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Climate change impacts on water balancing components for a tropical river basin, Western Ghats India.

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Summary:

- The Soil and Water Assessment Tool (SWAT) hydrological model is used for the assessment of WBCs for the Kalada river basin (KRB) in the Western Ghats, India.
- To assess the climate change impacts of near (2021 – 2040), mid (2041 – 2060), and far (2081 – 2100) future for moderate scenarios under representative concentration pathways (RCP) 4.5 and worse scenarios (RCP 8.5) were considered by using the present (2018) fixed land use.
- The multi-optimization techniques have been used for model calibration and verification of climatic data of the five General Circulation Models in the study area.
- The results indicated that the actual evapotranspiration (ET), surface runoff, and water yield are decreased (16 to 27%) in all-time slices for both RCP 4.5 and 8.5 emission scenarios but the decreasing trend is non-uniform.
- Furthermore, results indicated that the wet season showed less decrease in comparison to winter and summer, but impacts are high because more than 80% of rain occurred in the monsoon season.

Motivation of Study

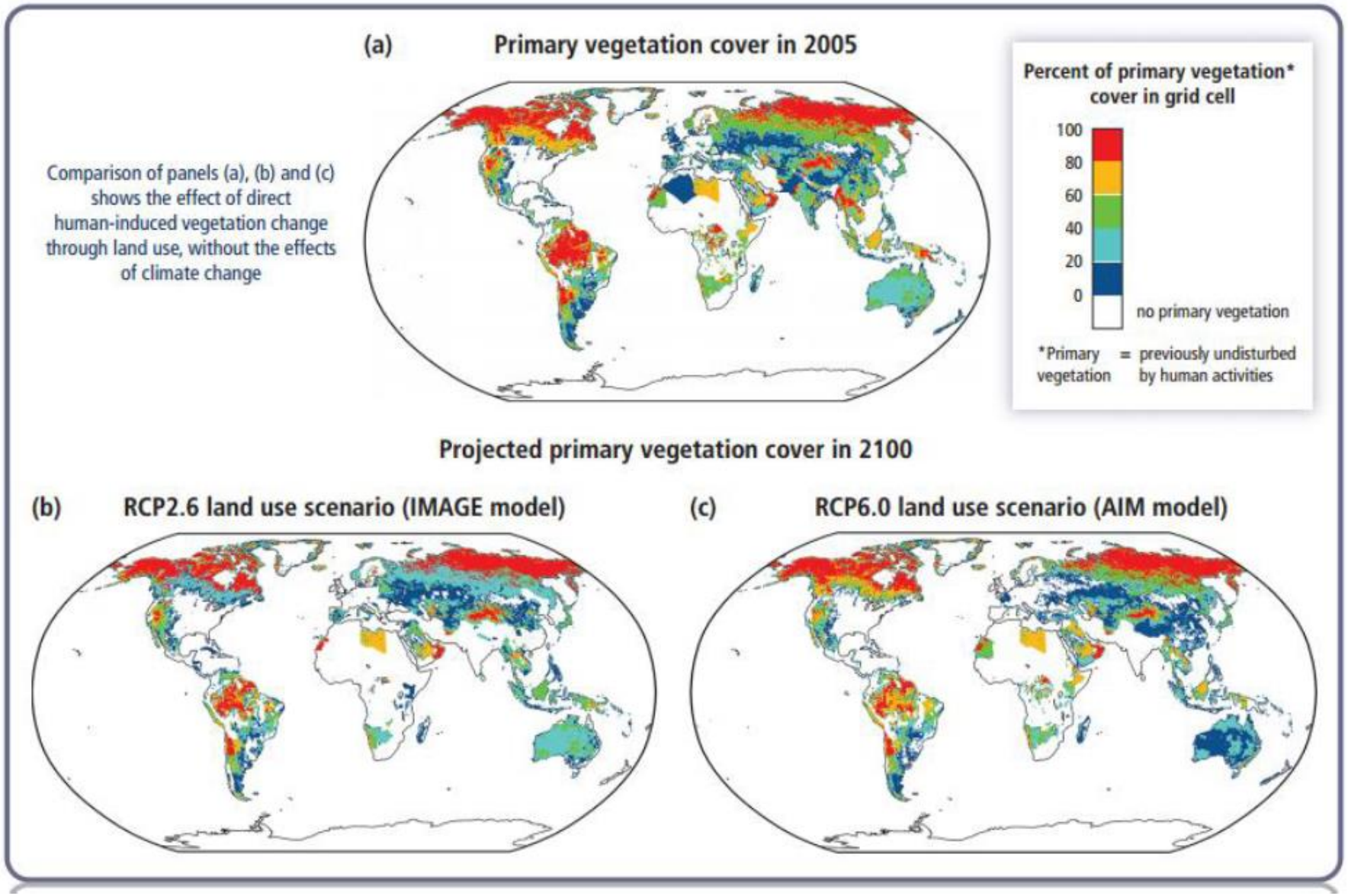
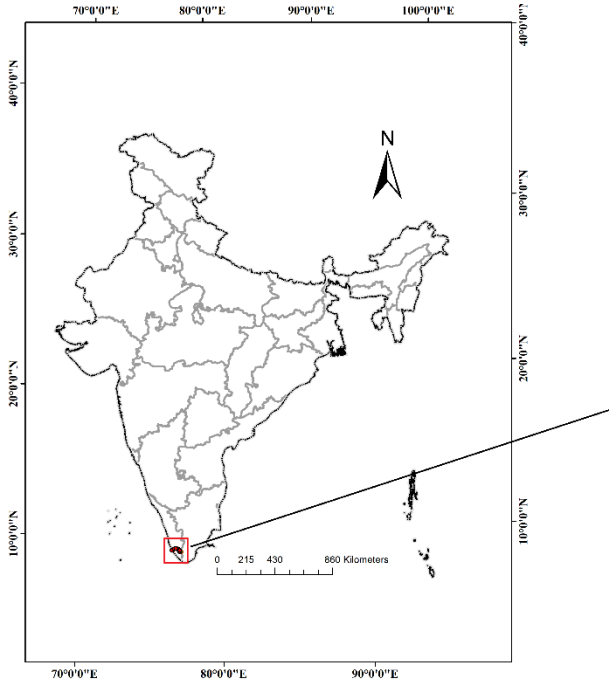
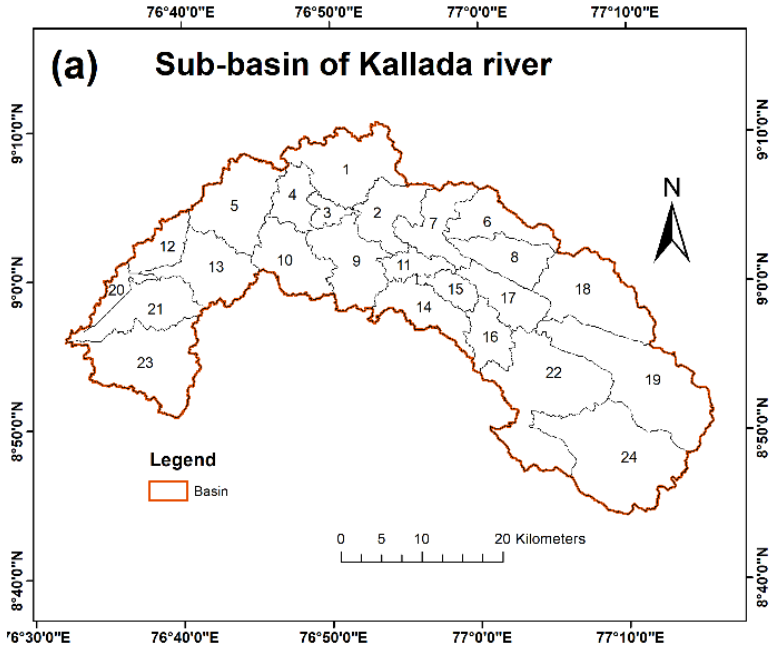
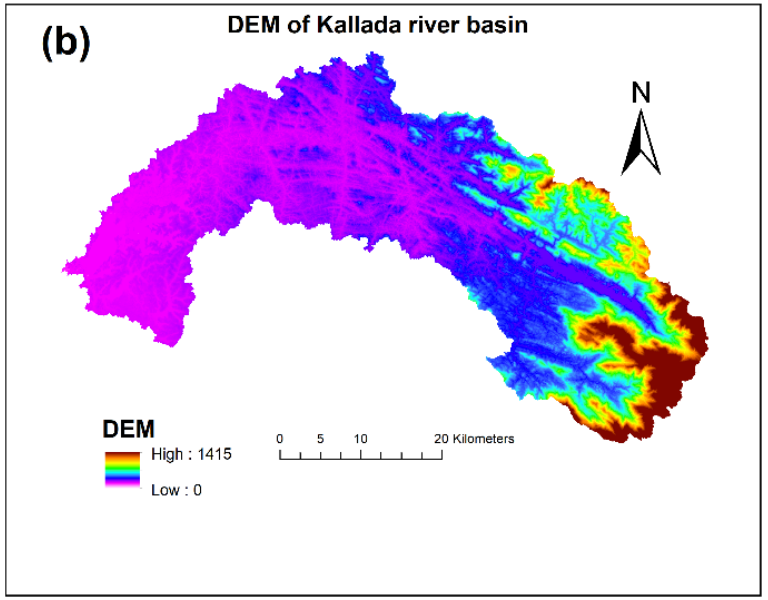


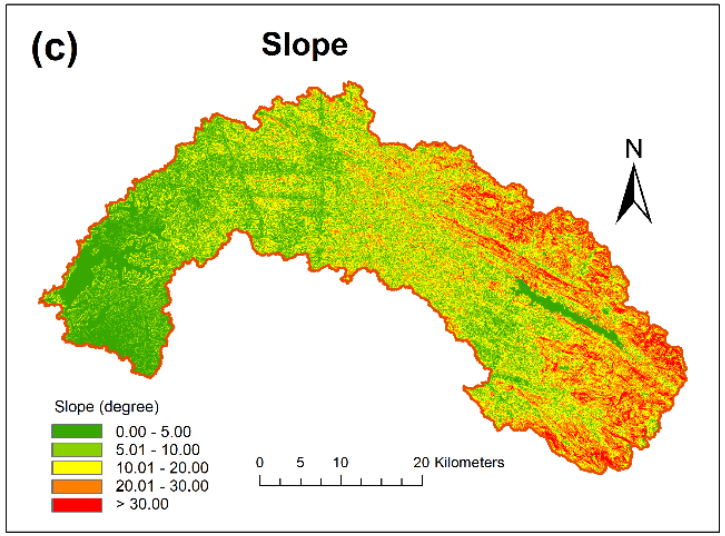
Figure: Projections of climate change-driven biome shifts in the context of direct human land use. (a) Fraction of land covered by primary vegetation in 2005. (b) Fraction of land covered by primary vegetation in 2100 under the RCP2.6 land use scenario, with no effect of climate change. (c) Fraction of land covered by primary vegetation in 2100 under the RCP6.0 land use scenario, with no effect of climate change (IPCC-AR5, 2014)

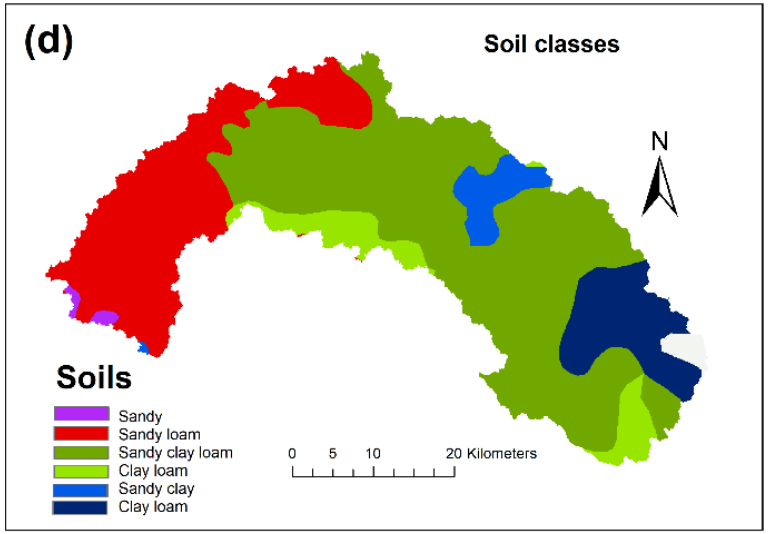
Study Area











S. No.	Feature	Descriptions
1	Basin Extent	Latitude 09.10° – 08.40° N and Longitude76.30° – 77.20° E
2	Area (Sq.km)	1654
3	States in the basin	Kerala
4	Mean Annual Rainfall (mm)	3021
5	Mean Maximum Temperature (ºC)	30.21
6	Mean Minimum Temperature (ºC)	18.57
7	Highest Elevation (m)	1415
8	Number of Sub Basins for study	24
9	Numbers of gauging station	1 (Pattazhy)
10	Length of mainstream (km)	103

Dataset Used

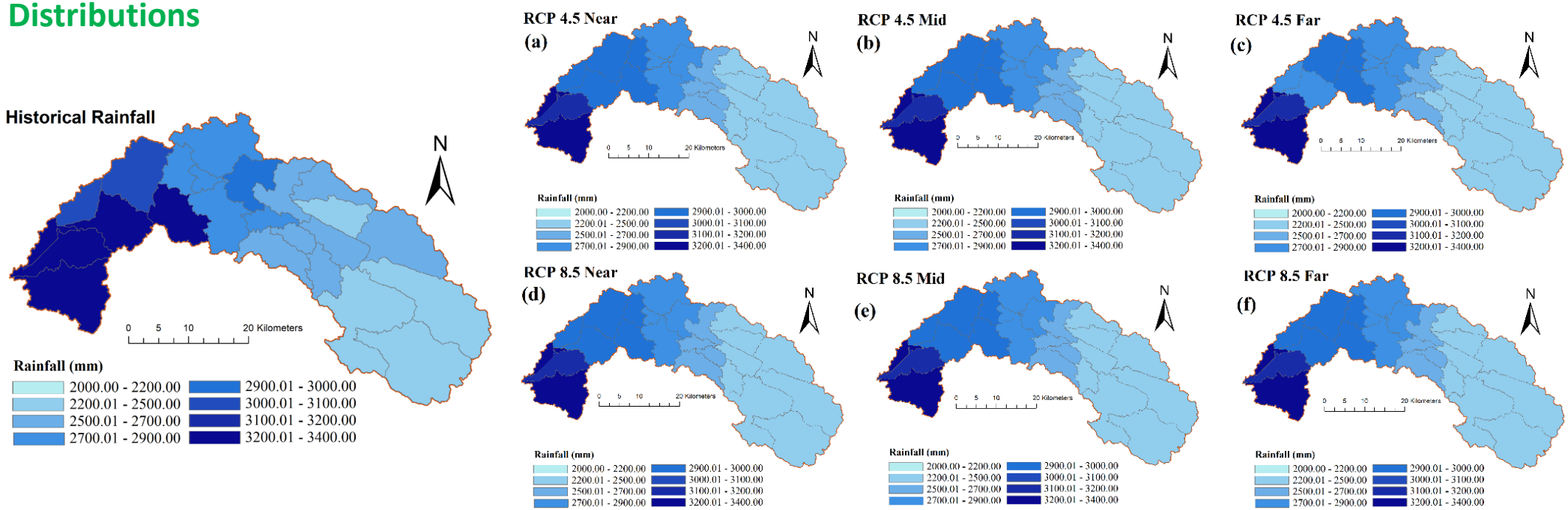
Input data used in the present study

Input data	Resolution	Source
Cartosat Digital Elevation Model (DEM)	30 m	National Remote Sensing Centre (http://www.nrsc.gov.in/)
Land use map	30 m	Landsat imageries (http://earthexplorer.usgs.gov/)
Soil data	toposheet	National Bureau of Soil Survey (NBSS)
Meteorological data (rainfall and min-max temperature)	0.25º (daily)	Indian Meteorological Department (IMD)
Meteorological data (solar radiation, relative humidity, and wind velocity)	0.25º (daily)	Climate Forecast System Reanalysis (CFSR)
Observed Hydrological data (streamflow)	Daily	Central Water Commission (http://www.india-wris.nrsc.gov.in/)

Input data used for the future period

Model	Institution	Spatial Resolution	Scenarios
CanESM2	Canadian Centre for Climate Modelling and Analysis	2.8°x2.8°	RCP 4.5 and 8.5
BNU-ESM	Beijing Climate Center, China Meteorological Administration	2.8°x2.8°	RCP 4.5 and 8.5
CNRM-CM5	Centre National de Recherches Meteorologiques/Centre Europeen de Recherche et Formation Avancees en Calcul Scientifique	1.4°x1.4°	RCP 4.5 and 8.5
MPI-ESM-LR	Max Planck Institute for Meteorology (MPI-M)	1.8°x1.8°	RCP 4.5 and 8.5
MPI-ESM-MR	Max-Planck-Inst. for Meteorology	1.87x1.87	RCP 4.5 and 8.5

Rainfall and ET Distributions



Spatial distributions of actual rainfall for near, mid, and far future of RCP 4.5 and RCP 8.5 emission scenarios.

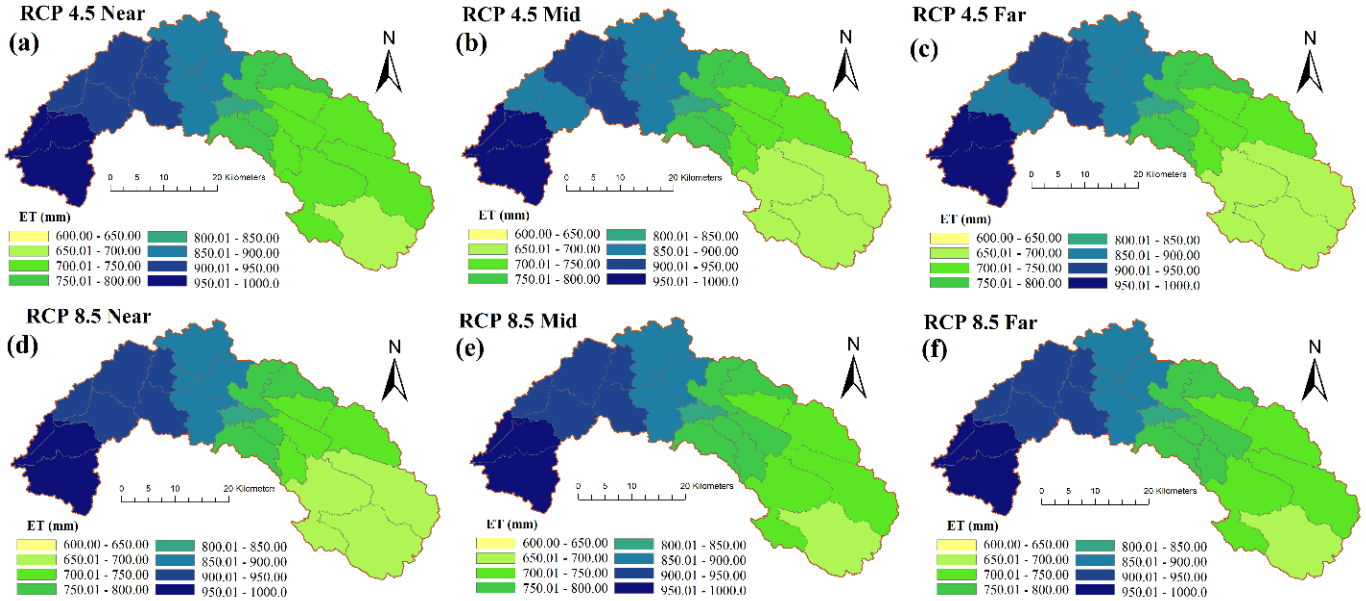
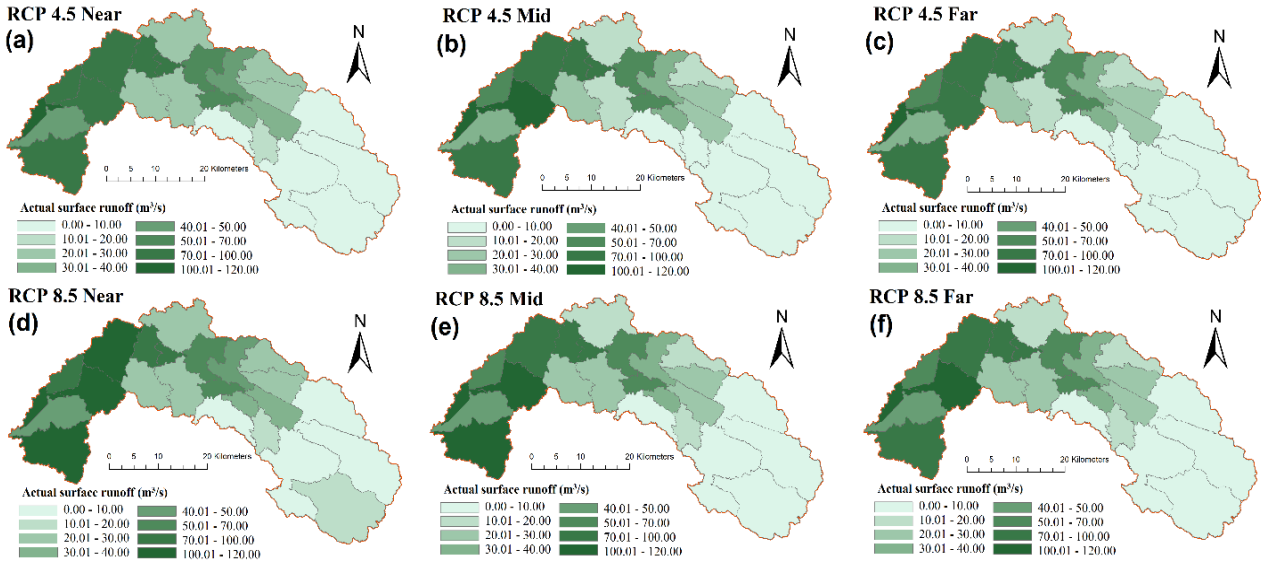
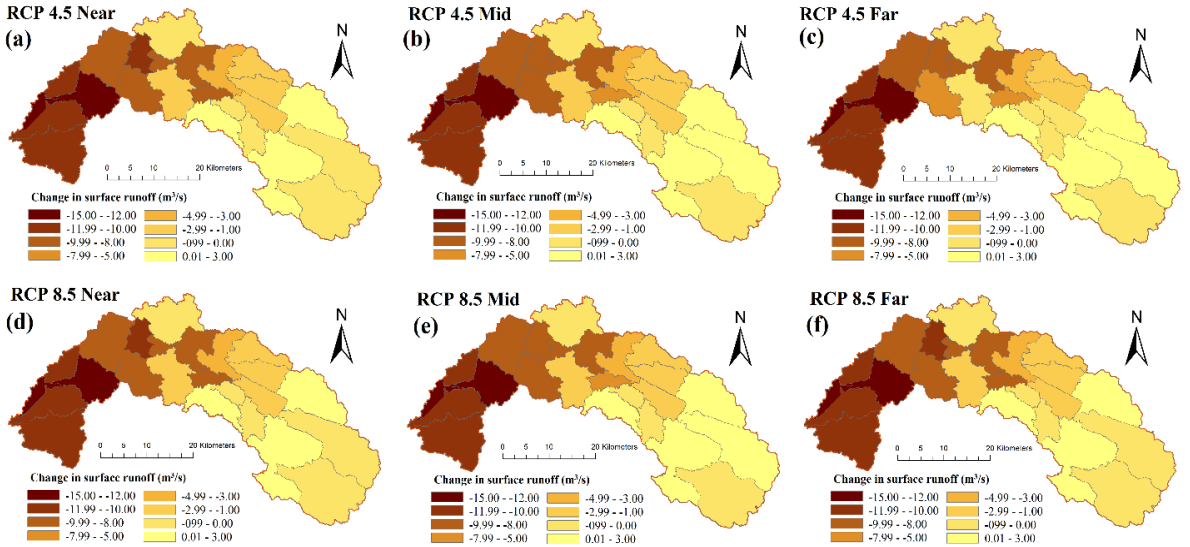


Fig: Spatial distributions of actual ET for near, mid, and far future of RCP 4.5 and RCP 8.5 emission scenarios.

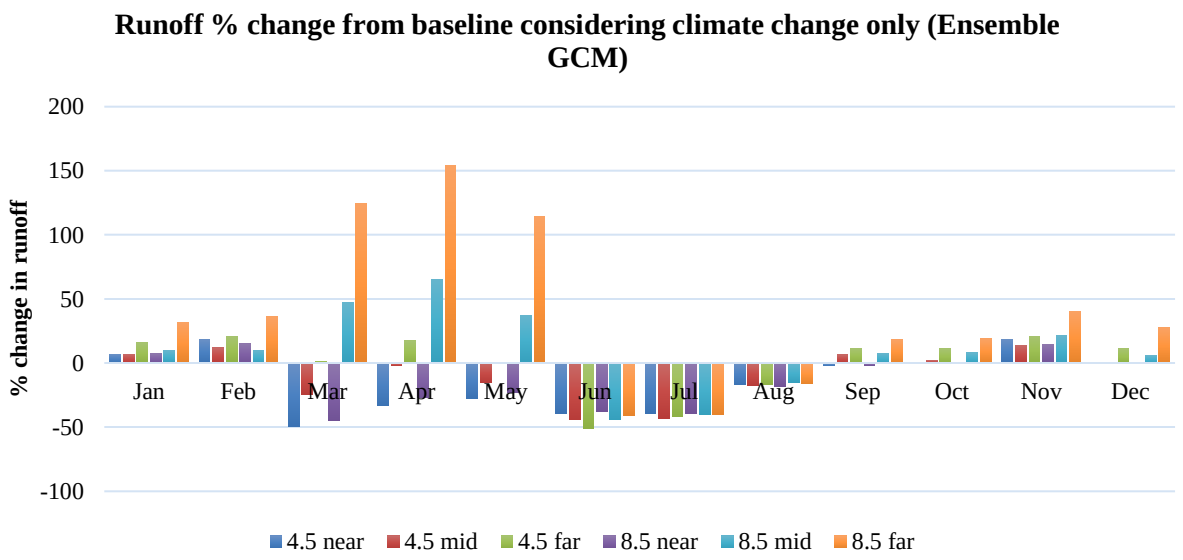
Actual and Change Surface runoff

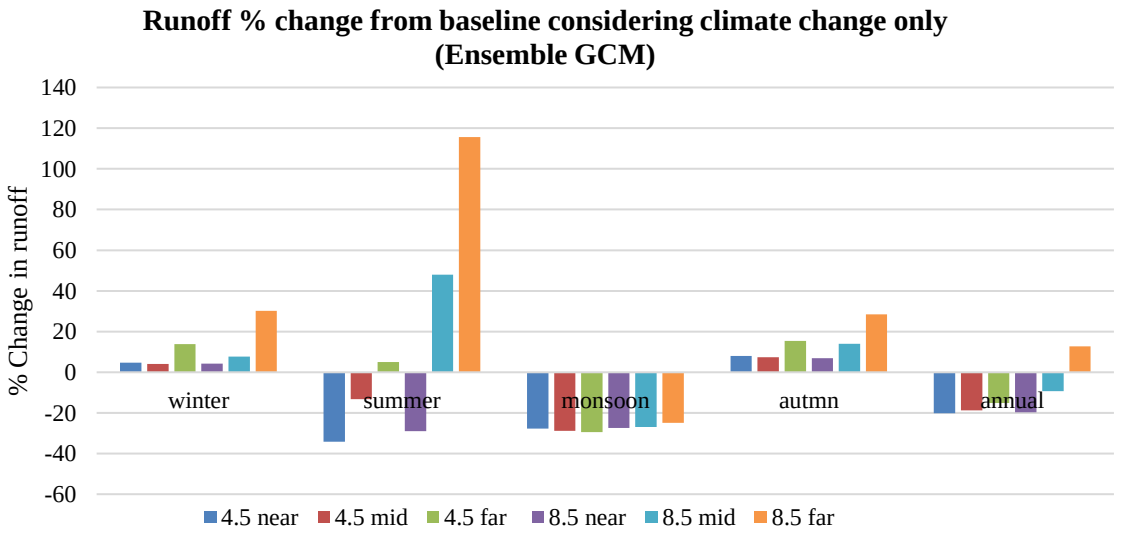


Spatial distribution of actual surface runoff for near, mid and far future of RCP 4.5 and RCP 8.5 emission scenarios.



Spatial distribution of changes in the future surface runoff for three different scenarios of climate change between 2011 to 2099 for RCP 4.5 and RCP 8.5 (a) RCP4.5 (2011 - 2040); (b) RCP4.5 (2041 - 2070); (c) RCP4.5 (2071 to 2099); (d) RCP8.5 (2011 - 2040); (e) RCP8.5 (2041 - 2070); (f) RCP8.5 (2071 to 2099) in the KRB.





Changes in streamflow for the future time periods relative to the baseline period. (a) Changes in mean monthly streamflow. (b) Changes in mean seasonal and annual streamflow in the KRB.

Conclusions based on findings

- Ensemble rainfall for near, mid, and far future will decrease due to climate change by 5.01%, 1.89%, and 1.20% for RCP 4.5 and 5.85%, 2.54%, and 1.24% for RCP 8.5 emission scenarios, in comparison to baseline.
- Ensemble surface runoff for near, mid, and far future will decrease due to climate change by 11.37%, 7.85%, and 9.24% for RCP 4.5 and 15.54%, 8.37%, and 3.84% for RCP 8.5 emission scenarios, in comparison to baseline.
- For monthly and seasonally, results indicated monthly streamflow increases from January to May and decreases from June to December and maximum relative percentage change in May in all scenarios under both RCPs 4.5 and 8.5 emission scenarios.
- The general pattern indicated an increase in summer and winter and a decrease in monsoon season and summer is showing more changes than winter season due to LULC and climate change under RCPs 4.5 and 8.5 scenarios.
- The long-term planning for water resources in the river basin must be adjustable and resilient to the changing pattern of these impacts. Furthermore, both planners and policymakers should develop a land-use strategy for reducing the adverse impacts of urban and agricultural area expansion and deforestation in the river basin considered.

Thank you