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Impact of Climate Change on Water Resources in Kabul City

Rahimullah Alokozay[1] Jagan.J[2]

[1-2]*SCHOOL OF CIVIL ENGINEERING, GALGOTIAS UNIVERSITY, GREATER NOIDA*

Abstract- *In Kabul city water resources have been increasingly stressed duo to population growth and climate change. These research is about to know the present and future impact of climate change on water resources, in this study region and global data is collected and the soil and water assessment tools (SWAT2012) was applied to evaluate the water availability in the Kabul river basin. In this study the simulated analyses period was (2008-2012), two most sensitively parameter was considered temperature and precipitation. Three deferent climate change scenarios (A1, B1 and A1B) being applied to the model for simulation of past and future water availability. Snowfall, rainfall, evaporation, surface water and evapotranspiration is investigated hydrodynamic characteristic.*

Based on the result a warmer climate is expected for the study area with a projected change of temperature between 1.5°C and 2.90°C for winter and summer season. Based on A2 scenario the snowfall is expected to decrease for the months of November, December, January, and February especially between 20% to 40% due to increasing temperature in the mentioned months. The output of (SWAT2012) model was showed that the stream runoff in the months of January, February, March and April is increasing between (35% to 45%) and runoff is expected to decrease in the months of June, July, August, and September between (40% to 50%).

Key word: climate change, water availability, temperature, precipitation

1. INTRODUCTION

Climate change is very big challenge to the world us we know those country which they are new in development they need to energy to reach their high energy requirement for developing, so its producing the greenhouse gases which affect the atmosphere layer and affecting the water resources. Climate change affects global hydrological cycle, which increases the risk of drought and flood.

Climate change effect on water hydrology system which increase average level of ocean, melting of ice, air temperature, sea level and other factors. By affecting these factors its predicate that water resources will be affected in future by global warming. Climate change also effect on runoff, evaporation and evapotranspiration, it's the big problem to the water hydrology system. Many studied shows that the potential impact of climate change effects on agriculture sector and food production.

1.1 Afghanistan river basins overview

Afghanistan is a landlocked country with total area of 652,238 km^2. Its border by Tajikistan, Turkmenistan and Uzbekistan to the north, Pakistan to the east, China to the northeast and Iran to the west. Afghanistan basin according to its topography and water resources divided into 5 major river basin.

1. Kabul river basin
2. Helmand river basin
3. Harrirud Murghab river basin
4. North river basin
5. Amu river basin

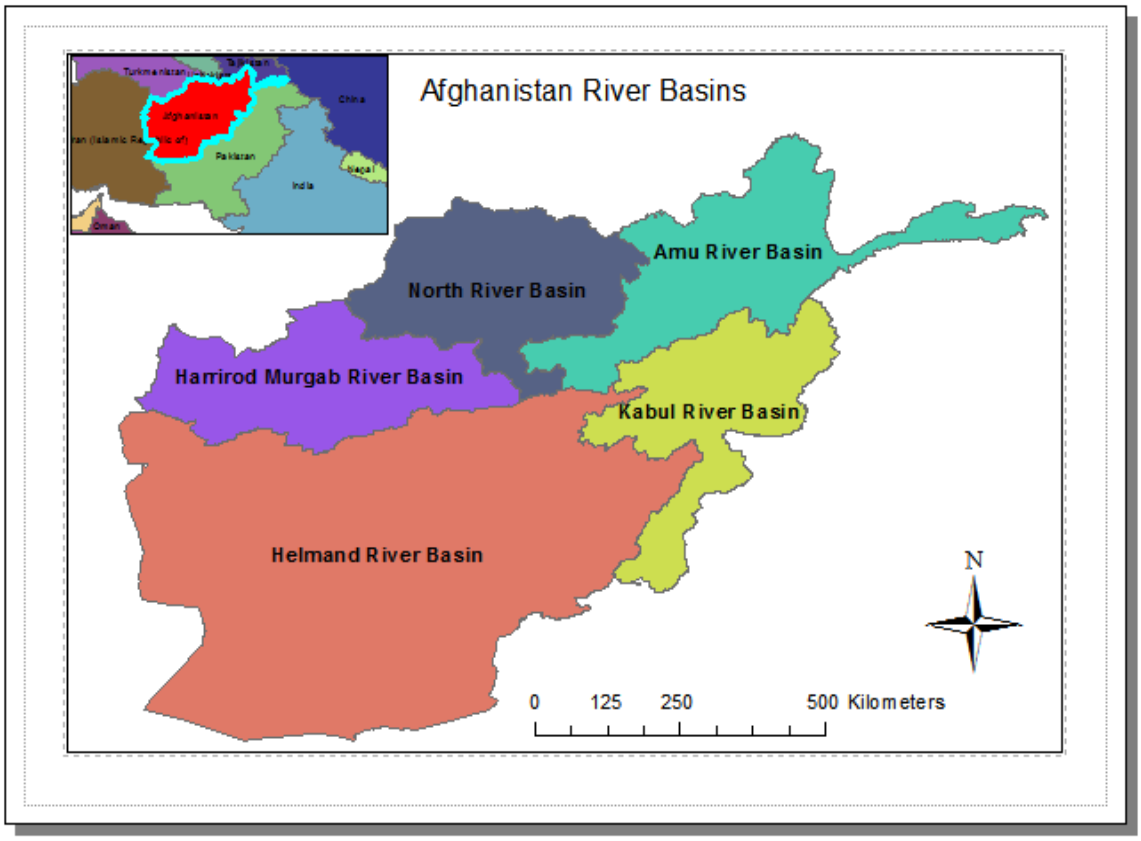

Fig -1: Afghanistan five river basin map

2. Material and method

2.1 Study area

Kabul river basin is trans-boundary catchment. Its located in the east part of Afghanistan and Chatral valleys of Pakistan. North latitude is between (33° - 37°) and east longitude is 67° -74° as shown in figure 1.2 with drainage area of 65202 km². This basin is divided into 23 sub-basin and 10 provinces, including Kabul, located in this drainage area. The upper catchment of the Kabul river basin consist of steep mountains valleys in the Hindokash mountain range, which reach over 7500 m above the sea level. The Kabul river basin is divided into four distinct areas.

1. The logar-maidan Kabul areas
2. Panjshir-Ghorband areas
3. Lower Kabul comprises areas
4. Loghman and kunar area

Finally all these tributaries and river joint in the Aba area of Nangarhar province and pass the border throughout the Pakistan territory.

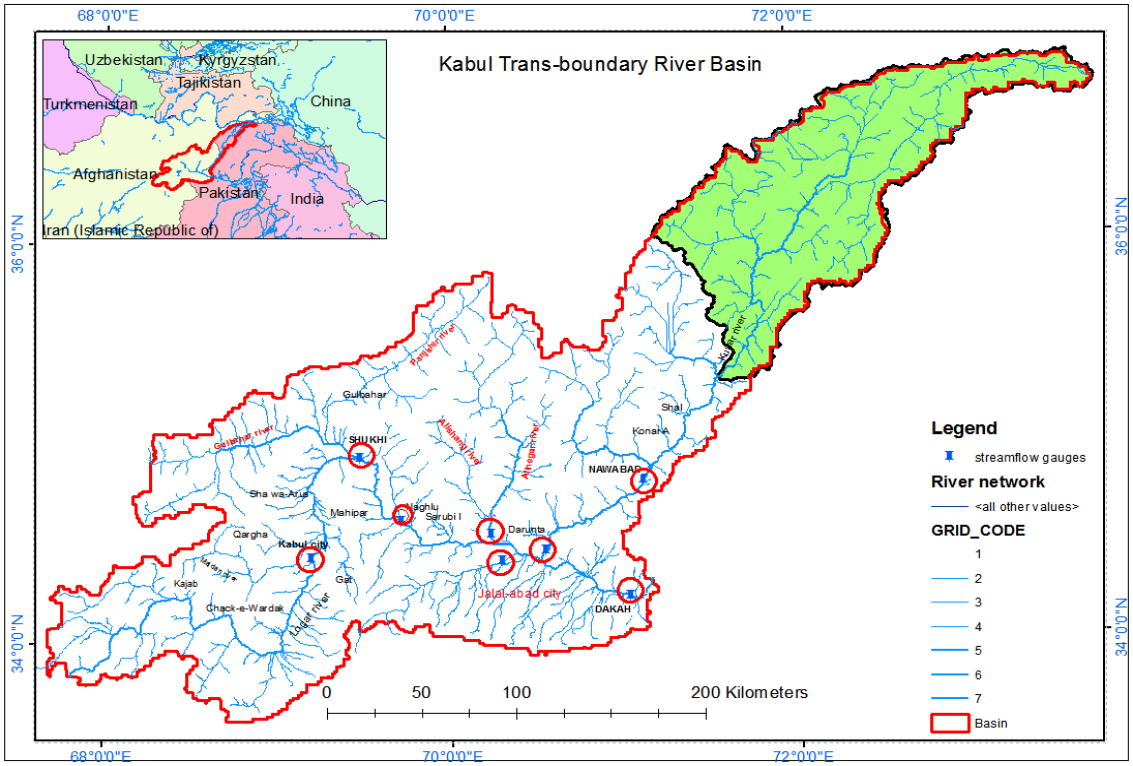

Fig -2: Kabul river basin map, study area

2.2 Data collection and method

For collection the data and method two steps were applied step one of the study, collections of primary data through the serving of area and second step is collection of secondary data form the relevant ministry of water and energy and published studies.

- primary data

1. observation of field
2. questionaries'

- secondary data

1. Demographic data
2. Hydro climatic data

2.3 Climate change Scenarios

Global climate change impact on both social and natural system, water resources and ecosystem partially both affected by climate change. Global warming can sooner hydrological cycle by increasing both evapotranspiration and evaporation rates. In present scenario by mitigate the greenhouse gases can decrease the effect of climate change on water hydrological system, evapotranspiration and evaporation is both important variable can be vary by changing temperature.

The first and primary anthropogenic source for the greenhouse gases to emitting the pollution to the environment its carbon di oxide (CO2), which is producing by burning the fossil fuel. However scientists are assured about the effect of climate change

and global warming duo to human activities that haw large warming will be and what will be the impact of climate change in deferent part of the earth.

In present time climate change is one of the big environment challenges to the earth, rising temperature, milting polar ice, increasing the world free water and changing the waterway from its consequences.

Fig -3: climate changes in region

One of the important impacts of changing climatic conditions is the distribution of precipitation, the spread of droughts and their continuity, and to a large extent, the negative impact on global water resources. Rising up the temperature and amount of evapotranspiration and also decreasing rainfall increases the phenomenon of desertification and salinity of the soil. Increasing temperature and rising winter temperatures mean that winter and summer temperatures will decrease, including the consequences of reducing groundwater injection and reducing water resources. The issue of climate change affects the quantity and quality of water resources and affects the needs of industries, agriculture, and drinking water supply.

It is have a close connection between the climate system and hydrological cycle. Any change in the climate changes all the elements of hydrology, conversely is also happens. Flood waters, river discharge, groundwater, flood and drought are all affected by rainfall, which is one of the most important climatic elements.

Due to the human activity increase in CO2 and consequently global warming and its impact on national and regional water resources, it seems necessary to consider the impact of the above changes on water resource management planning. Increasing the temperature of the globe between 1 and 4 degrees in the present century reflects the dimensions of the frequency of disasters such as droughts and floods that can affect surface water, underground, land drainage, and so on, Kabul has little role in climate change and greenhouse gas contamination, but it is more harmful than other parts of the area, Climate change affects Kabul province in 3 parts; first, surface and underground water resources; second agriculture; and third, forests and grasslands, it is a concern that with further climate change, Kabul faces more problems such as the water crisis and food supply.

Climate change affects Kabul province in three stages; first stage, surface and underground water resources; second stage agriculture; and third stage, forests and grasslands, it is a concern that with further climate change, Kabul faces more problems such as the water crisis and food supply.

2.4 Water resources

The snow pack in the mountains in the north and northeastern regions in the river basin constitutes the major runoff in the basin so water supply varies from year to year. In general, more than 72 percent of the runoff occurs between May and September and 40 percent occurs between October to April.

A trans- Basin division also transports water from the Chateral valleys, Pakistan to the Kabul river basin Figure 4.

There are four aquifers in the Kabul area. The Paghman-Darulam area has 2 aquifers lying along the course of the Paghman river and the upper Kabul river. The two other aquifers are located in the Logar sub basin. The main sources of recharge for this aquifer are infiltration of surface water from the river, irrigation and the ditches and canals. These aquifers are the main source of domestic water supply and supplemental for irrigation purpose. There are dams and reservoirs and lakes in the basin and their functions for generating electricity, irrigation and domestic water use are important. During June and July the peak runoff increasing due to snow melt while the peak demands for water usually is during July and August because of demand from the Agriculture sector. Further there are more some reservoirs and lakes are used for irrigation, domestic purposes.

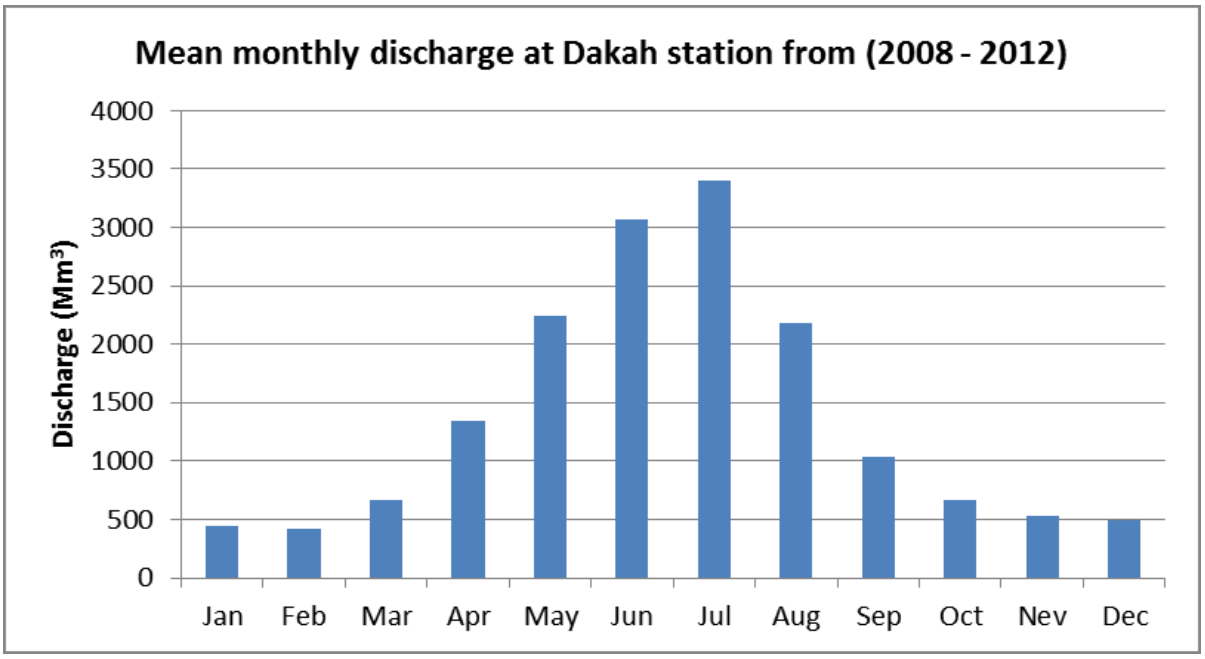

Fig -4: Mean monthly discharge at Dakah station in the period of (2008 – 2012)

2.5 Water availability in the Kabul city

In estimated survey during (2019) identified that the Kabul city has population of around 4.1 million it's growing rapidly, by growing of population increase the demand of water in current city, In Afghanistan the Kabul city is first growths population city. Water availability in the Kabul city the availibilty of water resources is biotic to economic and social wellbeing and rebuild of Afghanistan.

In present years the population of Kabul city is growing, its effects on the water availability and recent drought placed new stress to Kabul city. Population growth and recent drought both caused many wells to become contaminated and dry in the future. According to (Milly and others, 2005) there will be for long time drought, dry will, in future if the global warming is rapidly on Afghanistan Kabul city.

Table -1: Impact climate of climate change on water resources anticipate with change of climate

Sources major impact component potential effect of CC		
Aquatic system	• Level of water in aquifer • Level of water in surface water • Stream flows • Flux of water in subsurface	• Duo to flood fail of dam • Duo to sedimentation fail of dam • Drought
Water supply system	• Per capita water demand • Demand for agriculture	• Increasing the level of water demand behind the project
Quality of water	• Temperature of water • Brininess water • Concentration of contaminate	• Duo to flood fail of dam • Duo to sedimentation fail of dam • Drought
Water managing system	• stream flow • Level of water in surface water • Level of water in aquifer	• Reducing the water supply system • On water treatment system reduce the load • Change in production of hydropower
Hydrologic sources	• Runoff water • Transpiration • Recharge of contaminate water • temperature • Evaporation	• Duo to flood fail of dam • Duo to sedimentation fail of dam • Change in soil moisture • Shortage of water

3. Result and discussion

3.1 Precipitation consistency analysis

For analyzing the precipitation available metrological data from Ministry of energy and water for the period of (2008-2012) were used, to evaluate the precipitation. The primary result is shown that the annual precipitation is record have close similarly. For the most distinguished result tree time data was analyzed in SWAT model past, present and future from (1967-2012).Then monthly precipitation changes estimated by combination the three GCMs.

Table -2: precipitation analysis using three GCMs in the Kabul River

GCMs	Scenario	Annul precipitation (mm)			
		Past (1962-2000)	Present (2008-2012)	Future (2046-2064)	PBIAS (%)
CNRM-CH3	A2	525	515	554	6
	A1B	525	515	555	5
	B1	525	515	544	4
CCCM3.2	A2	523	515	504	-5
	A1B	523	515	528	2
	B1	523	515	447	-14

MIROC3.2	A2	491	515	575	16
	A1B	491	515	473	-3
	B1	491	515	455	-7

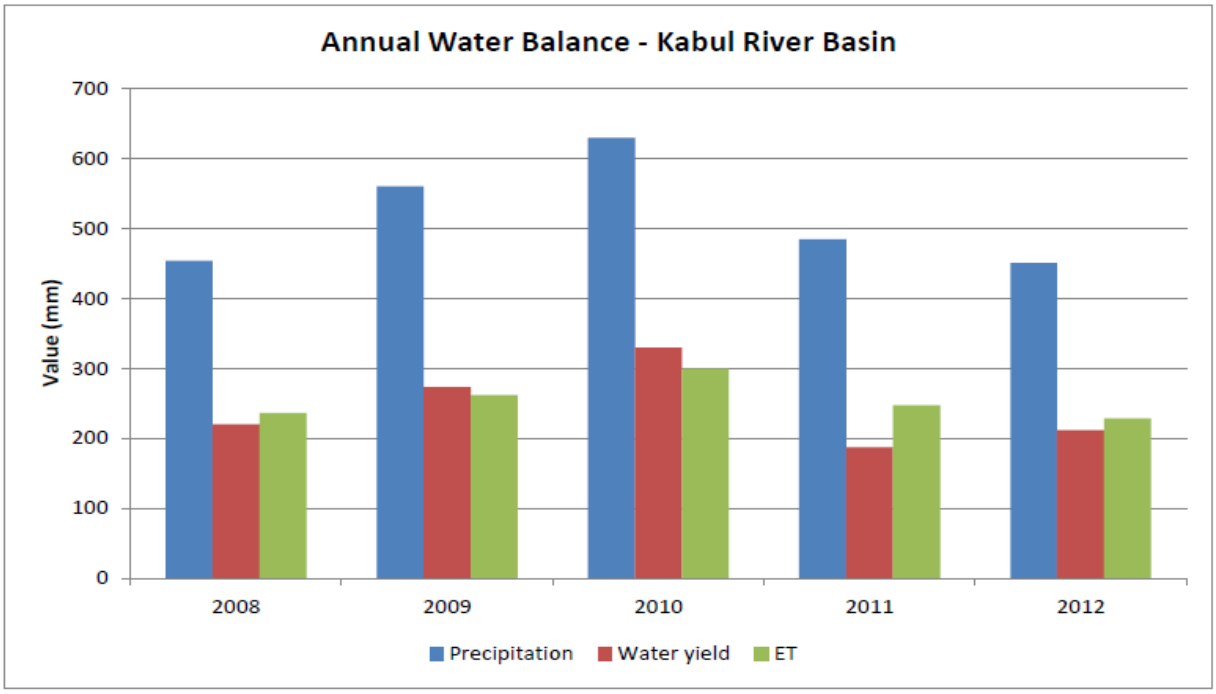

Fig -4: Annual water balance in the Kabul River

3.2 Temperature change analysis

One of the mean aim of this study to analyses the past, present and future temperature to known about the change of climate change in study area. The result is based on four GCMs, future climatic data were analyzed for prediction to identify the mean temperature from past, to current to future. The result is shown in below figure that the overall annual temperature is increasing.

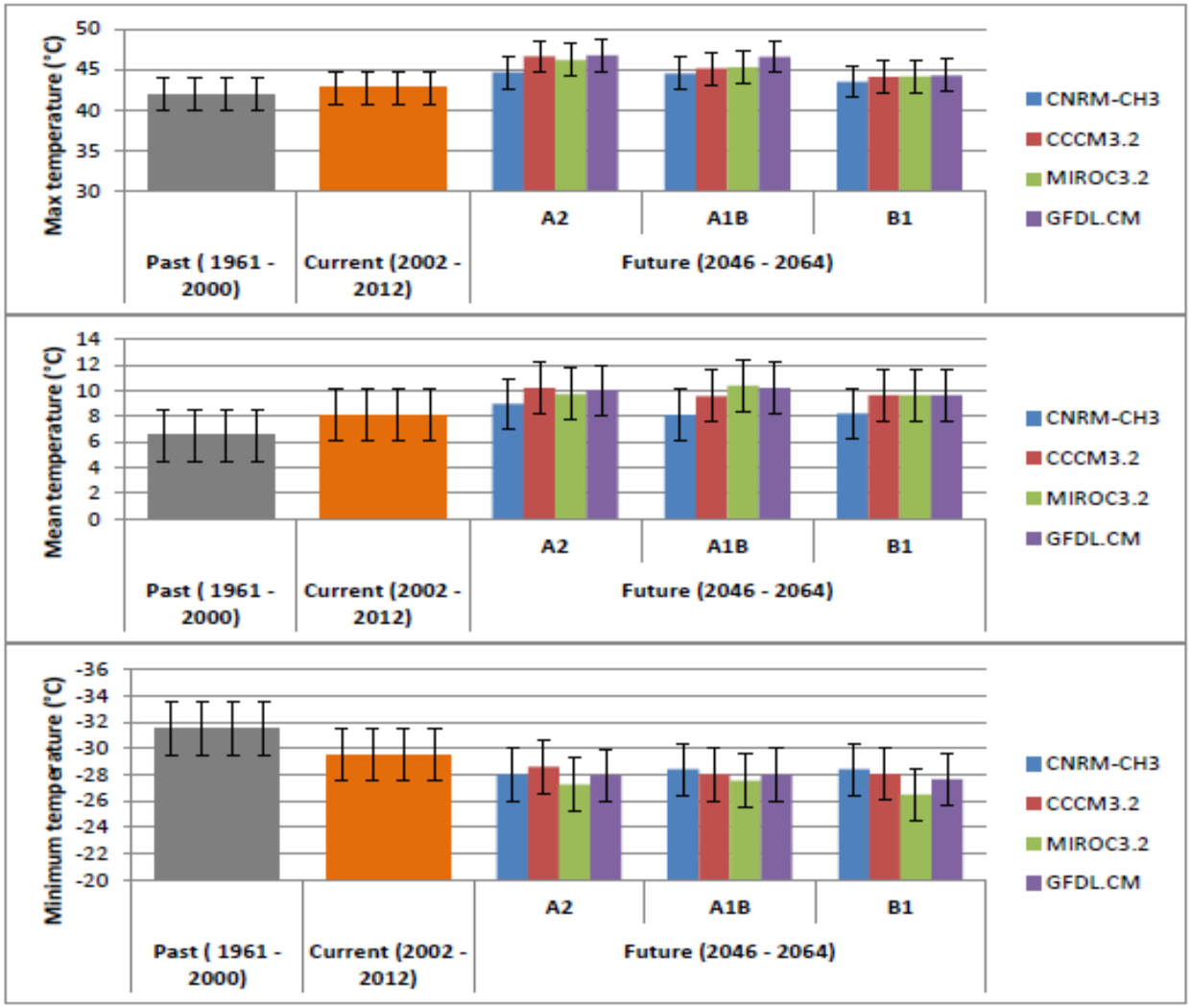

Fig -5: comparison of past, present and future temperature based on four GCMs

Table -3: change of annual temperature based scenarios

Mean temperature trend by (°C)					
		Past (1961-2000)	Current (2008-2012)	Future (2046-2064)	Δ T
CNRM-CH3	A2	6.51	8.09	8.97	2.47
	A1B	6.51	8.09	8.13	1.63
	B1	6.51	8.09	8.21	1.71
CCCM3.2	A2	6.56	8.09	10.22	3.66
	A1B	6.57	8.09	9.57	3.01
	B1	6.57	8.09	9.64	3.08
MIROC3.2	A2	6.54	8.09	9.72	3.22
	A1B	6.52	8.09	10.38	3.88
	B1	6.54	8.09	9.64	3.11
GFDL.CM	A2	6.82	8.09	10.02	3.20
	A1B	6.82	8.09	10.21	3.39
	B1	6.82	8.09	9.64	2.84

3.3 Protection and resolution of future climate change challenge

However the climate change is the big challenge to the world, Resolution is also important to the present time, the firs important way to control the future climate impact of climate change its mitigate the greenhouse gases (GHG), (CO2, CO, SO2, SO……) which helps to the global warming. There is few ways to control the global warming, those country which is need high amount of energy for development, use friendly and environmentally energy to reduce the emission of greenhouse gases.

1. Use of renewable energy in country.

Substitution of non-renewable energy to renewable energy, reducing usage of fossil fuel in country, develops of new technology like electronic metro station and other electronic services.

2. Global action to climate change.

UNFCCC is focus on to reduce the greenhouse gases from the sources, and mitigate the greenhouse gases emission. Face to this problem the first conference was in Kyoto protocol in 1997, this protocol set target for 37 industrialized countries to reduce their emission.

3. Sustainable forest management and agriculture

All country government has responsibility to save their environment and forest, reduce emission from deforestation

4. Sustainable transportation
5. Sustainable infrastructure

4.1 conclusion and recommendation

In this study the concept of vulnerability impact for water resources duo to climate change, future water availability based on climate change was assessed. Observe and dependable metrological and hydrological data sets were the main hurdle toward the present research. Dynamic and regression method have been applied for gap filling of existing metrological data which I have been obtained during data collection, all observed station located in the flat areas of the basin.

Then the observed precipitation in four stations compared with tropical rainfall measuring mission (TRMM) precipitation data set based on blocking method, the R^2 applied for total variation in the both data sets the result evaluated satisfactory with R2 = 0.80, eventually tropical rainfall measuring mission (TRMM) identified as acceptable precipitation data sets. Extension of hydro metrological networks in whole the basin is essential to create precise and dependable data base for future planning, research and development.

SWAT2012 model and GIS used for modeling hydrology spatially estimation of current (2008-2012) available water resources in the Kabul river basin, Afghanistan. For this research the SWAT model applied to quantify the current water availability, calibration scenario tested. The optimal scenario result for the simulated monthly and yearly flow the SWAT runoff simulation were tested again measured runoff data.

Then the annually simulated averaged stream discharge (244.0 mm) is 86% of the measured average value (284.0 mm). So the water yield results of simulation shown underestimate less than 14.1% of observed annual stream discharge.

In this study totally 11 combination were applied in the SWAT model to project future monthly and yearly water availability based on high, medium and law emission greenhouse gases (GHG) till 2064 to assess change in temperature, precipitation and hydrology component in the study area.

For future projected temperature, precipitation and water stream runoff four GCMs and three climate scenario (A2, A1b and B1) were used in the Kabul river basin for the period of (1961-2065). Based on the results of the 3 climate scenarios, the trend of impact of climate change is similar.

A warmer climate is expected for the study area with a projected change of temperature between 1.5°C and 2.90°C for winter and summer season. Based on A2 scenario the snowfall is expected to decrease for the months of November, December, January, and February especially between 20% to 40% due to increasing temperature in the mentioned months.

Generally based on these three scenario rainfall expected to increase slightly and snowfall is anticipated to decrease significantly in 2064. The output of (SWAT2012) model was showed that the stream runoff in the months of January, February, March and April is increasing between (35% to 45%), and runoff is expected to decrease in the months of June, July, August, and September between (40% to 50%).

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