

Chapter 10

Water-Energy-Food (WEF) Nexus and the SDGs in Central and South Asia



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Abstract The international research community has been attracted to the concept of a “water-energy-food” nexus as an approach for more integrated planning for global environmental change. The Sustainable Development Goals may well be approached using such a nexus approach for data gathering and for holistic policy implementation. This chapter considers how Central and South Asia might adopt this approach, particularly in the context of rapid development which is taking place across the region. We focus on energy efficiency and public-private partnerships as two key areas where robust metrics for such a nexus being realized hold promise. We also consider some of the criticism of the nexus approach in terms of research depth and policy implementation and the use of tools such as the Water Energy Food Nexus Index in the context of this region. Overall, we find the concept is appropriate for use in this region, particularly as a means of cross-border and regional development planning.

Keywords Sustainable Development Goals · Central Asia · South Asia · WEF nexus

10.1 Introduction—SDGs and WEFS

Over the past decade, the interface between water, energy and food (WEF), as well as soil has become a recurring theme in global environmental change research (D’Odorico et al. 2018). Figure 10.1 shows the interactions between the three sectors.

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The extraction of water not only requires the input of energy (pumping of groundwater, desalinization of water, and heating and cooling of water), but the water itself is input to the production of energy (hydropower production and cooling processes) and food (irrigation and processing of food). Moreover, incentives for energy generation can sometimes conflict with food production. For instance, hydropower production may occur at those times of the year, where there is less demand for irrigation. Consequently, there is a need to adopt a governance mechanism that is inter-sectoral.

The framework for the WEF nexus provides a holistic approach for addressing the disconnect between the three sectors. Although the interconnection of three sectors was always present, it was formally defined at the Nexus conference in Bonn 2011 (Mahlknecht et al. 2020), recognizing the need for collective governance for these three sectors in particular. Soon thereafter, the United Nations started the process of developing the next set of development planning horizons. The 8 Millennium Development Goals, which had only been instituted for developing countries from 2000 to 2015 were replaced with the Sustainable Development Goals over the 2015–2030 planning horizon. These 17 goals were mandated for all countries, regardless of income, and had a series of very specific targets as well. There was also a tracking mechanism put in place by the United Nations alongside independent tracking platforms supported by donors. A separate civil society platform called the Sustainable

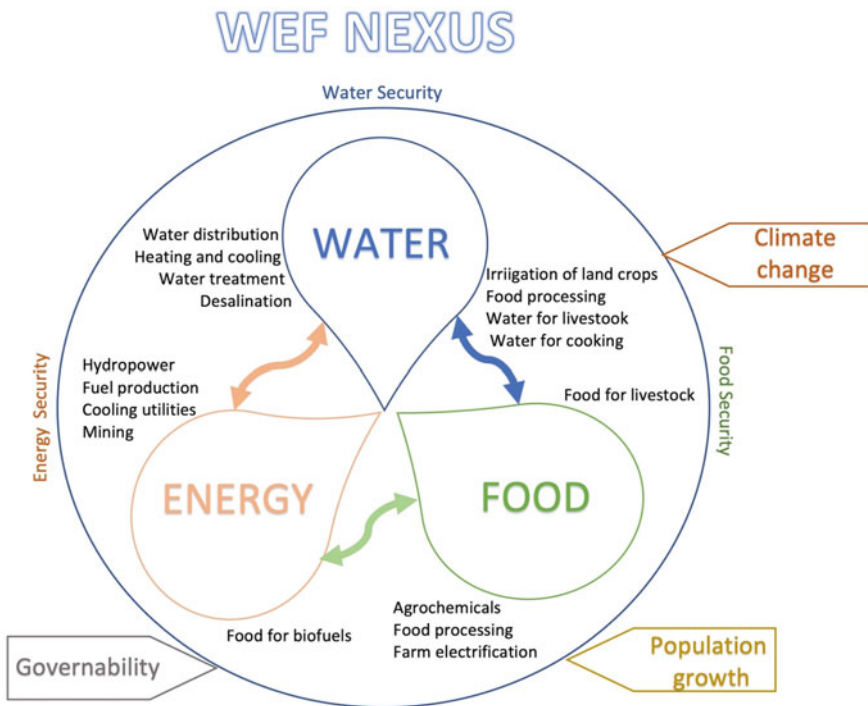


Fig. 10.1 Summary of the WEF nexus. Adopted from Mahlkecht et al. (2020)*



Fig. 10.2 Key connections between the WEF nexus and the SDGs. Adopted from Learn More About the SDGs—SDG Compass (n.d.)

Development Solutions Network (SDSN) was put in place to ensure that the SDGs were not just top-down but also bottom-up in their implementation. Out of the 17 goals, the three which are most directly relevant to the WEF nexus are Goals 2, 6, and 7. Figure 10.2 presents these 3 goals and the most significant targets under each of these 3 which need to be interwoven in a WEF approach to SDG planning (Mohtar 2017).

In order to keep track of the interactions between these factors, there have been attempts to track the relationship and measure discrete variables which can provide us a monitoring mechanism. Criticisms of the WEF approach have come from human geographers and scholars who are concerned about proximate livelihood impacts of securitizing environmental discourse. Calls for linking the WEF approach to a means of prioritizing the SDG agenda have come under considerable scrutiny as well, since they tend to create a hierarchy between the goals (Simpson and Jewitt 2019). However, there is little doubt that ultimately social and economic systems must depend on natural capital. Thus, giving some measure of primacy to optimize interactions between water, energy and food are likely to lead to a more sustainable and resilient outcome for livelihoods as well. The WEF Nexus Index has recently been developed by the European Union and accounts for a range of variables to constitute an index which can measure the degree to which these interactions are synergistic. Figure 10.3 presents the three pillars of this index and what is being measured.

The index was formally launched in November 2020, and an effort was made to also consider the correlation between its indicators and the well-established Human Development Index (HDI) which is regularly published by the United Nations Development Programme (UNDP). HDI focuses on income, education, and demographic health indicators as a composite for development. The correlation plot between the two indices is shown in Fig. 10.4. There is a coefficient of determination (r squared) of 0.6609 which indicates that over 66% of the variation can be explained by the

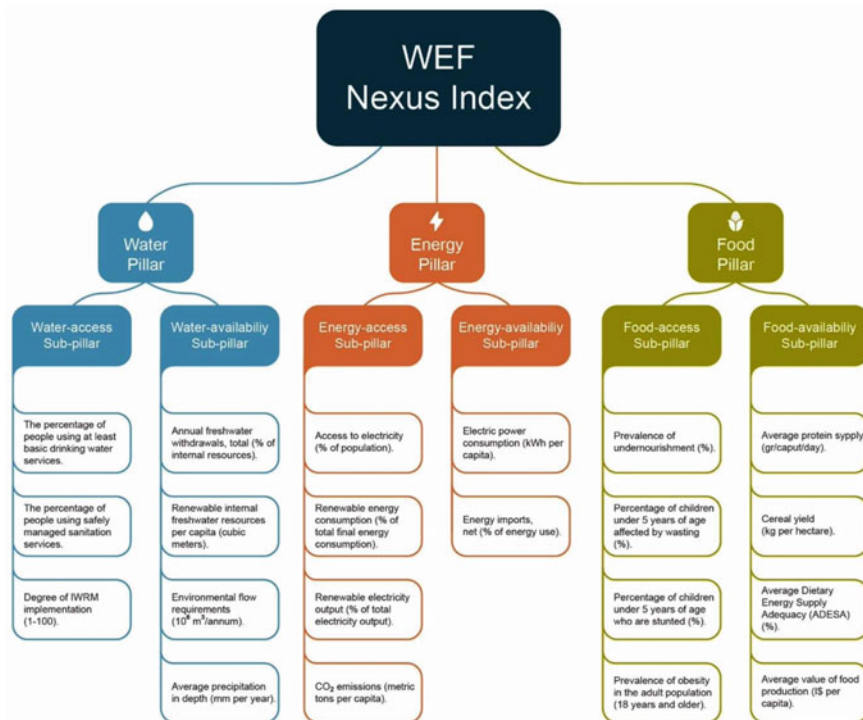


Fig. 10.3 The WEF Index (EU and German Government project). Figure from <https://www.water-energy-food.org/>

relationship between the two indices. The WEF Index has been calculated for all countries in the Central and South Asian region, except for Kyrgyzstan (due to data deficiency). As this region urbanizes, there is also growing evidence for the WEF approach to improve sustainable cities development (Arthur et al. 2019). Such targets can be linked to the World Bank's Global Platform on Sustainable Cities and the impact programs for the regions being supported by the Global Environment Facility.

Rather than considering the absolute values of this index,¹ the comparison with the HDI is more instructive as the 45° line suggests divergence between conventional human development metrics and ecological indicators. In this comparative plot of HDI versus the WEF Nexus Index, countries that have data point above the regression line typically have human development that exceed their available domestic natural resource base. In other words, they are able to import materials and resources from outside of their borders to maintain higher human development, while exporting their ecological footprint to other nations. The corollary is true of nations that plot

¹ The exact values for each country are regularly updated and viewable online at <https://wefnexusindex.org/>.

This approach was particularly apparent during the Soviet control of the Central Asian region, where top-down policies have resulted in inefficient resource allocation and environmental degradation. The depletion of the waters of the Aral Sea was a particularly stark example of this degradation (Micklin 1988).

As a result of the growing awareness of the need to adopt a Nexus approach in the region, the Regional Environmental Centre for Central Asia (CAREC), in cooperation with the International Fund for Saving the Aral Sea (IFAS), are implementing the Nexus Regional Dialogues Programme activities. There are a number of studies conducted in the region to assess the possibility of the implementation of the nexus framework within the region. Jalilov et al. (2018) conducted an economic analysis by considering the effect of infrastructure development and climate variability for central Asian countries (Tajikistan, Afghanistan, Turkmenistan, and Uzbekistan) sharing the Amu Darya River basin. Infrastructure development in terms of the building of two hydroelectric dams was considered in the study. Climate change scenarios investigated the impact of a 50% reduction of the river flow. According to their analysis, there is a considerable chance of economic gains for the basin countries if they decide to cooperate on collective infrastructure development and sharing the benefits from the development. Economic gains are in the agriculture and energy sector. However, gains are not equally spread between the two sectors: Uzbekistan, being lower riparian, will have proportionately higher gains in agriculture; on the other hand, energy generation gains will be more for Afghanistan and Tajikistan.

This study has not considered the environmental impacts of the development. The Amu Darya is the major supplier of water to the Aral Sea; agricultural developments starting from the 1960s have resulted in the reduction of its water level. Therefore, it is important to see the cost and benefits of further developments and protect and restore the Aral Sea. However, negotiations based on collective but differentiated benefits for the countries of the region will require altering water allocation among different crops, sectors, and locations. Therefore, it is a big challenge and opportunity for effective collective environmental mitigation strategy also. Saidmamatov et al. (2020) provided a meta-analysis of the studies conducted for the water-energy-food-nexus in the Aral Sea basin. Major rivers of the basin are the Syr Darya and the Amu Darya; 70% of the basin area of these rivers is located in just two mountainous countries (Tajikistan and Kyrgyzstan) relying on more than 80% for a hydroelectric generation due to waters of these rivers, while the majority of agriculture consumption is in Uzbekistan and Turkmenistan.

The region's current water infrastructure is based on former Soviet Union central planning, which resulted in massive water withdrawals for irrigation purposes in lower riparian countries and hydroelectric dams for power generation in the upper riparian regions. Soviets were also instrumental in negotiating and supervising the transboundary water management in the region. However, the policy was formulated top-down, resulting in an inefficient allocation of water for agriculture and energy sectors. For instance, cotton cultivation in the dry regions resulted in an over-draw of water from the Amu Darya (the main contributor to the Aral Sea), at the same time contributing to the food security of the region by depriving cultivation area for other food crops.

Although Saidmamatov et al. (2020) highlight the importance of the water-food-energy nexus approach for effective management of water resources of this region, they also bring forward challenges in the form of ‘poor market structure, diplomacy, and governance in the region.’ Moreover, reliable hydrological data and quantifiable information on the environment are also major hurdles for setting any management and environmental goals.

In South Asia, the Indus basin is one of the most intensively irrigated areas of the world. The Indus basin is located in four countries, of which the largest part in Pakistan, and substantial upstream parts in India, China and Afghanistan. Almost 60% of the irrigated land of the Indus Basin area lies in Pakistan with the remaining in India (37.2%), Afghanistan (1.9%) and a negligible portion in China (Laghari et al. 2012). Inefficient surface irrigation practices result in the loss of surface water and cause salinity of the soils. Moreover, groundwater is pumped to irrigate the crops excessively within the basin resulting in massive energy use.

Further, in Pakistan, hydroelectricity is generated from the dams located on the Indus River, and its tributaries provide about 28% of the total electricity to the country’s national grid (NEPRA 2020). Therefore, the importance of the water-energy-food nexus approach cannot be more important than any other place (Siddiqi 2014). Yang et al. (2016) modelled the future climate impacts, different water allocation, and future water infrastructure development scenarios in Pakistan’s Indus River basin. They considered different climate projections scenarios—increased precipitation and increased temperatures, reduced precipitation and increased temperature, current water allocation practices at the sub-government level and federal government level through the Water Apportioned Accord, and optimum water allocation based on the marginal value of water in the basin. The model results show that there will be increased water and energy consumption in future higher temperatures and precipitation scenarios. However, better allocation policies can reduce crop water use and increase hydropower production, but it will also cause more variability in the crop’s annual water supplies. Additionally, it will also increase surface water use. Furthermore, Pakistan seriously lacks in the governance of all three sectors. Similarly, in case of India, Afghanistan, and China long-term challenges will emerge such as (1) water resource changes due to climate change; (2) increase in population, urbanization, and industrialization will increase demand for water in domestic and industrial processes, energy, and food production; (3) shift from surface water to groundwater which will deplete the groundwater both in Indus and Ganges basin. Overall, countries collectively lack a holistic and integrated governance framework. This problem is added to the top of fragmented policies that have historically taken place in each sector (Bazmi 2018). A regional SDG approach that considers such deficiencies of fragmentation needs to be considered.

Regional projects connecting Central and South Asia through gas pipeline infrastructure or electricity grids remain important (Huda and Ali 2017). However, there are many broader dividends which could be harnessed through a joint SDG agenda approach that considers a regional WEF nexus. There is potential for regional entities such as the Shanghai Cooperation Organization (SCO), comprising China, India, Kazakhstan, Kyrgyzstan, Pakistan, Russia, Tajikistan, and Uzbekistan, that spans

both Central and South Asia to play a role in this regard. The Green Belt and Road Initiative Center could be a useful host body for developing a research agenda and further enhancing regional synergies for collective SDG attainment. The Food and Agricultural Organization (FAO) of the United Nations signed a partnership agreement with the SCO in November 2019 to enhance food security efforts in the region (FAO 2019). Such an agreement could be extended to consider the WEF approach and associated SDGs.

10.3 Energy Efficiency as an SDG Operative Metric

There is a general presumption that industrialization leads to a reduction in the percentage of energy used by households. In general, industrial development leads to greater per capita household energy usage as well. Central and South Asia vary dramatically in their industrialization levels but can potentially exchange lessons from each other on energy efficiency as a common means of improving resource access. Central Asian countries, in particular, are still relying on resource extraction rather than orientation toward efficiency improvements—a result of ageing industrial infrastructure from the Soviet era (Rakhmatullaev et al. 2018). The improvement in energy efficiency has slowed down below 2.6 energy intensity per capita rate, which was requisite to attain the SDG Target 7.3 according to the tracking report prepared by the International Renewable Energy Agency (IRENA) in May 2020 (IEA, IRENA, UNSD, World Bank, WHO 2020). Energy efficiency plays a pivotal role in the WEF nexus as it helps to decouple the economy of the country from a range of environmental harms. Developing mechanisms to adapt readily available efficient technologies is one of the most cost-effective way of saving energy while reducing emissions and achieving wider SDGs goals. Globally, there is low investment in energy efficiency which clearly indicates a missed opportunity. However, unlocking the full potential of efficiency would require USD 600 billion for energy efficiency until 2030 (United Nations, n.d.).

In Central Asian countries though there is an abundance of diverse energy resources, but there is an absence of suitable energy services which leads to the use of available natural resources to meet basic energy needs. This heavy reliance on natural resources results in considerable exposure to indoor and outdoor air pollution for women and children (Mehta et al. 2021). On the other hand, in the South Asian region, the role of women in collecting firewood for cooking expose women and children to indoor air pollution (“The Clean Cooking Alliance,” n.d.). This links to SDG 5 (gender equality), as well as SDG 8 (decent work and economic growth) and (this connects with SDG 3 on “good health and well-being”). Exposure to indoor air pollution is estimated to “lead to 4 million premature deaths a year, which is 5-6% of global mortality (International Energy Agency and the World Bank 2017). Sustainable Development Goals 7, focused on Energy, explicitly mentions the need to address this risk, and the need to integrate sustainability principles which lower this risk into the goals and objectives of all national and international strategies. In Central

Asia, water issues are the centerpiece and water governance is “water-centric”. Electricity use in the region is projected to grow by 87% by 2035. Much of the demand will be met by thermal power plants, of which, fossil fuel and nuclear power plants have a heightened water need for cooling purposes as per unit of energy produced, they are the energy sector’s most intensive users of water” (“Data Tables—Data & Statistics” 2018). Much of the sector’s water demand would be greatly reduced if the future energy mix is inclined towards sustainable energy resources that are less water intensive. Thus, efficiency metrics would again be useful to incorporate as a corollary for WEF nexus planning. There is a wide diversity of stakeholders involved in the implementation and operationalization of the nexus approach and easy metrics are an important part of ensuring a common vocabulary to link them to SDG targets set forth by each country. According to Asian Development Bank (2018) the most reliable estimates for the Asian region’s irrigation requires annual investment of \$12.31 billion between 2005 and 2030.

Figure 10.5 provides the illustration of the management of nexus through different scenario development. The resource base is land, labor, and capital, as well as energy and water. The scenarios are developed through stakeholders’ dialogues based on evidence and response options to achieve desired goals and interests. The numbers of drivers impact the resource base, as well as goals and interests.

Some of the roadblocks in WEF nexus implementation are (1) the limited information which weakens evidence-based decision-making due to the frequent lack of reliable and updated data on the status of the WEF sectors at the local level, and often also at the national level (Scott 2017), (2) lack of awareness of the benefits of using the WEF nexus approach by relevant stakeholders, (3) negative externalities due to low or no pricing of water and energy use in the region (HICs; Sarni 2015), and (4) an inadequate coordination mechanism by relevant stakeholders, as the perceived transaction costs of coordination seems higher than the benefits (Keskinen et al. 2016).

Central and South Asian regions have multifarious challenges to implement the SDGs. Central Asian states are landlock with greater reliance on agriculture and forestry for livelihood; however, there is an abundance of energy resources (fossil and renewable resources). Central Asia, being the closed drainage basin, is facing significant challenges in water management. The South Asian countries depend on irrigation for food production which consumes immense energy resources—the energy resources are expensive and not abundant. The implementation of WEF nexus needs the policy framework with shared responsibility when there exist shared boundaries among sectors i.e., agriculture/food, water, energy, finance, as well as, municipalities, and other stakeholders locally and globally is a key. The program such as CAREC (Central Asia Regional Economic Cooperation Program) is a good example in this region. Similarly, One Belt One Road (OBOR) through infrastructure development is also addressing the WEF nexus.

However, the need for financing for effective implementation is one of the challenges for SDGs. To this end, partnerships will be an essential part of a success trajectory and the United Nations specifically enshrined SDG 17 (revitalizing global partnerships) to specifically be targeted at establishing such arrangements.

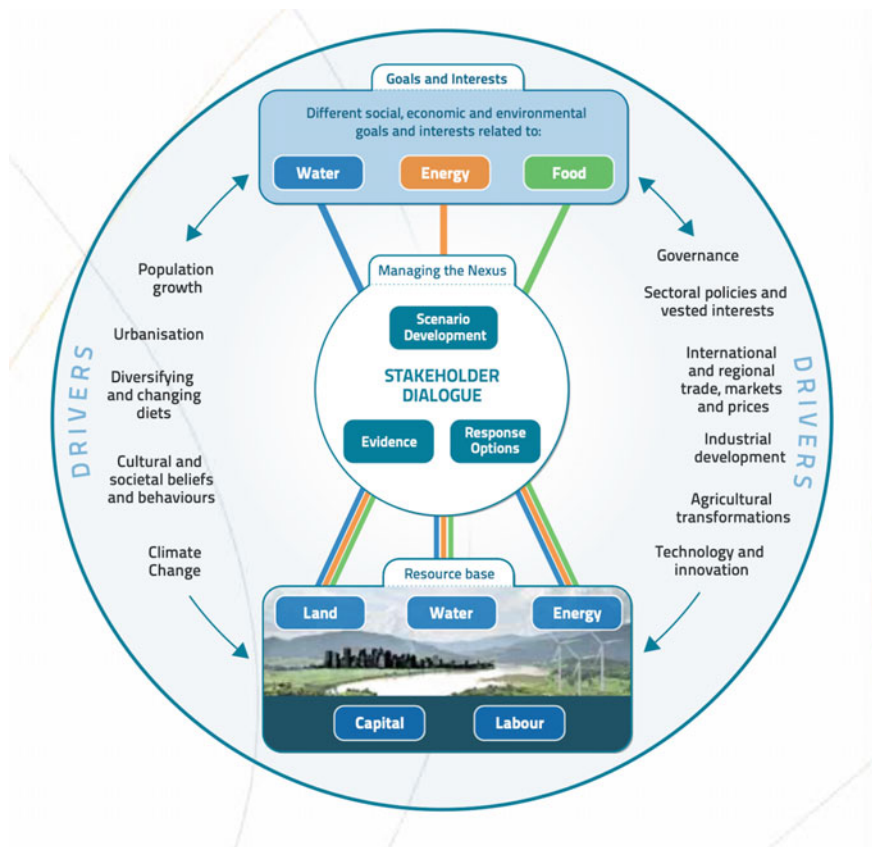


Fig. 10.5 The WEF nexus (FAO 2014)

10.4 Public Private Partnership for SDGs in the Region

Financing requirements for the implementation of SDGs require US\$5–7 trillion per year, where in developing countries USD \$3.9 trillion per year for basic infrastructure (United Nations 2016). Analysis of the existing public and private sector investment shows an annual gap of around \$2.5 trillion to meet the SDGs objectives. The WEF nexus approach under the SDGs subsequently requires the major portion of this investment, which can be translated into future financial savings. The investment requirement of this scale is not possible under constrained public spending or Official Development Assistance (ODA) as experienced in case of Millennium Development Goals (MDGs). Therefore, private finance will be required to fill the gap. Public-Private Partnerships (PPPs) have the potential to attract these additional resources. Within Central and South Asia, the opportunities for partnerships are often constrained in the WEF nexus because of geopolitical rivalries. The Belt and Road

Initiative is a mega-partnership effort, but because of its linkage with China, donors such as the United States and the European Union may perceive it as a threat. The WEF nexus approach has the potential to inject science diplomacy within this context to build trust purely through environmental research linkages.

The private sector is another important potential partner in the WEF nexus, given the salience of utilities for water and energy delivery and the range of companies involved in food production and delivery. However, proactive engagement of the private sector in Central and South Asia has been limited due to limited collaborative incentives, as well as resource nationalism by public sector companies. The water-energy linkages analysis reveals, in most developing countries water is subsidized. Hence, few individuals or municipalities pay the real cost of water and wastewater services. On the other hand, the energy sector's tariffs are based on a full-cost recovery basis which makes it a productive sector with reasonable income on a yearly basis. Contrary to the water sector, the energy sector has more leverage for investments. Establishing the linkages between these two sectors, and other sectors can promote and incentivize private investment for nexus approach (Schuster-Wallace et al. 2015).

Public-Private Partnerships have become even more prominent with the adoption of the SDGs. To achieve the targets set forth for the SDGs, the private sector role has been redefined through PPPs emerging as a recognized financial instrument. However, for PPPs' effectiveness to deliver the important services and infrastructure, it is critical that countries in Central and South Asia have an institutional capacity to create, manage and evaluate PPPs.

The role of these partnerships is thus of "regulatory intermediaries" who are able to share expertise and knowledge, implementation/enforcement capacity, and legitimacy (Abbott et al. 2017). The SDG agenda, coupled with global environmental mechanisms, such as the WEF nexus, can empower PPPs and prevent them from being marginalized by parochial politics that are so prevalent in the region.

One of the examples of a PPP is Central Asia-South Asia Regional Electricity and Trade Project (CASA-1000) which is the first step toward creating the Central Asia-South Asia Regional Electricity Market (CASAREM). There is a strong commitment of countries from Central Asia and South Asia to addressing their challenges together. Through PPP, the private sector is attracted to invest in infrastructure development (electricity transmission).

10.5 Conclusions

In the face of climate change, if Central and South Asian countries choose to cooperate and manage their transboundary resources in the framework of WEF nexus, it will result in the economic benefit to all the nations sharing these resources. There

is also growing evidence that the river basins that constitute the most contentious aspect of the resource nexus can be managed to provide maximum economic benefits for all nations in the region. The economic value of regional cooperation across riparian basins to consider a nexus approach in realizing the SDGs is now quite clear, particularly between Afghanistan, Pakistan, and India (Vinca et al. 2020).

In Central and South Asian countries an integrated approach is needed, and a WEF nexus approach is an entry point to capture and operationalize synergies in the implementation of SDGs. A more comprehensive and integrated strategic planning for operationalizing synergies and minimizing trade-offs in WEF among the goals and associated targets would help the region to achieve co-benefits. Therefore, this requires strengthening institutional coordination for mainstreaming SDGs. The 2030 SDG agenda has been assimilated in the governments' policies and program with reasonable financial resource allocations to meet the targets as per regional context. However, there are challenges in governance and management due to predicted political inertia in a lack of trust between countries. First, there is a critical need to create a political will to manage resources in the nexus framework. The upper and lower riparian rights in Central and South Asia region requires a nexus framework not only to address the challenges of water management but also generation of electricity from hydro-electric resources. The WEF nexus approach can definitely build a better political understanding for greater interest of regional stakeholders. Second, historical formation of policies was based on a top-down approach; this resulted in not only inefficient allocation but also an obfuscation of massive environmental harm from international donors. The focus on WEF nexus in this case is a paradigm shift from earlier developed program such as green revolution. Hence, the most effective path towards achieving any cooperation objective is to make policies that involve multi-sector and multi-level engagement with all actors of the shared resource nexus. Regional development organizations need to thus prioritize the linkage between the WEF nexus and the SDG agenda to optimize development outcomes, while also using such an approach for peace-building in this contentious region.

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