, Integration, Sustainable development, Water–energy–food nexus

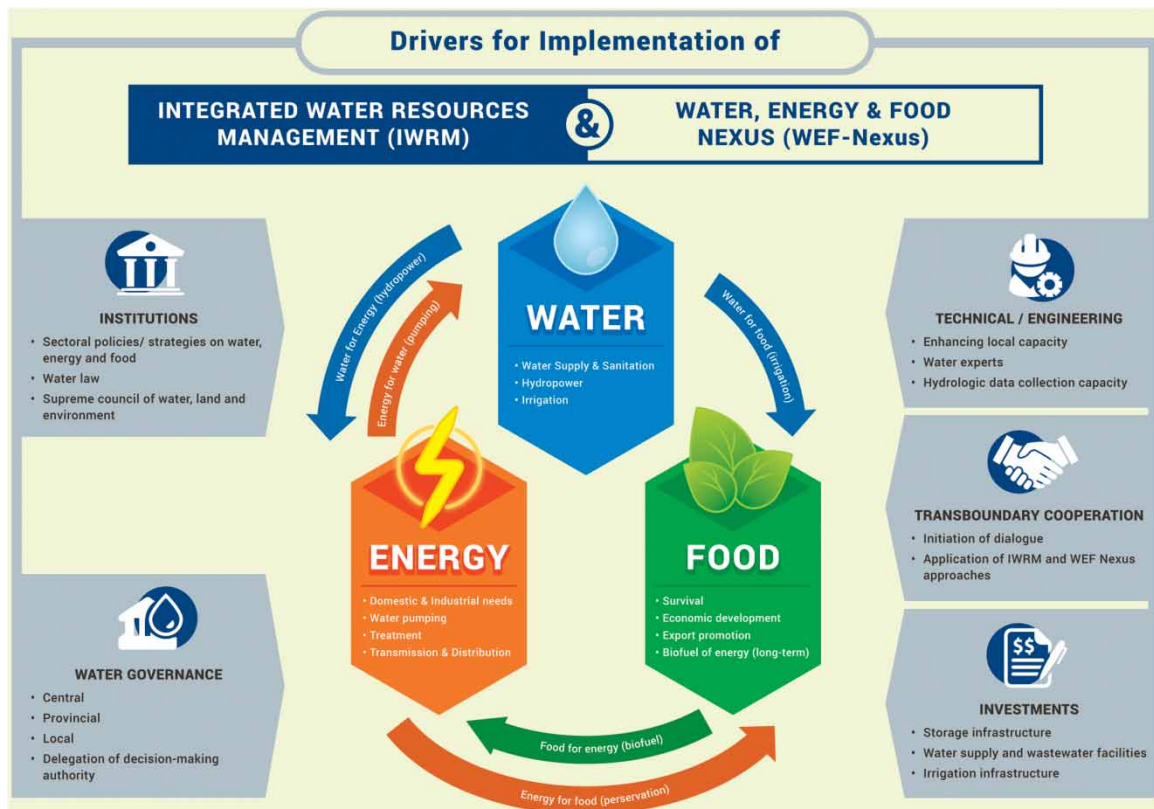
### HIGHLIGHTS

- Critical assessment on Afghanistan’s water resources development.
- Challenges to Afghanistan’s water resources development are inter-connected.
- A novel framework and multisectoral approach toward the implementation of IWRM and the WEF nexus in Afghanistan is proposed.
- Enhancing IWRM and WEF nexus may eradicate hunger as the agriculture sector is disconnected with water, land, and energy sectors.

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## GRAPHICAL ABSTRACT



## INTRODUCTION

Many countries face challenges in managing water resources in a highly dynamic and constantly changing environment. Some scholars believe that the water crisis in the 21st century is more related to management than to a real crisis of scarcity and stress (Rogers *et al.*, 2006), while Somlyody & Varis (2006) found that the deepening complexities of the water crisis are due to real problems of availability and increased demand, and to a sectoral management process that responds to problems without a systematic proactive approach. Therefore, there is an urgent need for a systematic, integrated, and predictive approach to water management (Tundisi & Matsumura-Tundisi, 2008).

For the past 30 years, Integrated Water Resources Management (IWRM) has been advocated as a response to mitigate the water crisis. The Global Water Partnership (GWP) defines IWRM as ‘a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner, without compromising the sustainability of vital ecosystems’ (GWP, 2000).

Although IWRM is intended to enable more efficient management of land, water, and other related resources in a sustainable manner, fulfilling basic human needs while preserving the natural ecosystem and balancing various conflicting issues related to these resources remain a challenge (Roitd & Avellán, 2019). Success stories related to

the implementation of IWRM as reported in the literature are scarce, partly due to its highly broad concept and associated challenges of operationalizing it (Biswas, 2008; Wichelns, 2017). Successful implementation of IWRM requires extensive information, cooperation from relevant stakeholders and involvement of interdisciplinary expertise to find the best solution, especially when conflicting interests come into play. For example, Indonesia currently faces huge challenges with regards to the implementation of IWRM owing to gaps in enabling environment, institutional frameworks, and appropriate management instruments (Fulazzaky, 2014).

Realizing the need to integrate various sectors and resources and to bridge the gaps in IWRM, the concept of water–energy–food nexus (WEF nexus) is used in this study to complement IWRM. In addition, the WEF nexus is also expected to assist in policy making, achieving higher resource efficiency and increase water, energy, and food security (Hoff, 2011). WEF nexus is defined as ‘the very close links between these three sectors and the way in which changes in one sector have an impact on one or both of the other sectors’ (Nagel & Cooke, 2017).

Questions may arise as to combining the two concepts of the IWRM and the WEF nexus. There is a recurring criticism of the nexus that it adds little to already existing integrated approaches for resources management such as IWRM, which acts as a conceptual framework by integrating and coordinating the management of water and land as a means of balancing different water uses, while meeting social and ecological needs and promoting economic development. However, by considering water alone as being at the center of the debate, there is a risk of prioritizing water-related development goals over others such as development objectives in energy and food sectors. The nexus approach considers different dimensions of water, energy, and food harmoniously and recognizes the interdependencies of various resource uses to develop sustainably (FAO, 2014). Hence, integrating IWRM with the WEF nexus approach provides a more holistic framework for the sustainable management and development of resources. This is especially true for countries like Afghanistan that are highly dependent on agriculture as their main activity for food security as well as economic development.

Currently, there is an extremely limited understanding on the concepts of IWRM and WEF nexus within the relevant stakeholders of water resources in Afghanistan. As a result, although the per capita annual water availability in Afghanistan is 2,500 m<sup>3</sup>, which is higher than 1,400 m<sup>3</sup> for Iran and 1,200 m<sup>3</sup> for Pakistan (Williams, 2009), the main challenge for Afghanistan is to maintain a critical balance between available water resources and their various uses at the national level. Also, inadequate research on the water sector makes it difficult to assess the current status, future potential and available opportunities for its vital development and growth (Wegerich, 2010). For the past 18 years, Afghanistan has been developing its water resources on a project-by-project basis characterized by *ad hoc* approaches with mono-disciplinary focus rather than more integrated and sustainable thinking. Therefore, an integrated, multisectoral and comprehensive approach to water resources planning and development is clearly needed. An initial effort was made by the government through the formulation of the Afghanistan Water Law of 2009 which included IWRM as a tool to develop national water resources (MoJ, 2009). However, in practice, no major steps have been taken to incorporate IWRM in water resources planning processes.

This paper aims to introduce a new framework to harmonize the concepts of IWRM and WEF nexus to increase resource efficiency in water, energy, and food sectors. The formulation of the proposed framework considers the integrative approaches, i.e. IWRM and WEF nexus, followed by a critical review and analysis on how these two concepts can be implemented synergistically. This requires consideration of the country’s economic and social needs, a review of the existing institutional framework and proposal for improvement as needed. The results presented in this paper can be used as part of the roadmap by the policy makers and water resources planners for sustainable management and development of water resources. The paper also aims to bridge the gap between policy and science in the implementation of IWRM and WEF nexus in Afghanistan. The past literature

on IWRM and WEF looks at the two approaches from a more generic perspective, which necessitated the application to the Afghanistan context.

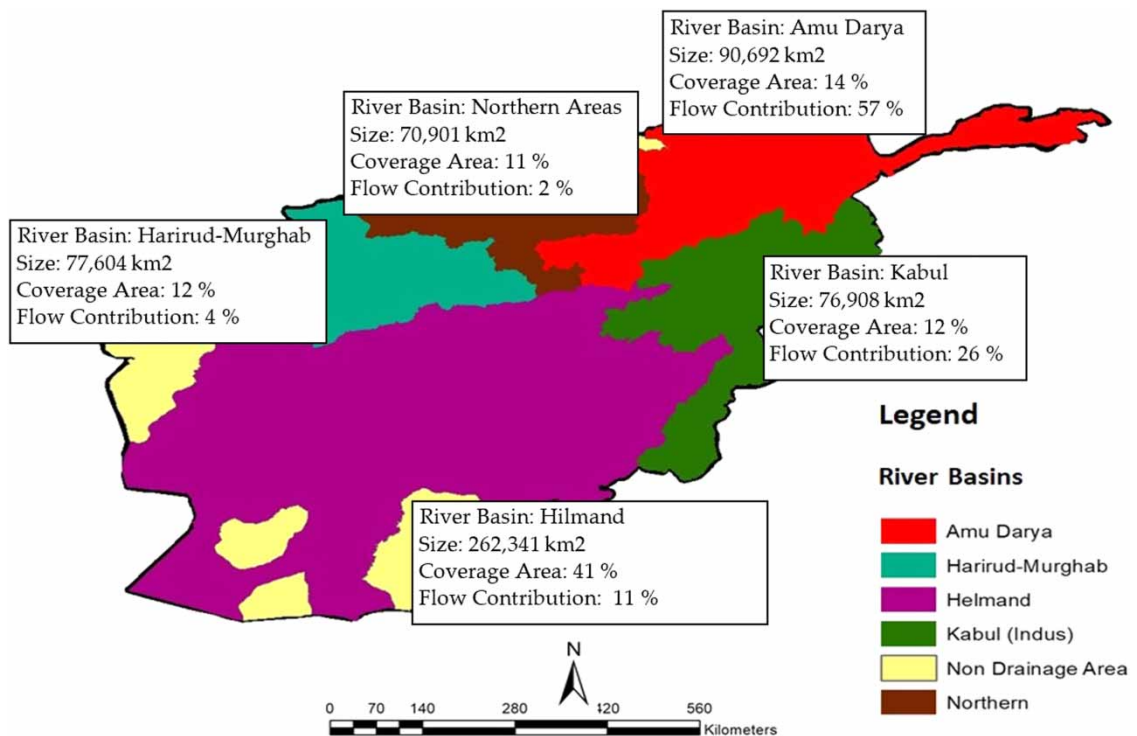
## Background

Afghanistan is a landlocked country located between Central and South Asia. The total area of the country is about 652,000 km<sup>2</sup>, with three-quarters of mountainous terrain and high peaks of Hindu Kush mountain range, and the remaining quarter are plains areas and deserts (Favre & Kamal, 2004). Most of Afghanistan lies between 600 and 3,000 m in elevation (Weinbaum, 2021). The general weather pattern is arid to semi-arid.

In general, water resources availability in Afghanistan varies spatially and temporarily. The annual average rainfall usually does not exceed 320 mm. As per the Food and Agricultural Organization (FAO, 2012), about 50% of the precipitation occurs during the winter season beginning in January till late March. A further 30% occurs in April to June and the remaining 20% falls during the remaining 6 months of the year with high spatial variability floods being frequent during the rainy season often causing human losses and damage to properties. Seasonal flows of streams and rivers fed by melting snow from high mountains recharge alluvial aquifers providing urban and rural populations with drinking water.

The country has five major river basins, namely Kabul, Amu Darya, Harirud-Murghab, Northern Areas, and Hilmand (Kamal, 2004). The location, size, coverage area, and their flow contributions to annual water flow generated in the country are presented in Figure 1.

It is obvious from the river basin data presented in Figure 1 that Afghanistan's water resources are unequally distributed. The occurrence of a severe drought lasting from 1999 to 2005 has further worsened the situation by



**Fig. 1.** | River basins map of Afghanistan (Modified from Kamal (2004)).

affecting vital beneficial uses of water as well as the economy (Yildiz, 2017). Therefore, without smart management practices like IWRM and WEF nexus approach, the country will be unable to reach its development goals in the water, energy, and agriculture sectors.

## MATERIALS AND METHODS

This study focused on the challenges faced by the Afghan government in implementing IWRM, which was incorporated in the Water Law of 2009, as well as in the new Water Affairs Management Law of 2020. The authors have taken a step further in analyzing the implementation of IWRM in combination with WEF nexus since these concepts are highly interlinked as discussed by Hoff (2011) and Roidt & Avellán (2019).

### Data sources

Data collection has been extremely challenging in Afghanistan due to prolonged conflict which consequently caused the country to suffer from the lack of sufficient hydrologic data. Therefore, this paper mainly relies on extensive literature review, data, information, and analysis from secondary sources like international agencies including the World Bank, Japan International Cooperation Agency, FAO, and research organizations like Afghanistan Research and Evaluation Unit (AREU).

### Methodology

In this study, the methodology is divided into three main stages, i.e. assessment of the current status of the WEF components in Afghanistan, critical evaluation on the challenges to implementing IWRM and the WEF nexus given the present environmental conditions, and formulation of effective management practices in the integration of IWRM and WEF nexus. The Methodology Framework is presented in Figure 2.

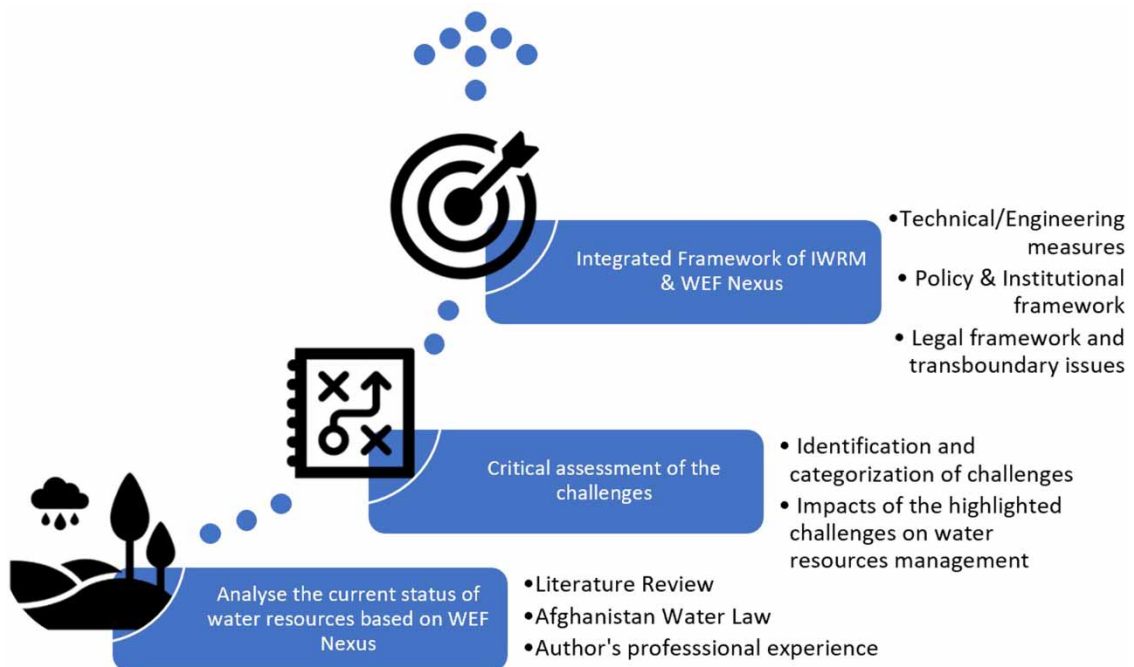


Fig. 2. | Methodology framework.

The first author's extensive experience gained from serving in the Afghan government both in technical positions as well as higher policy level roles in the water sector has significantly contributed to the preparation of this study. He frequently participated in cabinet meetings, High Urban Council meetings, Water and Land Council meetings and was actively involved in the government's debate about efficient and sustainable management of national water resources. Extensive literature review on existing water resources development and management practices, application of IWRM and strategizing WEF nexus forms the basis of the methodology.

## ANALYSIS OF IWRM AND WEF NEXUS COMPONENTS IN AFGHANISTAN

It is critically important for Afghanistan to develop its water resources in a systematic and efficient manner for its vital sectoral as well as growing economic development needs. In 2004, it was estimated that Afghanistan has 75 billion m<sup>3</sup> of potential water resources that include 55 billion m<sup>3</sup> of surface water and 20 billion m<sup>3</sup> of groundwater (Ahmad & Wasiq, 2004). However, the most recent estimate reported by the Ministry of Energy and Water is that the surface water resources have declined to 49 billion m<sup>3</sup> (Omid, 2018).

Despite abundant water resources, Afghanistan falls in the category of 'high risk' on the Water Stress Index (WSI). The WSI is defined as the ratio of domestic, industrial, and agricultural water consumption against renewable supplies of water from precipitation, rivers, and groundwater (Palau, 2013). Detailed analysis and discussions on the current status of IWRM and each WEF nexus components in Afghanistan are given in the following subsections. Similar to Water Law (2009), the new Water Affairs Management Law (2020) has included IWRM as an instrument to develop and manage Afghanistan's water resources (MoJ, 2009, 2020). The real challenge for the government though is to put into practice what is written in the law. The law does not specifically refer to the WEF nexus, but several policy instruments and institutions within the law can facilitate its implementation if proper strategies are put in place. It is important to highlight not only the physical connectivity of various systems but also the institutional connectivity. IWRM and the WEF nexus should therefore be looked at from a governance perspective as well. Water security, energy security, and food security are inextricably linked, making a strong case for application of IWRM in combination with WEF nexus. A detailed discussion is given in the following subsections.

### Water and sanitation

The Sustainable Development Goals (SDGs), adopted by all members of the United Nations in 2015, build on the Millennium Development Goals (MDGs), which provide a shared blueprint for peace and prosperity for the current as well as future generations. The agenda for SDGs has set 2030 for these goals to be achieved. Goal No. 6: Clean Water and Sanitation calls for 'Ensure Availability and Sustainable Management of Water and Sanitation for All' (UN, 2015). Afghanistan's Ministry of Economy has been tasked to monitor the progress toward the SDG in water and sanitation and as of now, no substantial information exists on the achievements so far (MoEC, 2019). On the other hand, substantial progress has been reported on MDGs especially in the drinking water supply delivery. As per the State of World's Water 2018, Afghanistan increased its access to clean drinking water from 27.1% in 2000 to 62.9% in 2015, which represents a 35.8% improvement (WaterAid, 2018).

Afghanistan has a very high rate of urbanization with the current urban population representing about 25% of the total population (UN-Habitat, 2020). Increasing urban growth has exerted stress on urban water supplies. The high imbalance between supply and demand and impacts of climate change have caused increasing temperature and lowering of groundwater levels in the country (UNFCCC & NEPA, 2017). Currently, the rate of extraction is higher than the rate of replenishment or recharge resulting in groundwater depletion affecting both cities and rural areas (Saffi & Kohistani, 2013). Introducing artificial recharge practices can mitigate the impacts of over-

pumping especially in the capital Kabul, which is the most vulnerable in this regard. Untreated surface water is being used by communities living close to rivers and streams often with health risks.

The situation of sanitation is quite dismal in the country. No city or rural areas, including the country's capital Kabul, has sewerage systems and associated wastewater treatment plants (UNICEF, 2014). If the country is to achieve its SDG target in water and sanitation, it must focus its efforts on sanitation along with access to safe drinking water and this requires the implementation of IWRM as per the new Water Affairs Management Law of 2020 (MoJ, 2020).

### Energy (Hydropower)

The state-owned electricity company, Da Afghanistan Breshna Shirkat (DABS), reported that electricity demand will increase to 3,000 MW by 2020. Unfortunately, the national hydropower generation capacity was just 500 MW in 2013, while most of the demand was met through imported electricity from neighboring Tajikistan and Uzbekistan. This number is significantly lower than the estimated hydropower potential of up to 23,000 MW per year (Delawari, 2016).

As mentioned earlier, Afghanistan is rich in water resources. However, without adequate institutional capacity, efficient governance and integrated strategies of water resources development, value addition in the form of electricity generation cannot be ensured. This scenario is happening in Nigeria. Although the country is rich in fossil fuels, inefficient energy production results from widespread corruption, weak institutions, and poor governance (Cho *et al.*, 2003).

### Water resources for food production through agricultural activities

Almost 80% of Afghans depend on agriculture for their livelihood. However, the agriculture sector has been severely affected due to prolonged conflict, droughts, and destroyed irrigation infrastructure. Afghanistan is currently using about 20 billion m<sup>3</sup> of its water for irrigation (JICA, 2011), of which about 82% is from surface water and the remaining 18% is from groundwater (UNAMA, 2016). The availability of both surface and groundwater, which is subject to high variability, depends on the amount of precipitation in any given year.

Before the war that began in 1979 with the Soviet occupation, Afghanistan was self-sufficient in food production and 62% of dried fruits in the international market originated from the country. By the mid-1970s, 3.3 million ha of agricultural land was under irrigation. In 2009, about 1.8 million ha of irrigated land was under cultivation (Wegerich, 2009). The numbers clearly show the destruction of irrigation infrastructure over the past several decades. As per FAO (2018) estimates, Afghanistan has the potential for 7.3 million hectares of irrigated and rain-fed farmland.

Agriculture is by far the major user of water, accounting for more than 93% of total water usage (Ahmad & Wasiq, 2004). Consequently, irrigated agriculture takes center stage in the water sector and the government has made it one of its major national priorities. Unfortunately, only 12% of Afghanistan's total area is arable (Rout, 2018) and has not been adequately utilized.

Besides surface water, substantial agricultural lands are being irrigated by pumping groundwater, which requires energy. Rural areas of the country that form the basis of agricultural production are not connected to the national electricity grid and pumping is carried out through diesel generators or the use of solar pumps. Thus, the increase in electricity production for rural areas to enhance pumping will support food security. The energy for food is well-established in this situation.

The Global Hunger Index (GHI) is a tool for comprehensively measuring hunger at various levels. It determines hunger on a 100-point score with 0 as the best possible score (no hunger) and 100 is the worst. Afghanistan has a GHI score of 30.3, which is categorized as serious (GHI, 2020). Hunger in Afghanistan is

associated with the country's current development level together with low agricultural productivity and reliance on extensive food imports. Enhancing the agriculture sector in disconnect with other associated sectors like water, land, and energy is not sustainable as a long-term strategy.

### KEY CHALLENGES FOR THE IMPLEMENTATION OF IWRM AND WEF NEXUS IN AFGHANISTAN

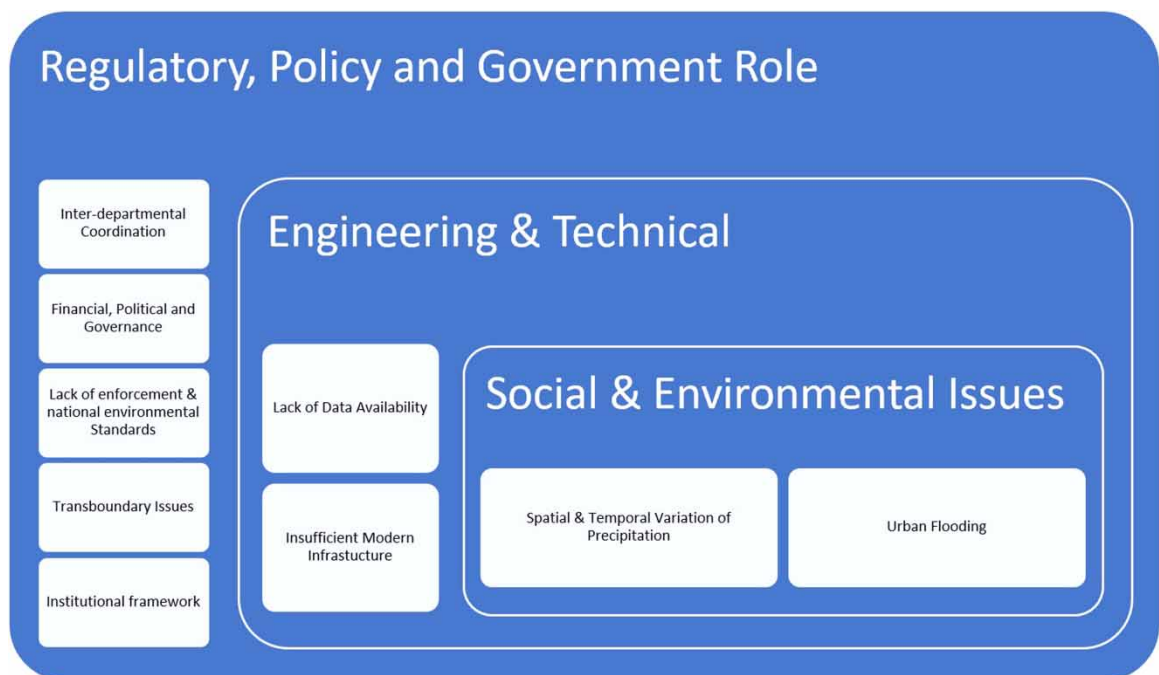
After an extensive analysis of the current WEF nexus status in Afghanistan, it was found that major challenges to the successful application of IWRM and WEF nexus to water resources can be systematically categorized as environmental, technical/engineering, and regulatory/institutional/policy in nature as shown in Figure 3. These challenges are inter-related. The environmental issues can be rectified through sound technical/engineering solutions, which are only possible through adequate regulatory/institutional/policy framework that the country lacks.

The key challenge for Afghanistan is to have a clear understanding of how IWRM and the WEF nexus can help increase resource efficiency, reduce trade-offs, build synergies, and improve governance across various competing sectors. A detailed discussion on these challenges is given in the following subsections.

#### Environmental characteristics

##### Spatial and temporal variability of precipitation

Annual precipitation in Afghanistan varies significantly spatially ranging from 110 mm in the southwest to 1,200 mm in the higher altitudes of the northeast (MIWRE, 2004). Most of the precipitation usually occurs from January to June. About 80% of Afghanistan's water originates in the Hindukush Mountains at altitudes of over 2,000 m (FAO, 2012). Most of the precipitation occurs during winter accumulating as snow in the high



**Fig. 3.** | Challenges in the implementation of IWRM and the WEF Nexus in Afghanistan.



mountains. The water flow becomes available during the snow-melt period from April to August (Beekma & Fiddes, 2014).

Due to spatial and temporal water availability, shortages sometimes lead to serious droughts while other times excess water causes destructive floods. This situation can be addressed by constructing storage facilities that can serve the dual purpose of mitigating floods as well as fulfilling the water demand in the event of droughts. Dam development in Afghanistan is, however, not easy because of (1) the very unstable and insecure context in terms of politics and status of national economy; (2) lack of adequate institutional framework; (3) the absence of trans-boundary dialogue and agreements; and (4) the lack of sources of finance due to reliance on foreign aid that is fragmented and uncertain. Given this context, the ambitious plan for the development of storage facilities in Afghanistan appears to be built on fragile institutional foundations (Ahlers *et al.*, 2014).

### **Urban flooding**

Urban stormwater management has been a major challenge for the country. Due to rapid and unplanned development over the past two decades, the stormwater flow patterns in all major cities have significantly changed. The old infrastructure is either destroyed or dysfunctional, lack of sufficient operation and maintenance by city municipalities make the condition worse. Many cities around the world have addressed this issue during post-development periods through novel solutions and methods. Kabul and other municipalities of the country can utilize innovative mechanisms based on principles of flood risk management to address the issue of urban flooding. The unplanned and haphazard developments, especially in Kabul city, have also led to the degradation of natural areas that used to act as recharge areas for natural replenishment of groundwater. One mitigation method is to construct flood ponds that serve multiple purposes like flood management, groundwater recharge, and other non-potable water use such as road cleaning and landscaping.

### **Current technical and engineering facilities/resources**

#### **Lack of data availability**

Research and development in the water sector is hindered by limited availability of long-term, accurate and comprehensive hydrological, meteorological, geo-physical and water quality data as well as information on socio-economic characteristics and indicators of water use efficiencies (GoIRA, 2008). Most hydrologic and climatic data collection activities in Afghanistan were interrupted in the early 1980s and restorations began after 2003 through a strategic partnership between the United States Geological Survey (USGS) and the Afghanistan Geological Survey (AGS) (Mack *et al.*, 2010). Between 2008 and 2011, approximately 127 historical stream gauges were re-established and supplied with modern equipment as part of the USGS and World Bank program (Yildiz, 2017). However, water researchers are still struggling with insufficient data due to long breaks in data recording and dysfunctional equipment.

#### **Insufficient water management infrastructure**

Agriculture is mainly dependent on irrigation in much of the country as rainfall is either limited or unreliable. By the mid-1990s, most of the country's limited modern infrastructure and many of its irrigation systems were destroyed. Part of the irrigation infrastructure that remained had become unusable because of lack of maintenance. Siltation is a common and persistent problem in irrigation canals and storage facilities, seriously affecting their capacities. Therefore, consistent and continuous maintenance and rehabilitation of the existing infrastructure and development of new irrigation systems are among the major challenges for the country's water resources development. Analysis of global data on dams and socio-economic conditions has established a close relationship between dams and socio-economic development particularly for least developed countries

(Chen *et al.*, 2016). Afghanistan is, therefore, justified in increasing its storage capacity. However, due to consideration of the environmental impacts of dams, development must be part of the overall strategy.

No city in Afghanistan, including the capital Kabul, has a municipal sewerage system. Individual townships operate decentralized sewage treatment systems using septic tank technologies, which require regular pumping and safe disposal. These practices are neither sustainable nor environment-friendly and do not fit modern cities. With the help of the World Bank, Afghanistan established the Urban Water Supply and Sewerage Corporation (AUWSSC) in 2007 (World Bank, 2019). However, AUWSSC has only focused on urban water supply services and no sewerage system has yet been established anywhere in the country by this entity. This is a clear deviation from IWRM as emphasized in the new Water Affairs Management Law of 2020 (MoJ, 2020). As most of Afghanistan's major cities are facing diminishing water resources, the multisectoral management in line with the WEF nexus approach can boost resource efficiency. For example, treated sewage effluent (TSE) can be re-used for urban irrigation as practiced in various large cities in the Gulf countries like Abu Dhabi and Dubai.

One of the reasons for Afghanistan relying mainly on groundwater for drinking purposes is the lack of energy required to lift, transmit, treat, and distribute large quantities of surface waters from rivers and streams. Such operations require a large amount of electricity that Afghanistan currently lacks. Energy is needed to pump, treat, transmit, and distribute water, which is part of the nexus approach.

## **Regulatory, policy and government role in water resources management**

### **Policy, institutional and regulatory framework**

The Afghan government initiated its effort toward water resources management beginning in the 1960s through establishment of relevant agencies and investments in irrigation and hydropower infrastructure. Water-related institutions evolved based on changing national priorities. Afghanistan had its first water law in place in 1981, which has evolved over the years since then. The latest version of the law was issued in 2020, which is known as the Water Affairs Management Law. Since 2014, the government has been highly focused on efficient management of the national water resources. The Supreme Council of Land and Water was established in 2016 and is chaired by the President. The new water law (2020) has added the environment to the mandate of the council (MoJ, 2020). The council holds regular meetings bringing together all major stakeholders and important decisions across sectors are made through a consultative approach. This helps operationalize both IWRM and the WEF nexus as cross-sectoral issues have a platform for coordination.

### **Inter-agency coordination**

The Afghanistan Water Law of 2009 (MoJ, 2009) proposed a highly complex regulatory environment involving various government ministries and other stakeholders that was hardly implementable. The scope and content of the law had significant gaps especially with regards to the clarity and division of responsibilities among various agencies and stakeholders.

Integrated water and land resource planning is at the heart of both IWRM and the WEF nexus. However, land management, land administration, and water resources planning are currently being carried out in isolation to each other. The new water law of 2020 addresses this issue up to a point. There is now need for increased policy coherence and implementation mechanisms to be in place to integrate land resources planning with water resources planning (MoJ, 2020). The nexus approach will encourage dialogue among policy makers, government entities, civil society organizations, and private sector leading to more sustainable resource use and increasing resource efficiency. Data sharing among agencies dealing with water, food, and energy should be

part of any integrating strategy. Data sharing platforms are considered a vital need to enable collaborative approaches across sectors (Wolfe *et al.*, 2016).

### **Financial, political, and governance**

Financial, political, and governance-related issues impact Afghanistan's ability to develop its water resources for achieving water, food, and energy security. Being a low-income country, it is not feasible for Afghanistan to self-finance large water resources projects. It has to rely on financing from international financial institutions and other donors.

The National Water Sector Strategy of 2008 and Water Affairs Management Law (2020) have formally adopted the three-pronged approach to water resources management. This includes integrated water resources management (IWRM), river basin management (RBM), and participation through Multi-Stakeholder Platforms (MSPs). This approach anticipates devolution of decision-making power from central government to basin-level platforms, and from the government to water-users (Thomas, 2013). The governance model might serve as a long-term goal, yet it is the central government that currently makes all major decisions related to water resource development.

Water resources development in Afghanistan for municipal uses, irrigation (food production) and energy generation have been sporadic, fragmented and project-based rather than sector-based. Afghanistan needs to transform from project-based development to sector-based and onward to multisectoral integrated planning and development in line with the nexus approach.

### **Lack of enforcement and national environmental standards**

Despite the fact that the Environment Law of Afghanistan (2007) clearly emphasizes that the natural resources of the country including water be properly managed and protected (NEPA, 2007), there are currently limited to no enforcement mechanisms in place. Waste disposal into water bodies is a common occurrence in the country especially when rivers and stream pass through urban areas.

Unfortunately, Afghanistan has weak institutional capacity and enforcement mechanisms to ensure sustainability and environmental integrity of its water resources. Not addressing this challenge in a timely manner will lead to environmental crisis in the not so distant future.

Lack of adequate national environmental standards and total reliance on international standards that may not apply to the conditions of Afghanistan is another challenge that the National Environmental Protection Agency (NEPA) and other relevant agencies need to address.

### **Transboundary issues**

Water, energy, and food security is particularly challenging in transboundary river basins as each riparian country tends to maximize its own benefits. The WEF nexus is thus more relevant in such settings (Jalilov *et al.*, 2016). Transboundary cooperation on shared water resources fit well within the domain of operationalizing the WEF nexus approach. The need for cooperation between riparian states with shared water basins is anchored in SDGs as per SDG 6.5 (UN, 2015). Besides the Hilmand Water Treaty with Iran, Afghanistan has not yet entered into any other agreement with its neighbors on the transboundary rivers. This situation has complicated the inflow of resources for the financing of its water storage facilities from international donors like the World Bank, the Asian Development Bank, and others. The lack of accurate hydrological data for Afghanistan's five river basins is another constraint to the negotiation process with downstream riparian states on any potential transboundary cooperation.

The new Water Affairs Management Law is in sharp contrast to the previous Water Law of 2009, which defined the transboundary river as the one flowing on the common border of Afghanistan and other countries. However, the new law defines transboundary water as one that originates inside the territory of Afghanistan and flows into

one of Afghanistan's neighboring countries or vice versa (MoJ, 2009, 2020). Thus, this can be considered as progress toward potential transboundary water cooperation with downstream riparian states.

Afghanistan has to improve its legal, regulatory, and institutional framework and enhance its technical and negotiating capacity to address transboundary issues with its neighbors. The current leadership in the water sector mainly consists of young graduates with limited technical knowledge and expertise to understand and negotiate the water interests of the country at the international level.

Water, energy, and food security issues have become global and often cannot be considered within the confines of national territories. Uses of transboundary water within Afghanistan for power production and/or irrigation can have potential adverse multisectoral impacts on downstream countries. Thus, transboundary issues have close links with the WEF nexus. Management of transboundary water resources is often complicated by geo-politics. The nexus approach could offer potential solutions for addressing the problematic nature of transboundary issues.

### Institutional framework in Afghanistan

Water governance refers to a set of social, political, administrative, and economic procedures that oversee the development, management, and regulation of water resources at multiple levels of government (Global Water Partnership, 2002). Efficient water governance depends to a large extent on the quality and functionality of water-related institutions. This is very true in the case of Afghanistan given its weak institutional framework due to prolonged conflict.

Wolf *et al.* (2005) concluded that institutional capacity is the key to successful water management in arid countries. Some common obstacles in the case of Afghanistan are conflicting mandates, fragmented authority, and limited capacity of national institutions. The agriculture sector consumes around 98% of the total water withdrawn, but the country's dependence on imported food highlights the inefficiency of the irrigation system as well as the low capacity of the responsible institutions (Akhtar *et al.*, 2018).

Since 2003, Afghanistan has been making modest progress to build its institutional arrangements and legal framework. The High Council of Water, Land and Urban Development (HCWLU), chaired by the president, was established in 2020 to make high-level decisions related to water, land, and urban development (AOP, 2020). Figure 4 shows the organizational structure of the HCWLU. Such high-level patronage shows strong political support for the water sector by the Afghan government.

## WAY FORWARD – APPLICATION OF IWRM AND WEF NEXUS IN AFGHANISTAN

Every country has unique characteristics in terms of geography, hydrology, climate, topography, geopolitical and socio-economic conditions, institutional environment, and governance model. Therefore, application of IWRM and WEF nexus to Afghanistan context will need a more specific approach.

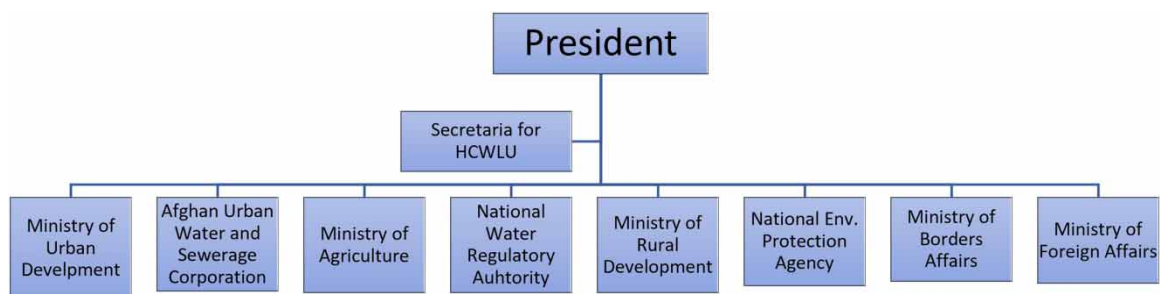


Fig. 4. | Organizational structure of High Council of Water, Land and Urban Development.

In this paper, concepts of integrated IWRM and WEF nexus were analyzed and are presented in the form of a framework relevant to Afghanistan’s context, as shown in Figure 5. The idea is to transform the IWRM and the WEF nexus debate with reference to Afghanistan from a largely abstract domain to more of implementation and operationalization. Smaigl *et al.* (2016) believe that the WEF nexus has remained largely within the conceptual domain without being sufficiently applied practically. The goal is to trigger appropriate action by the policy-makers and decision makers in this regard. It aims to act as a planning and management framework.

Hoff (2011) has provided sufficient evidence that the nexus approach can ensure water, energy, and food security through integrated management across multisectors. Thus, the way forward for Afghanistan is to reduce trade-

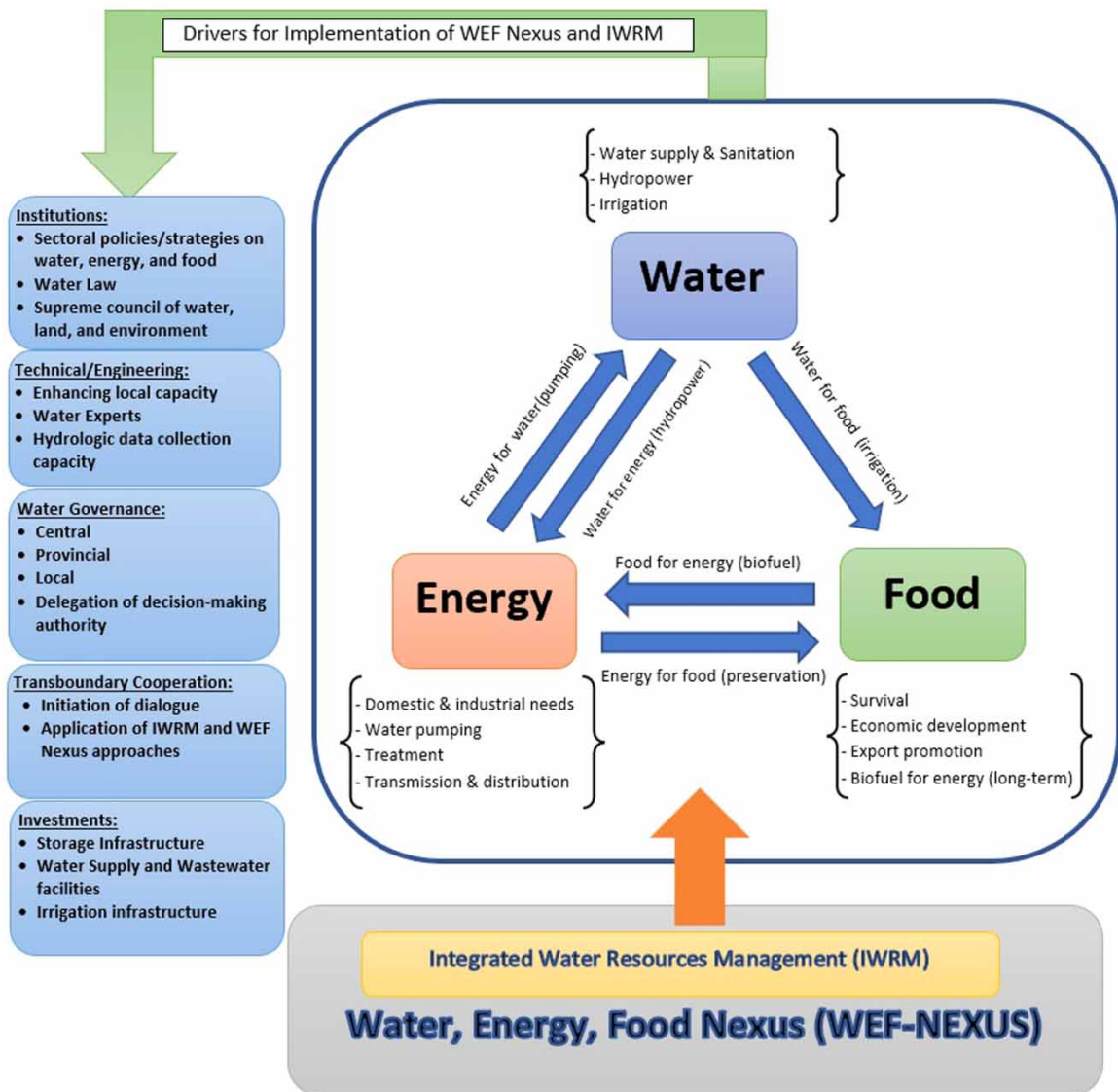


Fig. 5. | WEF and IWRM implementation framework in Afghanistan.

offs and build synergies across sectors to meet its growing needs for water, energy, and food for vital necessities as well as economic development. IWRM alone cannot address this and, therefore, integration of IWRM with the WEF nexus is presented as a framework for the country to develop policies, planning systems, and implementation strategies moving forward. Afghanistan, with underutilized water resources and a small population, will have minimal trade-offs among competing sectors while the potential for synergies among various sectors is high. For example, if storage capacity is increased, it can increase water supplies, irrigation potential, and energy production.

Afghanistan's rush, especially since 2002, on productivity of individual sectors rather than enhancing system efficiency as advocated by a WEF nexus approach (Hoff, 2011) needs to be properly addressed as cross-sectoral management can boost overall resource efficiency.

On the engineering and technical side, national capacity needs to be enhanced through increasing the number of water resources experts having knowledge and experience in complex water issues including sound knowledge of Afghanistan's water resources (Hoff, 2011). Afghan universities must add the water resources subject to the engineering curriculum. Thus, the knowledge gap on water resources in general and clear understanding of instruments like IWRM and the WEF nexus is considered as one of the key issues to be addressed as part of the framework (Malyar, 2017). It is important to highlight that the domains of science and policy must be integrated harmoniously to carry forward the agenda of the nexus. Without a strong scientific basis and policy support from the government, integrative approaches like IWRM and the WEF nexus cannot be successfully operationalized in Afghanistan.

The hydrologic data collection systems should be made more functional, efficient, modernized, and user-friendly. This will require training and capacity building of data collection engineers through workshops, on the job and field training. Building local capacity will make the national hydrologic data sources more sustainable and enriched to be used for future water resources research and sound planning. Insufficient hydrologic data is one of the main constraints to developing an integrated framework for IWRM and the WEF nexus.

Afghanistan needs to increase its water storage capacity by building multi-purpose storage reservoirs creating synergies among water (for municipal and industrial needs), energy production, and food supplies (irrigated agriculture). Additionally, the impacts of climate change such as severe floods and extended droughts can be mitigated (Hanasz, 2011). While large-scale water infrastructure projects might have potential impacts downstream on food-ecosystem and communities re-settlements. Thus, the inclusion of environmental impact assessment forms an essential part of Afghanistan's efforts to develop its water resources in an integrated manner.

Afghanistan has different layers of government, i.e. central, provincial, and district. However, decision making is highly centralized and bureaucratic leading to inefficiency and extended delays in implementing water resources projects. Thus, it is critical that local institutions be empowered and their technical and managerial capacities enhanced.

As Afghanistan is landlocked, virtually all of its major rivers drain off into riparian neighboring countries. Transboundary cooperation on water is, therefore, essential. By addressing this gap, Afghanistan can genuinely benefit from its precious water resources by opening the way for international cooperation. Transboundary cooperation with riparian states can unlock the potential financial support from international financial institutions like the World Bank, the Asian Development Bank, the Islamic Development Bank, and the Asian Infrastructure Investment Bank. Afghanistan's current economic situation does not allow it to finance mega projects in water resources from its domestic revenues.

It is to be noted that there is no 'one size fits all' implementation model for integrative approaches like IWRM and the WEF nexus as each country has unique physical and environmental characteristics as well as different

institutional and governance structures. Thus, for Afghanistan, there has to be a specific implementation mechanism that can be applied in Afghanistan.

In summary, Afghanistan requires a three-pronged approach to implement the IWRM plus WEF nexus. This includes policy/strategy, institutions, and investments as detailed in [Figure 5](#).

## CONCLUSION

Adequate availability of water resources is vital to the social well-being, economic growth and rebuilding of Afghanistan. Water resources in Afghanistan remain largely under-developed due to lack of financing, continuing political and economic instability and an ongoing conflict for the past four decades. In case of Afghanistan, water is at the center of both energy and food security. This study found that it is important to apply integrated approaches like IWRM and the WEF nexus to ensure sustainable resource management for water, energy, and food security in Afghanistan for its current as well as future needs.

The authors have identified the challenges and comprehensively summarized them into three major categories, namely environmental characteristics, engineering and technical, and regulatory, policy and government role. Moving forward, the government of Afghanistan must play a crucial role with regards to the efficient management of country's water resources in an integrated manner as outlined in this paper. There is a clear need for top-down planning together with a bottom-up community approach for effective management of Afghanistan's water resources. Although Afghanistan Water Affairs Management Law (2020) incorporates IWRM as part of the government's strategy for water resources management, it does not refer to the WEF nexus, which is an emerging concept that needs to be promoted through appropriate policy, institutional and regulatory mechanisms ([MoJ, 2020](#)). Additionally, the government must change its project-based fragmented approach to a more integrated and sectoral approach and transform to multisectoral and integrated management of water, energy, and food resources.

Since Afghanistan is a landlocked country, transboundary water cooperation with its neighboring countries is highly important. Afghanistan's water resources have remained both as an opportunity as well as a challenge because of insufficient transboundary collaborative mechanisms in place. The policy makers and water resources planners in the country are in dire need of a clear roadmap for addressing the transboundary challenges that could potentially evolve into water conflicts with Afghanistan's co-riparian states.

Afghanistan, which is largely dependent on foreign aid for its development, will have to seek international assistance to develop its water sector that will contribute to making it self-sufficient in energy and food and will spur its economic growth. Appropriate platforms such as peaceful dialogues should be conducted to reach feasible agreements that will be mutually beneficial for all interested parties. Also, such measures will avoid potential conflict over water increasing regional stability, which can become a win-win situation for all.

This study has made an attempt to present a framework for operationalization of integrative approaches like IWRM and the WEF nexus with the ultimate goal of improving resource efficiency and ensuring water, energy, and food security in the short, medium, and long terms. It provides a path forward for the government and relevant stakeholders. Application of IWRM and the WEF nexus approaches will not only help Afghanistan fulfill its food and energy security needs but will also significantly contribute to the country's growing economic development moving forward.

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## CONFLICTS OF INTEREST

The authors declare no conflict of interest.

## DATA AVAILABILITY STATEMENT

All relevant data are included in the paper or its Supplementary Information.

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