The Resiliency of High Altitude Watershed to Dry Condition under the Changing Climate

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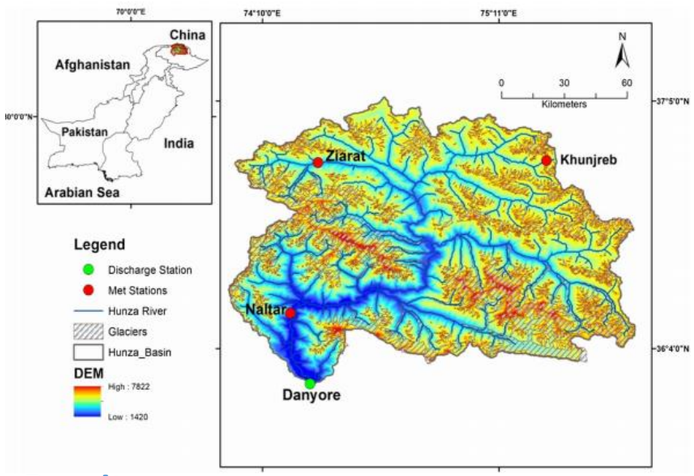
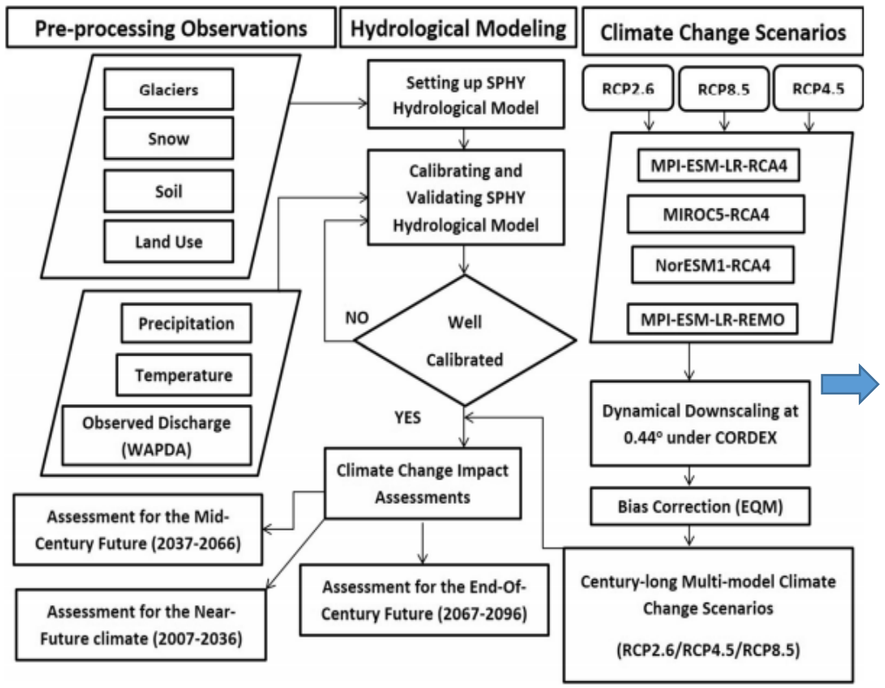
Introduction:

The climate change have prominent impacts on the hydrological cycle of the high latitude regions, particularly the cryosphere-rich Hindukush-Karakoram-Himalaya (HKH) Mountains (Hasson et al. 2013).

The study basin of Hunza Covering an area of 13,728 km2 lies within the high mountains of the western Karakoram range between 35.9° and 37° North and 74° and 75.8° East . Hunza is mainly a glacier-fed basin (Hasson et al. 2017)



Methodology: Hydro-Climatological modeling



Dry condition

Streamflow Drought Index (SDI)

$$SDI_{i,k} = \frac{Q_{i,k} - \overline{Q_k}}{S_k} \quad i = 1, 2, 3, \ldots k = 1, 2, 3, 4$$

State	Description	Criterion	Probability (%)
0	Non drought	$0 \leq SDI$	51.6
1	Mild drought	$-1 \leq SDI < 0$	25
2	Moderate drought	$-1/5 \leq SDI < -1$	12.5
3	Severe drought	$-2 \leq SDI < -1/5$	10.9
4	Extreme drought	$SDI < -2$	0

Resilience

Resilience of watershed defined as the speed of recovery from dry condition. Resiliency determine by (Hashimoto et al., 1982 and Fowler et al., 2003).

Where x is SDI values

The resiliency of a watershed determines with the threshold levels of -0.5 and -1.0

$$\text{Resiliency} \quad C_{RS} = \frac{\sum_{t=1}^{T-1} W_t}{T - \sum_{t=1}^{T} Z_t}$$

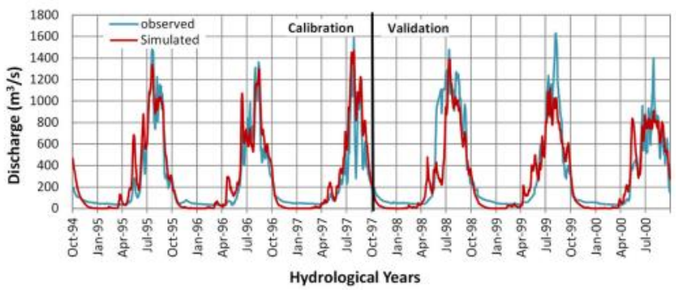
$$\text{If } x_t \in S, Z_t = 1 \text{ else } X_t \in U \text{ and } Z_t = 0 \qquad (1)$$

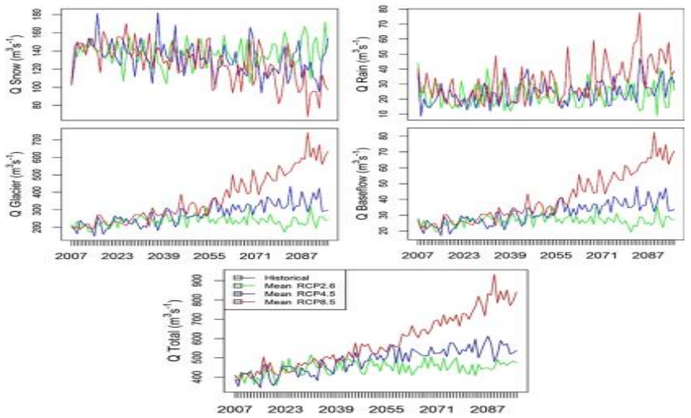
Let W_t be an indicator for the transition from unsatisfactory to satisfactory state such that

$$W_t = \begin{cases} 1 & \text{if } X_t \in U \text{ and } X_{t+1} \in S \\ 0, & \text{otherwise} \end{cases} \qquad (2)$$

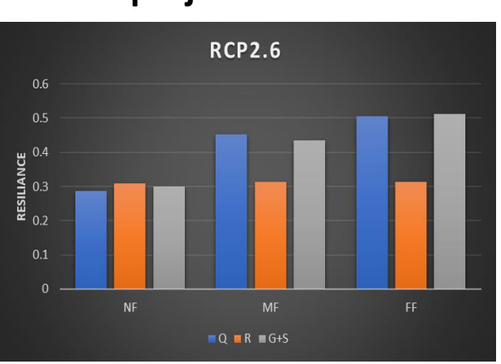
Results:

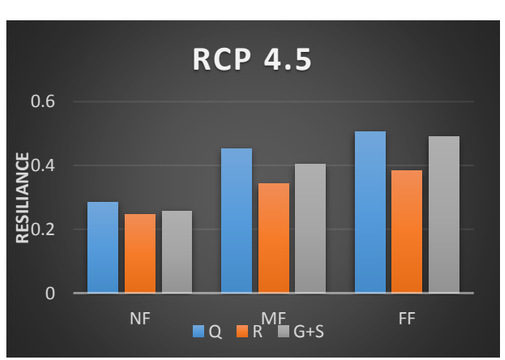
Future projected Run off

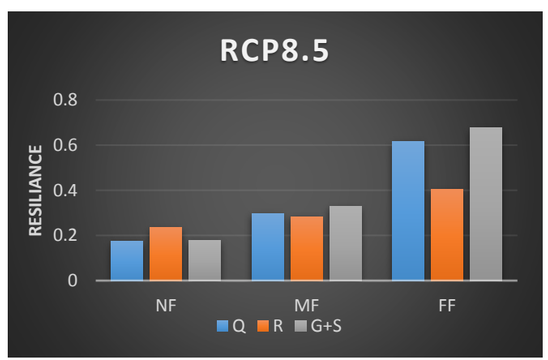




Future projected







Conclusion:

- The analysis indicates that the resiliency of the basin has increased from 0.3 to 0.5 in future under the RCP of 2.6.
- The value of resilience under the RCP of 4.5 is 0.29, 0.45, 0.52 for near, mid and far futures respectively.
- Under extreme climate conditions (RCP 8.5), the basin's resilience is 0.2 in the near future and 0.3 in the mid-future, and 0.6 for the far future.
- Therefore, it can be concluded that the health of the reservoirs will be very good in the future to stabilize the drought.

References:

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