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Impact Assessment of Climate Change and Mitigation and Adaptation Methods on Water Resources in Kabul River Basin

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Abstract: ***Kabul river basin which is located in the eastern part of the Afghanistan is one of the most populated area. Its water is using for multiple purposes, including domestic and industrial water supply, hydropower, mining, agriculture irrigation, and environment. Collating information of the basin such as, the existing and potential water resources, water uses and demands in a simple and friendly form is important. Therefore, multispectral analysis and optimization of development options in the basin by the concerned ministries and development partners should be enable. The study is expected to help strengthen adoption of integrated approaches to basin planning and water resources in the country. Climate change is a certain "potential" risk and a very real threat impacts in the future that have already been felt. It shows how drought and flood risks have changed over the past thirty years. The aim is should to inform national level prioritization of areas and water resources for climate change adaptation and mitigation. Climate change analyses show which areas have seen or are expected to see the biggest change in rainfall, temperature or other climate parameters. The theme of climate change analysis is "where the impact of droughts and floods on water resources has been most severe and frequent?" by answering these questions can obtain an overview of which areas and population groups are most vulnerable to climate change. The climate hazards which are put the largest risk in Kabul Basin is the drought caused by reduced spring rainfall, declining river flows, and groundwater tables due to reduced springtime snowmelt in the highlands; and is the floods caused by increasing heavy spring rainfall, riverine flood's, and rapidly snowmelt in the highlands. The issue of this article is understanding of the impact of climate change especially flood and drought on water resources Kabul River basin and the adaptation and mitigation method climate change on that basin.***

Keywords: Climate Change, Flood, Drought, Adaptation, Mitigation

1. Introduction

Hydrology of Rivers

Water is the one most precious natural resources. Without it, there would be no life on the earth. Hydrology is the science which give information about the water and its usage, and it has developed as a response of understanding of a complex system of water in the earth and human's involvement that it can help to solve the water problems. The problems are included the occurrence, distribution, movement, and properties of the water in the earth and their relationship with the environment within each phase of hydrological cycle. Water is used for a variety of activities such as, households, businesses and industries, irrigation of farms and parklands, and for production of electric power. After use is returned to a part of the cycle.

Because of water is used for a variety of activities such as, households, businesses and industries, irrigation of farms and parklands, and for production of electric power. Therefore, most cities in the world solve their water needs from using nearest river basin, lakes or other reservoirs. One reservoir is the Kabul river basin which is located in Asia, and the area of the study. Therefore, it is useful to link it with the Asia's river basins.

The Asian's rivers basins are Indus, Ganges, Brahmaputra, Yangtze, and Yellow. More than 1.4 billion people (over 20% of the global population) depend on water from these rivers vary considerably in their characteristics. The Yangtze and Ganges are the most densely populated of the five basins. The Indus and Brahmaputra basins have extensive upstream large glaciated areas (i.e., above 2000 m). The Indus, Ganges, and Yangtze basins support large-scale irrigation systems with high net irrigation water demand. The total discharge of Indus basin is 151% which is naturally generated in the downstream areas by snow and glacial melt (Fig. 1 and Table. 1).

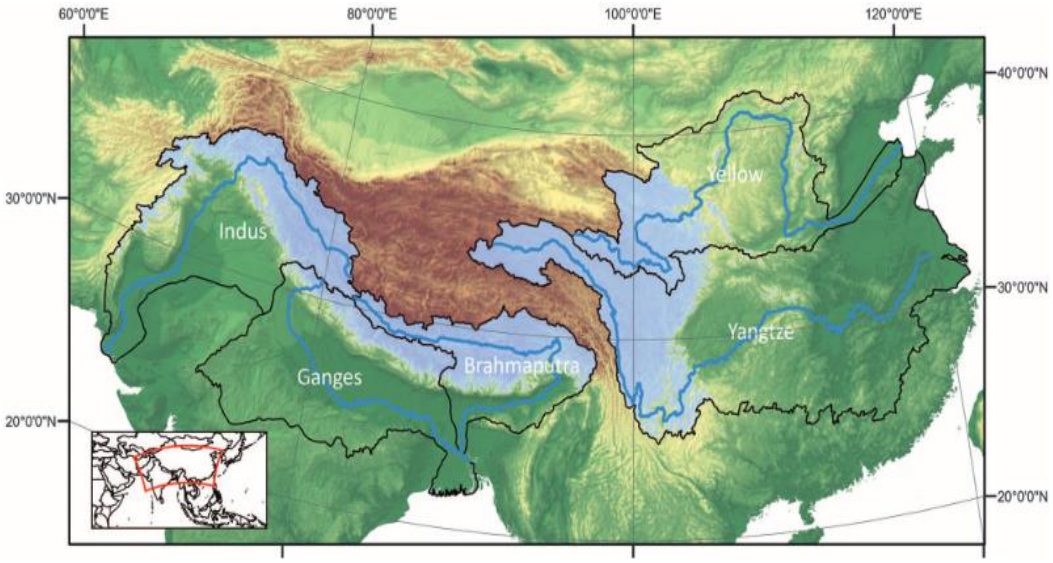

Figure 1: Asian's river basins (Indus, Ganges, Brahmaputra, Yangtze, and Yellow) and their boundaries

Table 1: Characteristics of the five major south and west Asian basins

Parameter	Indus	Ganges	Brahmaputra	Yangtze	Yellow
Total area (km^2)	1005786	990316	525797	2055529	1014721
Total population (10^3)	209619	477937	62421	586006	152718
Annual basin precipitation (mm)	423	1035	1071	1002	413
Upstream area (%)	40	14	68	29	31
Glaciated area (%)	2.2	1.0	3.1	0.1	0.0
Annual upstream precipitation (%)	36	11	40	18	32
Annual downstream precipitation (%)	64	89	60	82	68
Irrigated area (km^2)	144900	156300	5989	168400	54190
Net irrigation water demand (mm)	908	716	480	331	525

Sources: http//sedac.ciesin.columbia.edu/gpw

The Indus river basin which is the most popular river in Asia and at least 300 million people are estimated to live on it stretches from the Himalayan Mountains in the north to the dry alluvial plains of Sindh province in Pakistan in the south. Finally flows out into the Arabian Seain the Indian Ocean. Its 14 % drainage areas are lying in the states of Jammu and Kashmir, Himachal Pradesh, Punjab, Rajasthan, Haryana and Chandigarh in India. Only about 14 percent of the total catchment areas of this basin lies in China and Afghanistan (Fig. 2).

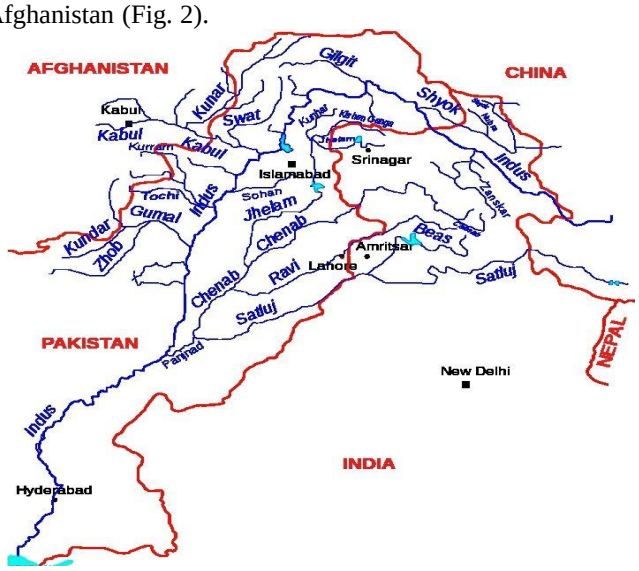

Figure 2: Indus River Basins

Source: https://www.eurasiareview.com/23082018-indus-water-dispute

Pakistan (520000 km2), India (440000 km2), China (88000 km2), and Afghanistan (72000 km2) are the countries in the Indus River basin already facing with major water shortages and water security. (Cruz &, 2007; Milly and others, 2005). The Indus River Basins with its other minor tributaries drainage area of 18600 km2 drain southeastern of Afghanistan and all flow eastwards into Pakistan, and provides irrigation to more than 16 million hectares of agricultural land. Also from its water 13 gigawatts of electricity through hydropower plants is generated in the Pakistan, India, and Afghanistan.

River Basins in Afghanistan

The Kabul River basin and other tributaries of the Indus together drain 11 percent of Afghanistan. Almost 90 percent of Afghanistan's land area is located in the five river basins, namely the Amu Darya, the Hari Rod-Murghab, the Kabul (Indus), Northern, and the Helmand and Western (Fig. 3 and Table.2).

Figure 3: Location of Afghanistan's River Basin

Table 2: Characteristics of water resources by Afghanistan's River Basins

River Basins	Area (km^2)	Part of Total Area (%)	IRSWR[a] (km^3/year)	TARAWR[b] (km^3/year)	Groundwater Recharge (km^3/year)
Kabul (Indus)	72600	11	11.5[c]	21.5[c]	1.92
Helmand and Western	270000	41	9.3[d]	8.48[d]	2.98[e]
Hari Rod-Murghab	80000	12	3.1	3.1	0.64[f]
Northern	75000	12	1.9	1.9	2.14[f]
Amu Darya (Panj)	91000	14	11.7[g]	20.7[g]	2.97
Other	63400	10			
Total					

[a]IRSWR= Internal Renewable Surface Water Resources
[b] TARAWR= Total Actual Renewable Surface Water Resources
[c]Flow of Kunar, entering from Pakistan into Afghanistan, 10 km^3
[d]0.82 km3/year is to be reserved for the Islamic Republic of Iran from the Helmand river according to an agreement from 1972
[e] Groundwater Recharge: Helmand2.48 km^3 and Western 0.5 km^3
[f] Groundwater Recharge: for Northern 2.14 km^3 includes Murghab, for Hari Rod-Murghab 0.64 km^3 excludes Murghab
[g] The flow of border river Panj where the Bartang enters is 33.4 km^3. According to the treaty in 1946 with Soviet Union 9 km^3/year can be used by Afghanistan
Source: Rout, 2008

Kabul River Basin Profile

The Kabul River originates in the central region of the Hindu Kush about 100 km west of Kabul city and lies in the northeast quarter of Afghanistan. The Kabul Basin is an 80 kilometer long valley formed by the Paghman Mountains to the west and the Kohe Safi Mountains to the east that contains Kabul city and surrounding communities. It has a drainage area of 54 000 km^2 in Afghanistanthat flows through in Kabul from west to east with 560 km long. It is rising from the Sanglkh by range of 72 km passes the Jalalabad and north of Khyber and then pass into North-West of Pakistan (Peshawar). It joins the Indus River northwest of Islamabad at Attock.Its main tributaries include the Logar, Panjshir (with its major tributary the Ghorband), Laghman (Alingar) and Kunar rivers**(**Fig.4).The Kabul River Basin represents around 12% of available water resources in Afghanistan that is crucial for the livelihoods of millions of people that use this water resources for drinking, sanitation, agriculture, power generation, and industry (Favre and Kamal 2004, Part III).

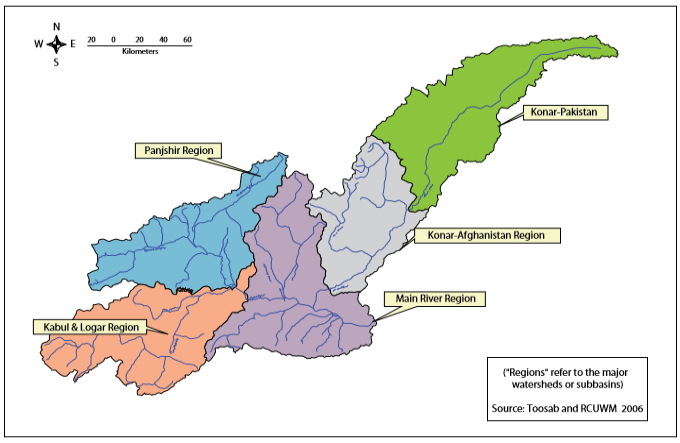

Figure 4: Kabul River Sub basins (Favre and Kamal, 2004; Rout 2008; Uhl and Tahiri, 2003)

Due to insufficient storage capacity in the river basins and the melting of snowpack will be accelerated by the increasing summer temperatures expected due to climate change. Therefore, will put further stress on groundwater resources for meeting the growing water needs in each sector. The climate of Kabul Basin (average temperature

and average annual precipitation) (1957–77 and 2011–15). Shows in Fig.5.

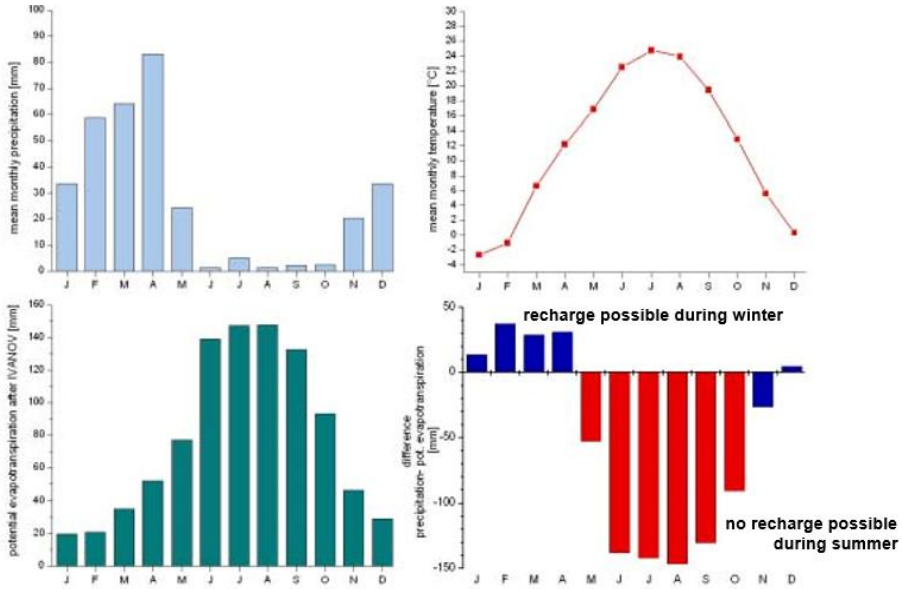

Figure 5: Climate of the Kabul River Basin

Water Supply and Water Demand in Kabul River Basin

The current water production per capita is approximately 16 liters per person per day and the per capita electricity consumption is about 20–30 kilowatt-hours per year in Kabul which is a major city and one of the fastest growing in Asia. On the basis of United Nations population projections, the population of the Kabul Basin could more than double to 9 million by 2057 (Sustainable Development Department South Asia Region). Thus, the current water production is less than the estimated demand from existing connected customers, and current unanswered demand is estimated to be more than twice the current energy availability. Water supply and water demand of Kabul River Basin has shown in figure (6).

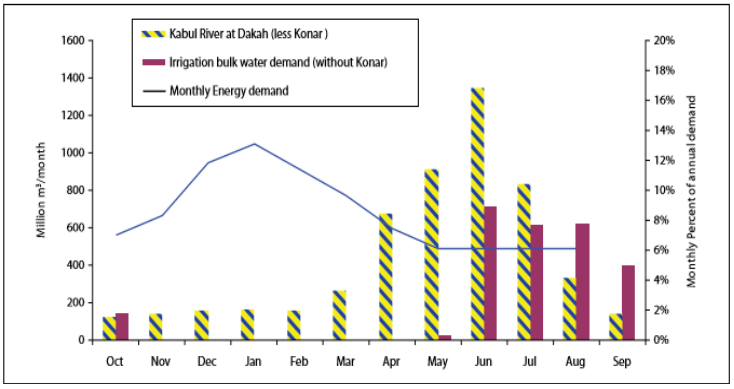

Figure 6: Average Monthly Flow in Kabul River Basin, Irrigation Bulk Water Demand, and Energy (Electricity) Demand (% of Annual)

Existing community water-supply wells that are shallow likely would be affected by increased groundwater withdrawals, and their level with groundwater-level declines about 1 meter could be unworked or dried during the summer months as low as possible. Simulations of the effects of climate change and increasing water use from the groundwater indicate that large percentage of existing shallow water-supply wells in urban areas may contain little or no water by 2057 (Mack & others, 2010).

Climate Change in the Indus Basin

Lee and Bae (2015) assessed the impact of climate change on water availability in terms of green water and blue water over the Asian monsoon region. They emphasized the need of appropriate water resources management in arid and wet regions. They also showed average decrease of about 10 % in precipitation over the region by the periods of 2040–2069 and 2070–2099 with high diversity over different countries and basins. Precipitation and temperature have shown different trends in different locations of the Indus Basin. Generally, temperatures have increased while precipitation have shown different trends in different seasons. There seems to be more rainfall than snow(Ali, A. 2013).

Most of the precipitation falls in winter and spring and originates from the west of Indus river basin. Climatic variables are strongly influenced by altitude. Northern valley floors are arid with annual precipitation from 100 to 200 mm. Total precipitation increase from 600 mm at 4400 mm, and glaciological studies suggest its accumulation rates of

1500 to 2000 mm at the 5500 m altitude. Winter precipitation (October to March) is highly correlated especially across the Upper Indus basin, north and south of the Himalayan. From 1961 to 1999 there were significant increases in winter, summer, and annual precipitation. Significant warming occurred in winter and summer showed a cooling trend. Thus, these trends from the climate change will impact on water resource availability (Savage, M., &others. 2009). In July and August 2010, more than 18 million people were affected by the flood disaster in the Indus River basin. Among the severely affected provinces where as many as 1100 people is died due to overflows of river, one of them is the located cities of the Kabul River basin (Fig 11and 12).

Figure 7: Flood Damage in Indus River Basin at 2010

Figure 8: Occurrence of flood in Kabul River Basin in July and August 2010

Implication of climate change in Kabul basin

The fourth assessment report of the Intergovernmental Panel on Climate Change (IPCC in 2007) identified climate patterns that include warming trends for southwestern Asia. During the next 50 years 10 percent reduction in total annual precipitation is anticipated in Afghanistan. Increase in surface temperature in mountainous regions would be likely result to reduce the snowpack's and cause the occurrence earlier snowmelts in year (Fieger.9).

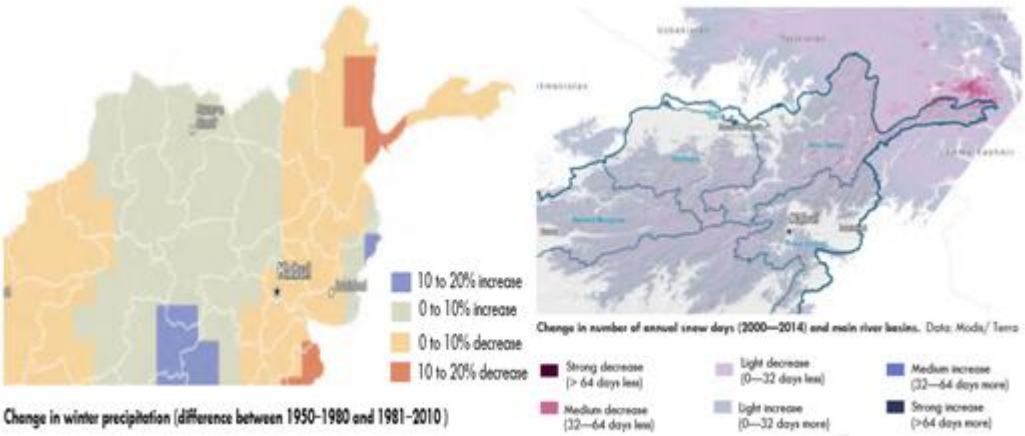

Figure 9: Climate change in Kabul basin
Source: Water Sector Achievements / Under NAPA

Also 10 percent recharge reduction was simulated that recognize the hydrologic effect in potential climate change on groundwater resources in Kabul River Basin. For example, a comparison of flow in the Panjsher River at Shukhi in 2014 by monthly historical observations of streamflow indicates that there is an early shift in peak monthly (high in May and below from normal in June and July). The groundwater recharge occurs after the snowmelt infiltration in the rivers. The five years' drought and intense overexploitation is indicated the falling groundwater levels and is caused significant recharge (Fieger. 10).

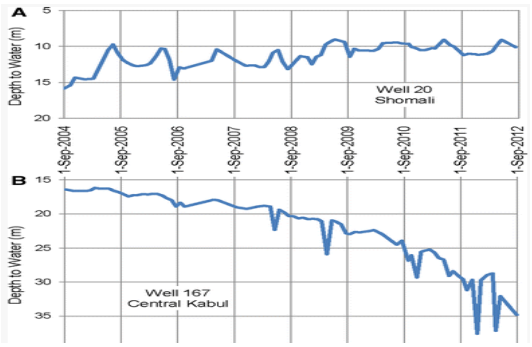

Figure 10: Monthly depth to water at Afghanistan Geological Survey wells A 20 and B 167 from September 2004 to 2012 in the Kabul Basin, Afghanistan

Climate Change Mitigation and Adaptation

Afghanistan has identified national priorities, urgent priorities, strategic priorities and development priorities for adaptation initiatives and programs. The ways to decrease the impact of climate change in water resources in Kabul River Basin are water management for energy efficiency and construction of dams for storage water and other approaches (Fieger's: 11, 12, and 13).

Figure 11: New Dam and Creation of Typical Canal Gate's in the Logar River

Figure 12: Creation Karez System for Abound Storage of Water and Traditional Irrigation Infrastructure

Figure 13: Creation Dam on Panjshir River and Installed Wells with Hand-Pumps

The United States Agency for International Development (USAID) has been working with the Afghanistan Geological Survey (AGS) and Ministry of Energy and Water (MEW) since 2004 for addressing future availability and water resources management in Kabul Basin which has affected by potential climate change (Ahmad, S. 2010).

Key Findings for Water Resources Development in Kabul River Basin:

- Water conveyance link to bring water from the Panjshir sub basin in order to supplying Kabul population, and for the Aynak copper mine.
- Development of multipurpose storage in both the Panjshir and Logar-Upper Kabul sub basins with cheapest flexible options.
- Creation irrigation development systemsuch as, diversions irrigation in Logar valley.
- Providing mixed hydro-thermal system energy demand.
- Adjustment of hydropower system project.
- Constructed canal that has stones in mortar cement which it makes more permanent and less degradation on over time.

Therefore, here is a framework towards effective water resources management which is showing in Figure 14.

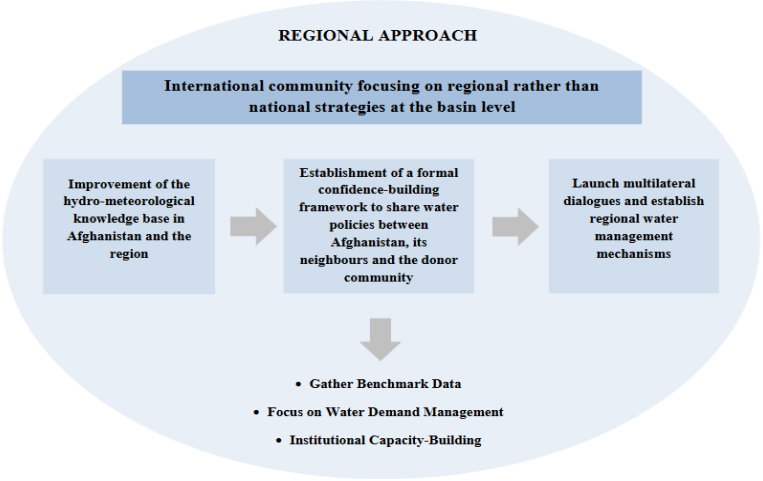

Figure 14: Scoping strategic options for water development in Kabul River basin (Hanasz, P. 2011)

2. Conclusion and Recommendations

Water is the one most precious natural resources that without it life on the earth would be no possible. The impact of climate change on water availability in terms of green and blue water is emphasized the need of appropriate water resources management in arid and wet regions. During the next 50 years, 10 percent reduction in total annual precipitation is anticipated in Afghanistan. Increased surface temperatures in mountainous regions would be likely result in reduce of snowpack's and cause earlier snowmelts in year. Also, 10 percent reduction in recharge in assess of hydrological effect of potential climate change on groundwater resources in Kabul Basin are simulated. The 2000–2005 intense drought and significant usage of recharge by overexploitation is indicated falling groundwater levels. Afghanistan has identified national priorities, urgent priorities, strategic priorities and development priorities for adaptation initiatives and programs based on the vulnerability assessment for water resources. Because throughout of the Kabul Basin, socio-economic impacts of climatic events have been significant and adverse, so for solution and access to green and fresh water some following suggestion are addressed:

- The government should recognize the degree of vulnerability from impacts of flood and drought, and disseminate information about the seriousness climate events to increase people awareness.
- National and International institutions should be encouraged to take an active role in providing the solution of creating problems in Kabul River Basin.
- Should be increase adaptation initiatives and programs in Kabul Basin to prevent falling of groundwater levels with limited capacity.

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