Analysis of the impact of climate change on the streamflow at Chaghasrai watershed in Afghanistan

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INDRODUCTION

Afghanistan is a water-scarce country; Its limited arable area (i.e. 12%) is not enough to meet the food demand of the country's growing population. Around 11 % of the total population of the country has been strongly hit by hunger and the situation might further worsen the already fragile conditions of the agriculture and water resources sector. Besides, Climate is expected to change in future in spite there are still many uncertain ties which will affect natural and human systems such as agriculture, forestry, water resources, human settlements and human health Global surface temperature has risen by 0.74 °C in the past 100 years, with temperatures increasing more rapidly in the past 50 years. The temperature and precipitation patterns have also changed in Afghanistan, it is therefore expected that this land locked country with most of snowmelt-fed rivers will suffer more especially at the already least productive agriculture sector. This study is designed to see the impact of climate change on the streamflow as the key mean for water provision to farms.

OBJECTIVE

To analyze the impact of climate change on the streamflow at Chaghasrai watershed in Afghanistan

STUDY SITE

Chaghasrai watershed is part of the Kunar sub-basin (Sub basin of Kabul) which is situated in the eastern Afghanistan and is part of the larger Indus basin. The area of the Chaghasrai watershed is about 8153 km².

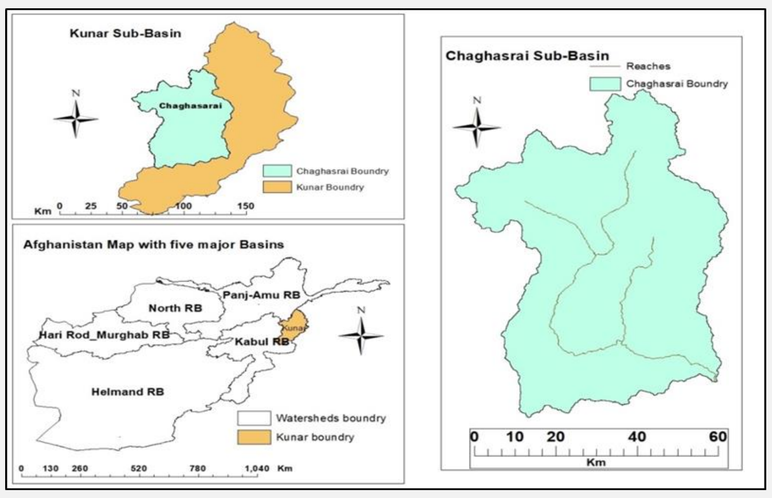

Figure 01: Chaghasrai watershed with main rivers network

METHODS AND MATERIALS

In this study we used a semi-distributed SWAT (Soil Water Assessment Tool) to evaluate the impacts of climate change on the river hydrology of the Chaghasrai watershed. The performance of SWAT model was evaluated using the Nash–Sutcliffe Efficiency (NSE) and the Coefficient of determination (R^2). The future climate changes scenarios of RCP 4.5 and RCP 8.5 were extracted from the Coordinated Regional Downscaling Experiment (CORDEX).

METHODOLOGICAL FRAMEWORK

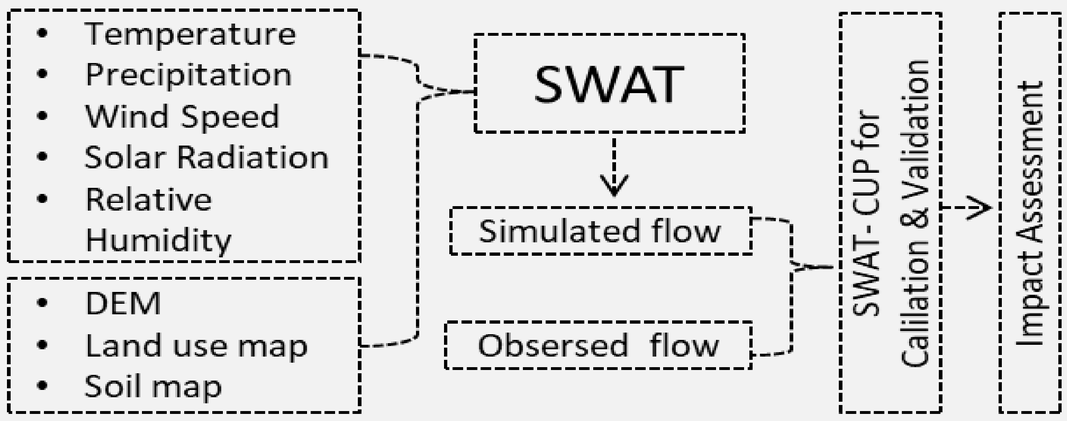

Figure. 02: Methodological Framework for streamflow quantification of Chaghasrai Watershed.

Results

The SWAT model was calibrated and validated for the Chaghasrai watershed at Chaghasrai discharge monitoring point for 2009 – 2011 and 2012 – 2013 . In order to project the impacts of future climate change on streamflow in the Chaghasrai watershed, Representative Concentration Pathways (RCP) of 4.5 and 8.5 were selected.

CALIBRATION AND VALIDATION OF SWAT MODEL

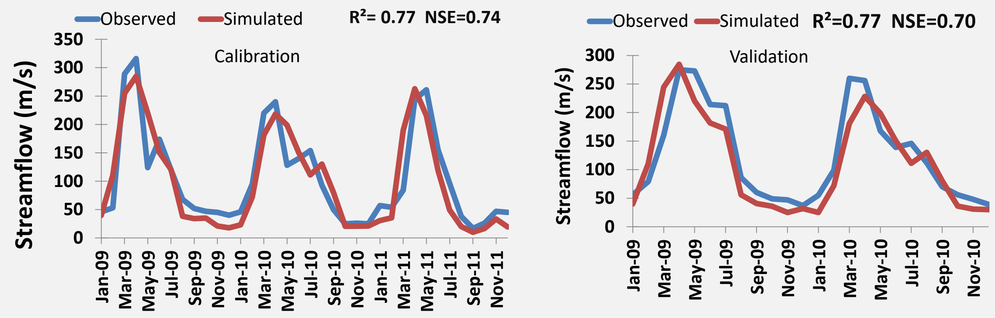

Figure 03: Comparison of the simulated and observed streamflow in monthly time steps (Calibration: 2009 - 2011 and validation:2012 to 2013). The mean monthly streamflow is 120m²/s

Projected Temperature and precipitation under RCP 4.5 and RCP 8.5

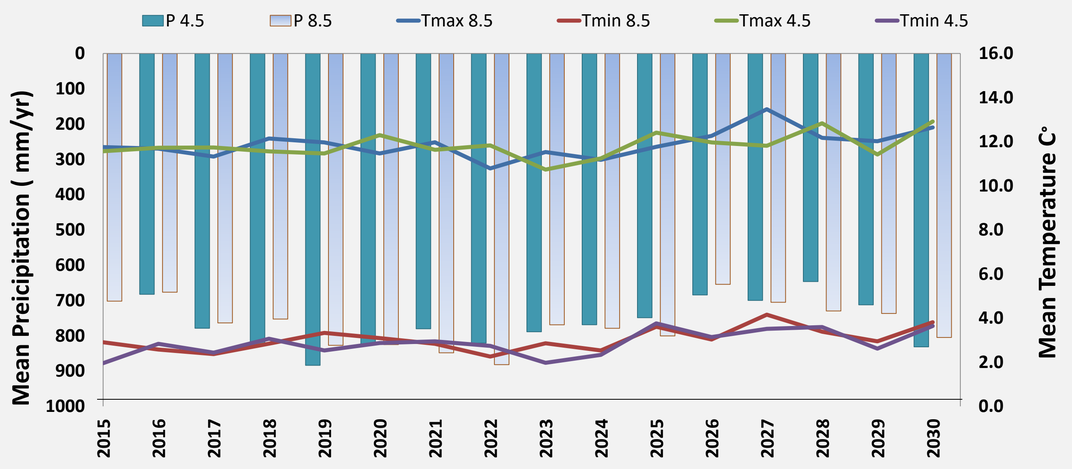

Figure 04: Mean annual temperature and Precipitation under RCP 4.5 and RCP 8.5 at the Chaghasrai watershed for the period 2014-2030

The mean annual projected temperature and precipitation is 13.9 C° and 760 mm..The project site is expected to experience a temperature increase of 1.8 ° while mean annual precipitation is expected to increase by 3 % (20 mm) under both scenarios during 2014–2030 as compared to previous data 1990-2008.

IMPACTS OF CLIMATE CHANGE ON STREAMFLOW UNDER RCP 4.5 AND RCP 8.5

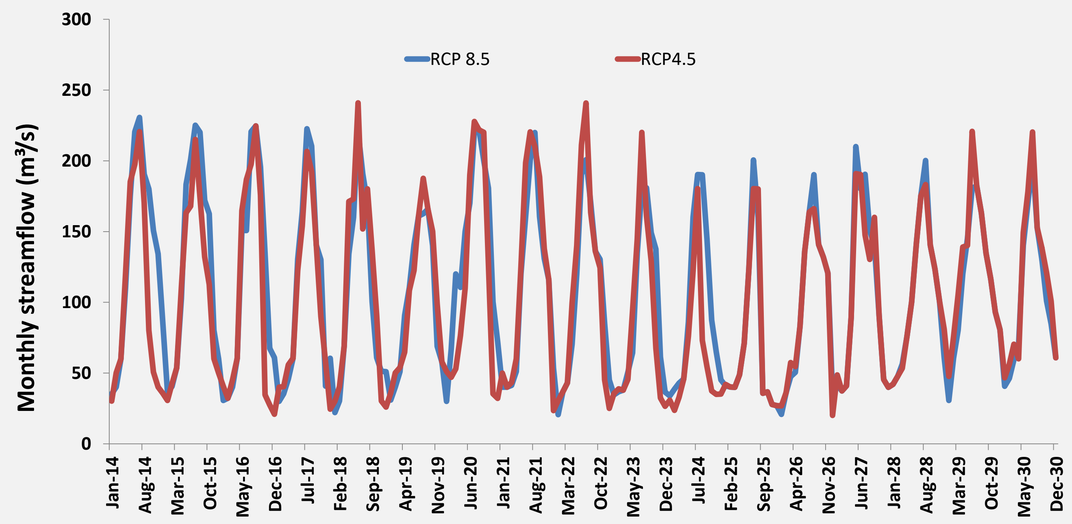

Figure 05: Mean Monthly streamflow under RCP 4.5 and RCP 8.5 at the Chaghasrai watershed for the period of 2014-2030.

The figure shows a decreasing trend with mean monthly stream flow of 102 m²/s. The overall streamflow is expected to be decreased by 20 % due to increase in temperature which triggers the rate of evapotranspiration during the study period.

Conclusion

The Increasing trend of the temperature in the hydrological cycle negatively affect the water availability, runoff especially during the peak demand period (May- August).
This study provides a base for estimation of the water supply (availability) in the watershed but future studies are required to consider water demand side (irrigation requirements).