Consequences of the Droughts in the Euphrates - Tigris Basin

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Abstract

In Euphrates Tigris Basin (ETB), droughts are a regular feature in the region and have significant social, environmental, and economic impacts, particularly in places where there are already pressures on existing water resources. Drought has a negative impact on health, the agricultural production, and the economic condition of most people who live in ETB; and food scarcity makes migration from these dry areas and expected to increase further in the future.
Droughts are a regular feature in the region and they have significant social, environmental, and economic impacts where rainfed farming is important. Therefore there is an urgent need to build resilience and adaptive capacity of riparian states focusing on innovative regional-based drought and agricultural investment strategies.

In this paper, the economic, social, cultural, and environmental aspects of drought in the Euphrates and Tigris basin is evaluated. An integrated or nexus approach to resources management and cooperation appears to be the evident way forward. The nexus approach identifies water, energy, and food as the central sectors and advocates for better physical as well as policy and governance integration.

Keywords: Drought, Euphrates and Tigris Basin, Nexus approach, Food Security

1.INTRODUCTION

In this paper, drought is defined as the consequence of a period of low lower than expected or lower than normal precipitation over an extended period leading to a water shortage for some activities, groups, and environmental sectors. (UNESCWA. 2005). Besides low precipitation levels, the occurrence of drought results from evaporation, which is affected by temperature, wind, vegetation, type of soil, and it's capacity to store water, as well as the presence of groundwater supply.

Iraq and Syria both rely on major shared rivers for water but equally, there are parts of the country that rely on rainfed farming. The 4-year drought, which started in 2006, has had major consequences with mass migration from the countryside to the cities and is thought to be a significant contributor to the overwhelming problems now facing Syria. The ETB is associated with ancient civilization where irrigation schemes had been developed about the 5 millennium B.C. The headwater basin generating ET flows was entirely located in the north and eastern parts of the basin in the highlands of Turkey, Iraq, and Iran as a result of watershed's topography.

2. HYDROLOGICAL AND SOCIO-ECONOMIC CHARACTERISTICS OF THE BASIN

Euphrates and Tigris Rivers are the longest Rivers in southwest Asia. The main utilizers of the water of these rivers and tributaries are Turkey, Syria, Iran and Iraq(Ansari 2018). The two rivers rise in Turkey, which makes it the upper riparian. Some of the tributaries of the Tigris and Shat Al-Arab Rivers rise in Iran, which makes it the second upper riparian for these rivers.

The annual precipitation in the upstream of ETB typically exceeds 1000 mm whereas in the south of Iraq and Syria it was found to be less than 100 mm. Most of this precipitation occurs as snow in winter and the water resources are mostly available in the form of snowmelt water during spring and winter. There are various dry periods, which affect these countries, especially during the past 15 years. Among these four countries, Turkey has less severity and frequency of drought than the other three countries, and Syria has the most.

Figure 1. Euphrates and Tigris River Basin

Although oil supports some economies, agriculture is still an important part of the region's GDP and essential for maintaining national food security. Over the past 30 years, flows in the Euphrates-Tigris river system was reduced to almost 50 percent of the average annual flow in drought years. The Intergovernmental Panel on Climate Change expects a decline of 29 percent in Tigris flows and 73 percent in the Euphrates flows in the future as a result of declining rainfall in the main catchments in Turkey's highlands (Voss et al., 2013).

The severe drought that began in 2006 in Syria was responsible for a large number of farmers

abandoning their farms and migrating to the cities and is considered by some as a factor in the civil war which has seen the major loss of life. (Bazza 2018).Frequent droughts, causing yield reduction exceeding 20 percent of the normal, occurred in 1970-1973, 1977-1979, 1983-84, and 1989 in Syria (Bazza 2018). The recent most severe droughts affecting the majority of zones occurred in 1999–2001. Since 2006, the country has endured four consecutive drought years. Poor and erratic rainfall since October 2007 caused the worst drought to strike Syria in four decades. Rainfall in eastern Syria fell to 30 percent of the annual average in 2008 – the worst drought in 40 years (Bazza, 2018).

The effects of climate change in Syria are already evident from the cycles of drought, which have shortened from a cycle of 55 years in the past to the current cycle of seven or eight years.

- Syria's inherent vulnerability may best be captured by the fact that food security is mainly determined by rainfall, particularly in rural areas, where 70 percent of the total population lives. Quantity and distribution of rain is thus a central determinant of crop success.
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- In Iran, Although Iran has a history of drought, over the last decade, Iran has experienced its most prolonged, extensive, and severe drought in over 30 years. The droughts of 1998– 2001 and 2003–2011 affected many farm families and rural communities across most of central, eastern, and southern Iran. A review of long-term annual rainfall trends (over 32 years) indicated that in some parts of Iran drought has a return frequency of 5–7 years, while the national expectation was every 20–30 years (Eskandari, 2001).

2.1.Socioeconomic facts

Recurrent droughts and periods of water scarcity negatively affect food production, aggravating the current imbalance between food supply and demand inside the country. In 2011, the number of food-insecure Iraqis was 5.7 percent of the population (1.9 million people) (WFP, 2012).

Since the internal supply is not enough to satisfy the needs of the population, food consumption is largely satisfied through food imports, which reached a peak between 2006 and 2008. Droughts cause food insecurity and poverty to increase, especially in rural areas where most of the population relies on agriculture as its main source of livelihood (Bazza 2018).

Water-related migration registered an increasing trend. The south of Iraq experienced a huge population movement due to the drainage of the Marshlands; people were displaced due to the insufficiency of water. Between December 2007 and June 2009, 4,263 families (25,578 individuals) were displaced due to drought in Iraq (UNESCO, 2014). According to the Ministry of Health, the highest number of diseases transmitted through contaminated water and food were registered between 2007 and 2010, during the most severe droughts (UNESCO, 2014).

The most vulnerable community groups (UNDP, 2013) to drought are inhabitants of the rural

areas. Farmers and herders (Bedouins) using marginal lands are particularly vulnerable. Other groups vulnerable to drought are internally displaced persons (IDPs); rural communities under the poverty line; and women head of households.

In Syria, in 2007-2008, nearly 75 percent of 206 000 households suffered total crop failure affecting farming in the middle north, southwest, and northeast of the country (UNDP, 2008).

In Syria, in 2009, approximately 30 000 families migrated and in 2010, as many as 50 000 families, mostly small-scale farmers migrated. In some areas, up to 70 percent of the population, including whole families, has gone to the cities in search of alternative work after two years of drought and failed crops (Bazza 2018).

In Iran, during the 1998-2001 drought, thousands of villages were partially or completely evacuated and the nearby cities were crowded by the rural people. A UN Technical Mission to Iran reported that "over 60 percent of the rural population may be forced to migrate to cities" (Bazza, 2018). Such immigrations create many social and cultural problems in the urban areas and for the emigrants (Siadat et al., 2001). The extreme drought conditions of the period 2003–2011 led to widespread migration, particularly from villages to the cities (Keshavarz et al., 2013)

3.THE SPECIFIC DROUGHT CHARACTERISTICS OF THE BASIN

In the basin, future predictions suggest lower precipitation accompanied with higher temperatures (Al-Ansari et.al., 2014). This condition will lead to more evaporation and drought periods in the basin (Hameed et al., 2018).

3.1 Iraq Case

Four droughts were recorded in Iraq in 2000, 2006, 2008, and 2009. Eleven governorates were affected in 2008 (UNESCO 2014). In 1969, drought-affected 500 000 people and caused economic damage of US$2 million. More recent droughts were recorded in 2007-2009 and from 2010-2011 (UNESCO 2014).

The drought that affected the country in the two consecutive years, 2008 and 2009, damaged almost 40 percent of the cropland in the country, especially in the northern governorates. From 2006 to 2007, barley production fell from 422,900 tons to 238 500 tons and wheat from 486,400 to 396,800 tons (UNESCO, 2014). In central and southern Iraq, the total production for irrigated barley decreased by 21 percent between 2007 and 2008, while wheat production fell by 31 percent.

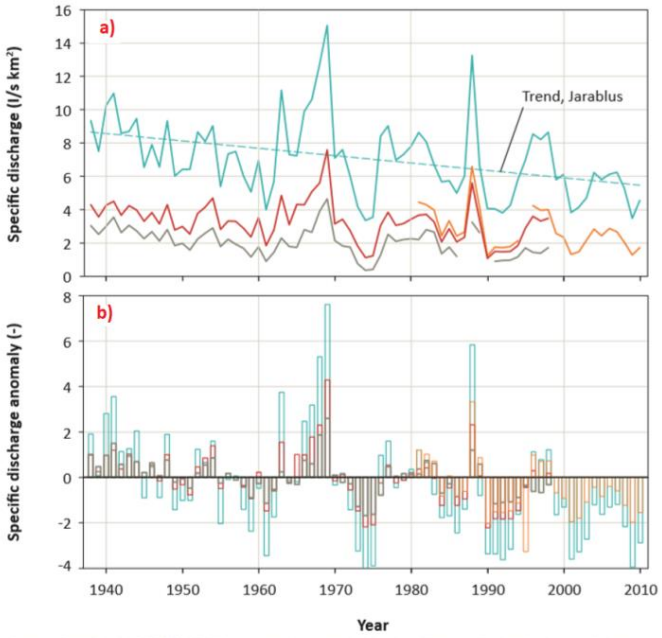
In addition to agriculture, several industries are affected by water scarcity, which may result in capital losses and layoffs, thus increasing unemployment. Hydropower generation represents the most important renewable energy source in Iraq accounting for nearly 10 percent of the electricity generation mix in 2010 (IEA, 2012). This reached a peak of 20 percent in 2005 but it dropped back to 7 percent in 2009, suggesting a possible effect of drought (UNESCO, 2014).

In 1999-2000, Iran imported nearly 7 million tons of wheat, making it one of the largest wheat importers in the world. The government recently approved an emergency aid package for US$183 million to assist drought-affected farmers (Khorasanizadeh,2012). In 2014, cereal

imports were forecasted at 12.6 million tons including 6 million tons of wheat, some 24 percent more than the previous year (GIEWS, 2014).

3.2.Frequency and severity of droughts

- Future projections indicate wetter winters, on the other hand, drier summers.

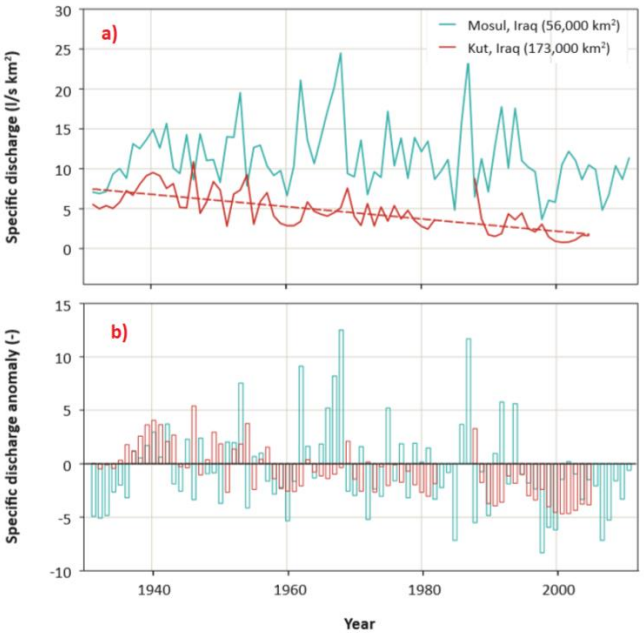


Source: Compiled by ESCWA-BGR based on data provided by the Ministry of Irrigation in the Syrian Arab Republic in ACSAD and UNEP-ROWA, 2001; USGS, 2012; Ministry of Irrigation in the Syrian Arab Republic, 2012.

Figure 2 a) specific mean annual discharge and b) discharge anomaly time series of the Euphrates (1937-2010)

Figure 2a. shows a statistically significant negative trend for the period of record (1937-2010) on the Euphrates at Jarablus indicating a decrease in mean annual discharge. Before 1973, the mean annual flow of the Euphrates at the Syrian-Turkish border (Jarablus) was around 30 BCM, but this figure dropped to 25.1 BCM after 1974. In the inventory, it says that "*This is most likely due to climate variability and more frequent drought periods, and the construction of large dams in Turkey as part of the Southeastern Anatolia Project (GAP)*" (UN-ESCWA, 2013).

Figure 2b shows the mean annual discharge anomaly in terms of water surplus (positive) and deficit (negative) compared to the long-term mean discharge throughout the record from 1937 to 2010. It shows wet and dry periods and reflects the impacts of stream regulation. The period of record exhibits four prolonged drought cycles (1958-1962; 1972-1976; 1983-1995; 1999-2011). (UN-ESCWA,2013).



Source: Compiled by ESCWA-BGR based on data provided by Hydrological Survey of Iraq, 1958; Ministry of Irrigation in Iraq in ACSAD and UNEP-ROWA, 2001; USGS, 2012; Ministry of Water Resources in Iraq, 2012.

Figure 3. a) Specific mean annual discharge, and
b) discharge anomaly time series of the Tigris (1931-2011).

Figure 3 b shows that in terms of discharge anomalies of the Tigris River. A major wet period in the 1960s is more pronounced compared to the overall mean. Below-average values since the 1990s can also be observed (UN- ESCWA, 2013).

The region is one of the most vulnerable to climate change, situated in arid and semi-arid climate regimes. The combined effect of increased temperature, leading to increased evapotranspiration, and reduced precipitation will result in large scale relative changes in annual runoff (water availability). For the period 2090-2099 relative to 1980-1999, the decrease in runoff is predicted to be in the range of 5-40% for a majority of the basin (IPCC2007). For the Euphrates River, it has been estimated that 88% of the water in the river derives from precipitation falling in Turkey (Cullen and deMenocal, 2000), which means that downstream water availability is very sensitive to changes in the precipitation in this sub-basin, as well as the management of the water resources in this basin. In the Tigris River, it is estimated that about 60% of the water in the river is received through precipitation in the sub-basins downstream from Bagdad.

A study by Fredrick Semazzi and Baris Onol shows that there will likely be a large decrease in rainfall over the southeastern Turkey region as well as a shift in rainfall patterns over Syria and Iraq in the next twenty-five to fifty years. This change in weather patterns would result in an increase in precipitation during the fall months and a decrease in precipitation for much of the winter season.

Another study carried out by Yıldız et al. clearly shows that streamflow trend of the Upper Euphrates River has decreased since 40 years mainly due to natural factors and it is prone to continue (Yıldız, 2019).

A broader climate assessment for the Tigris–Euphrates River basins evaluated the hydrologic impacts of climate changes (Bozkurt and Sen, 2013) showed that higher temperatures and evaporative demand in the basins, with the greatest increases in the highland areas, where precipitation is greatest. Precipitation changes were variable, with decreases in the northern portions of the watersheds and increases in the southern portions.

Statistically significant reductions of 25%–55% in annual surface runoff from the headwaters regions of the Euphrates–Tigris watersheds were seen in all simulations, along with a shift in the timing of runoff. The authors noted that these runoff changes ''suggest that the territories of Turkey and Syria within the basin are most vulnerable to climate change as they will experience significant decreases in the annual surface runoff.

3.3.Recorded and expected impacts

Drought impacts include a reduction in surface water flow, lowering of groundwater levels, the drying-up of open shallow surface wells, increasing water salinity and soil salinization, progressing desertification, decrease in agricultural production, growing frequency of dust storm conditions, and an associated increase in respiratory infections.

Transboundary water quantity and water quality is an important impact of the droughts. The historical Mesopotamian marshes used to be freshwater bodies. The drought of 2009 generally caused severe impacts on Iraq and Iraqi marshlands environment, in particular. These impacts can be summarized as decreased water quantity and cover area, reduced water quality, more concentrated pollution, increased soil salinity and abandoned agriculture lands, disrupted and fragmented marshlands ecological systems, decreased fauna and flora diversity, and increased human and animal diseases outbreaks (UNEP, 2010).

The droughts cascading to supply chain issues for other business create socio-economical problems as well as reduce hydro energy production

3.3.1 Syria

In Syria, the impact of successive droughts has been dramatic for both small-scale farmers and herders. In the affected regions, the income of these groups dropped by as much as 90 percent. Many families were forced to reduce food intake: 80 percent of those affected were reported to live on bread and sugared tea. The effects of drought on livestock and rangelands are linked. With a decreased range of resources, livestock is more vulnerable to drought. The current livestock population can no longer be maintained on natural rangelands throughout the year. This results in a chronic inadequate feed supply for livestock, with dramatic consequences in dry years (United Nations, 2009).

In Syria, during the 1983-84 drought, the national sheep flock declined by 25–30 percent (2.5 million head) due to starvation, crisis slaughter, and emergency export (Bazza, 2018). Meat prices collapsed and grain prices rose to cause a serious crisis in the nascent private sector poultry industry, with numerous bankruptcies (USDA, 1985).

3.3.2 Iraq

In Iraq Drought during 2008 and 2009 damaged almost 40 percent of cereal crops in the north (Raphaeli, 2009). In central and southern Iraq, the total production for irrigated barley decreased by 21 percent between 2007 and 2008, while wheat production fell by 31 percent.

In Iraq, hydroelectricity generation reached a peak of 20 percent in total in 2005 but it dropped back to 7 percent in 2009, suggesting a possible effect of drought (UNESCO, 2014).
In Iraq, According to the Ministry of Health, the highest number of diseases transmitted through contaminated water and food were registered between 2007 and 2010, during the most severe droughts (UNESCO, 2014).

3.4. Civil unrest and conflict

Severe multiyear drought beginning in the mid-2000s in Syria contributed to the displacement of large populations from rural to urban centers, food insecurity for more than a million people, and increased unemployment—with subsequent effects on political stability. There is some evidence that the recent drought is an early indicator of the climatic changes that are expected for the region, including higher temperatures, decreased basin rainfall and runoff, and increased water scarcity (Gleick 2014). Therefore the region is prone to civil unrest under the effect of climate change if regional cooperation can't be developed in a foreseeable future.

4.ENHANCING "REGIONAL COOPERATION APPROACH " ON FOOD, WATER, ENERGY SECURITY

Emerging threats force enhancing regional cooperation in the Middle East through regional development projects created with a mutually beneficial approach.
The region, which is mostly rich in conventional energy resources such as oil and gas, but the most water-scarce and food import-dependent in the world. Existing insecurities in water, energy, and food in the region have been linked to some of the conflicts in the region acting as a threat multiplier as well as pressure points.

One recent example is the devastating ongoing war in Syria which started as the result of complex interrelated sociopolitical and economic factors including, as well as challenges associated with climate variability and changes in the availability of freshwater.

The water and food insecurities are expected to be further intensified with the projected impacts of climate change, increase in the resettlement of internally displaced population, coming back of refugees from neighboring countries, and the ongoing security conflicts in the region.

The Middle East faces a highly complex and fragile security system. Increasing climate change effects, political uncertainty, forced migration and internally displaced people resulting from regional conflicts put food security of the region in danger. Although the priority in the region is setting up political stability, in parallel to this effort, regional cooperation on agricultural production and food security is also vital for the near future of the region

4.1. The emerging need for a vision for "The Day After"

In a valuable report prepared by FAO (FAO, 2018), it is indicated that "Climate change will affect world regions unevenly. It is already affecting vulnerable countries and will pose a major threat to their food security. Climate change will alter conditions for agriculture. This could lead to changes in comparative advantage across regions and consequently to changes in agricultural trade."

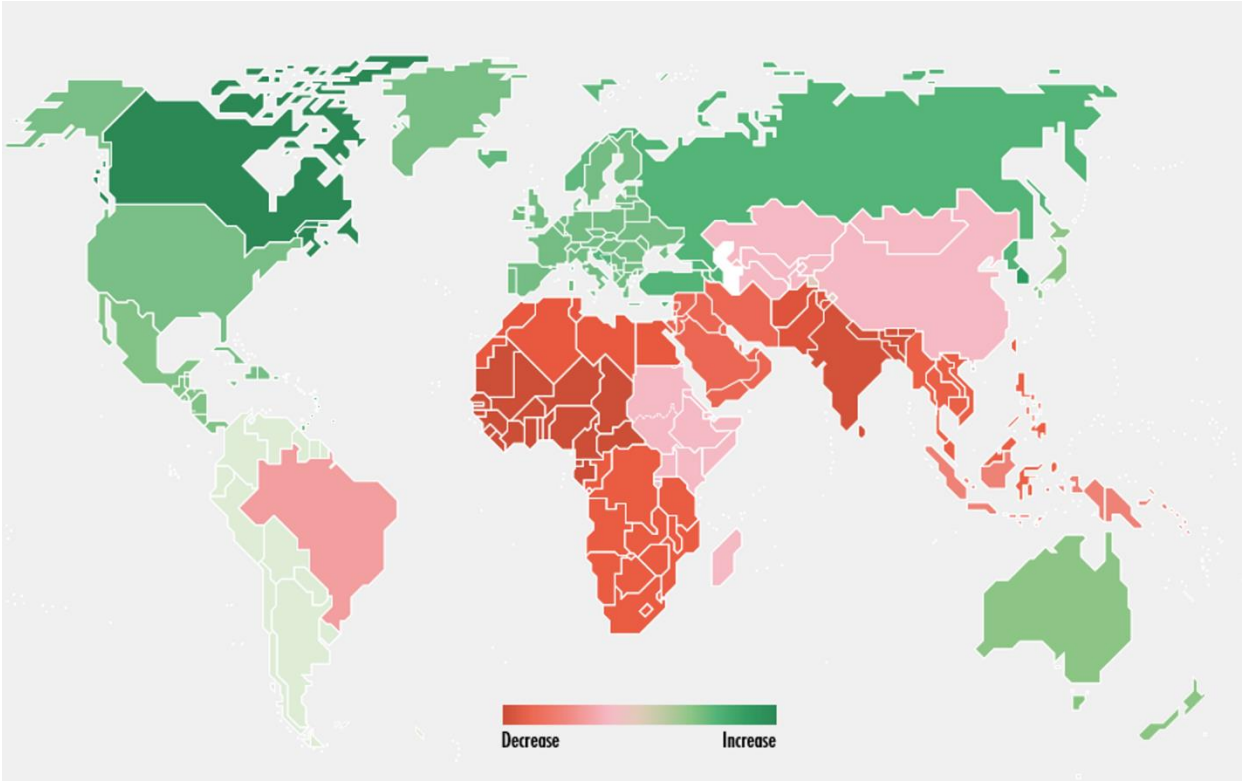


Figure 4. Changes in agricultural production in 2050: climate change relative to the baseline
Source: Based on data provided by Wageningen Economic Research. 2018. Climate Change and Global Market Integration: Implications for global economic activities, agricultural commodities, and food security. SOCO 2018 Background Paper, Rome, FAO (FA0, 2018)

In this valuable report it is also indicated that compared with the baseline, climate change is expected to result in declines in agricultural production in large parts of Africa, the Middle East, and South and Southeast Asia (Figure 4).

Someday the conflicts in the Middle East will be over and post-conflict reconstruction will begin. Therefore a vision is needed for the day after so that a region coming out of violence does not relapse into it again. Such a vision has to promote mutual inter-dependence and harness resources in the Middle East in the best interest of all the people.

4.2 Requiring need for a new regional concept

A regional concept starting from a bilateral relationship on the base of regionalization, institutionalization, civil society interrelation, strategic agricultural investment. Having effective institutionalized dialog can be a first step to adapt climate change, achieve regional water–energy–food security nexus (Farajalla, 2017).

Climate-related water scarcity will also affect the types of crops grown in the region. Water scarcity constraints may contribute to changes in the crop basket. Against this backdrop of decreasing agricultural production due to water constraints, a regional-based approach is needed. Intra-regional trade in the Middle East only accounts for 5 to 10% of the total trade of the region (Ekanayake, 2009). Some innovative and integrated approaches to improve strategic agricultural investments and interregional agricultural product trade are essential in the region.

5. CONCLUSIONS

Having the information given above, which shows that a decreasing trend is mainly due to natural climate factors dominating the region, it can be concluded that there is an urgent need to build resilience and adaptive capacity of riparian states focusing on innovative regional-based drought strategies and food security project. In this regard, preventive steps have to be undertaken to move towards a drought risk management approach in the Basin.

Increasing climate change effect, political uncertainty, forced migration and internally displaced people resulting from regional conflicts put food security of the region in danger. The regional food security approach will also be important during the transition period to relative stabilization.

For supporting these steps, there is a need to implement a drought early warning system which is consisting of monitoring, prediction, and well-developed information delivery structures and mechanisms among the countries. Furthermore, as realized by Turkey in the upper basin, downstream countries, namely Syria and Iraq, should promote new approaches, long-term strategies, and innovative methods to include modern farming systems, resources, and livelihood in drought-prone areas in the basin. In addition to this, the downstream countries should implement policies at all levels to encourage the uptake of more water-efficient technologies such as new methods of irrigation and rehabilitation of traditional water storage.

As known it is very difficult to deal with drought threats in such a conflict-ridden region, additionally to propose a roadmap and suggest guidance by taking into account climate change variations in reducing the water shortage/stress.
However, such an attempt could be very helpful for the water authorities of the concerned countries particularly for the efficient and effective use/management of the scarce regional water resources emphasizing the significance of their collaboration/cooperation.

Partnerships between institutions with an applicable road map can enhance coordination for more effective water-energy-food nexus policies. Enhancing institutions with innovative approaches and investment in region-wide agricultural development projects are essential steps to be taken in soon in the region.

An integrated or nexus approach to resources management and cooperation appears to be the evident way forward. The nexus approach identifies water, energy, and food as the central sectors and advocates for better physical as well as policy and governance integration.
Under the threat of climate change-induced drought and its experienced consequences, it seems that innovative approaches to co-operate around water, food, and energy nexus are essential in the region.

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