

Projected Change in Climate Under A2 Scenario in Dal Lake Catchment Area of Srinagar City in Jammu and Kashmir

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<http://dx.doi.org/10.12944/CWE.11.2.11>

(Received: June 04, 2016; Accepted: July 14, 2016)

ABSTRACT

The present study was done to study the effect of climate change on weather parameters like highest possible temperature, lowest possible temperature, average temperature and precipitation. Multiple linear Regression (MLR), Artificial Neural Network (ANN) and Statistical Downscaling Model (SDSM) models were tested in the Dal lake catchment area of Jammu and Kashmir State. Twenty seven year weather data (1985-2012) obtained from SKUAST-Kashmir weather station was used for the study. The modeling results showed a first-rate agreement between the observed data and predicted values for temperature series with high coefficient of determination R^2 values varying from (0.87-0.97) for different models. In case of precipitation R^2 values varied from (0.112-219) for different models. The low values of coefficient of determination in precipitation time series are due to lot of uncertainty in occurrence of precipitation which could not be defined by the selected models. The SDSM showed the best results of the three models tested for prediction of weather parameters. Thus SDSM was used for climate scenario generation. By comparing daily precipitation and temperature series for 1985-2012 with 2015-2030, an overall increasing pattern of 0.46%, 1.96%, 0.95% and 2.66% was observed for monthly, highest possible temperature, lowest possible temperature, average temperature and precipitation.

Keywords: Climate Change; Multiple Linear Regression;
Artificial Neural Network; Statistical Downscaling Model, A2 scenario.

INTRODUCTION

For the past century, increase in temperature and CO₂ concentration due various factors including change in the pattern of land use⁴ and greenhouse gas (GHG) emissions from industrial and agricultural sectors⁷, have caused changes in the earth's climate. This increased GHG's concentration was likely to influence earth's temperature as well as precipitation along with the pattern of storms as well as changes to sea levels^{3,1.6}. The visible impacts of the changes in climate of have been already observed in terms of occurrence of extreme events of cold, heat, floods or drought⁵.

The annual mean and maximum temperatures in India have been reported to have increased by about 0.7 and 0.8°C respectively². Many regions in India including the West Coast, Central India, the Internal Peninsula and North-East have shown a warming trend in climate⁴.

In this study, comparison between Multiple Linear Regression (MLR) model of MS-Excel, Artificial Neural Network (ANN) model of MATLAB software and Statistical Downscaling Model (SDSM) was done to determine the best fit model for downscaling the climate change in Dal Lake catchment of Srinagar City, Jammu & Kashmir, India.

The best out of the three was then used to project climate change in the catchment during the period 2015-2030.

Study area

The Dal Lake catchment lies in the Himalayan region of state of Jammu & Kashmir,

India between the latitudes 34°02'N and 34°13' N and longitudes of 74°50' E – 75°09' E. The lake's catchment has an area of 337 km² which is nearly 18 times the lake area. The topography of the catchment is uneven with an elevation range of 1580-4380m. Dal Lake is approximately 1580 m above the sea level. The normal annual precipitation in the

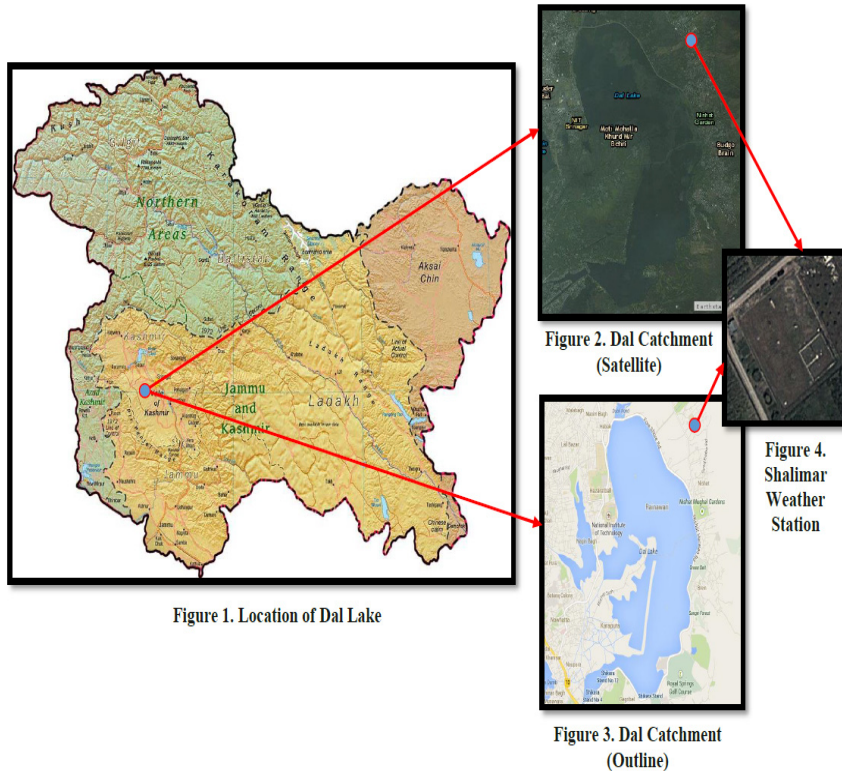
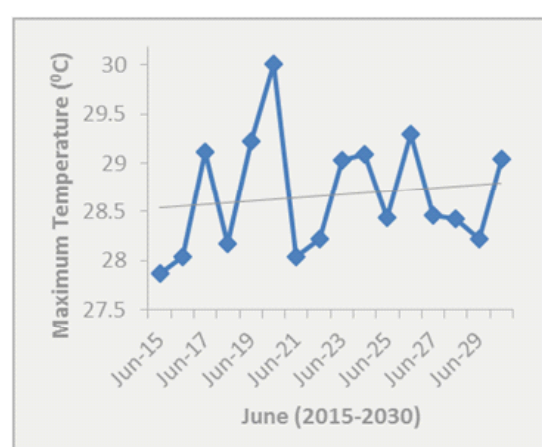
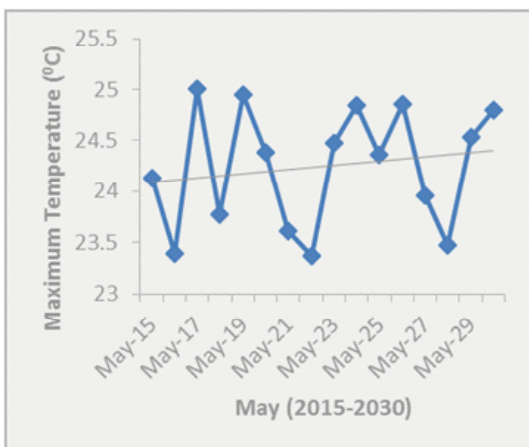
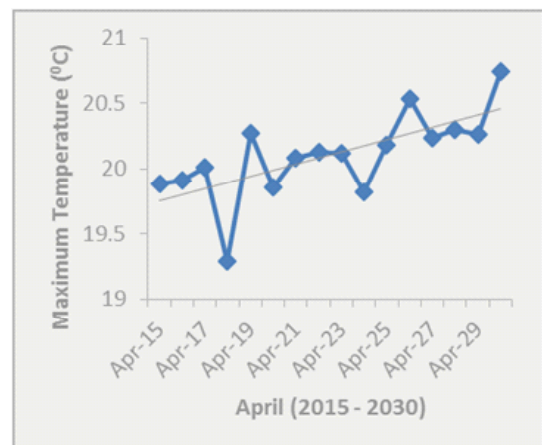
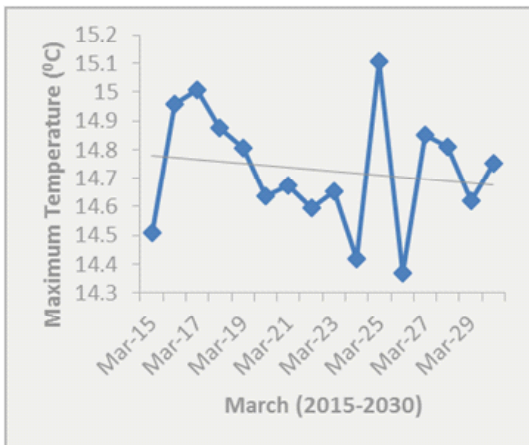
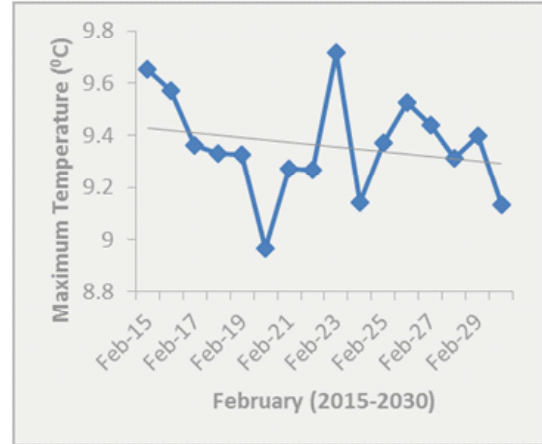
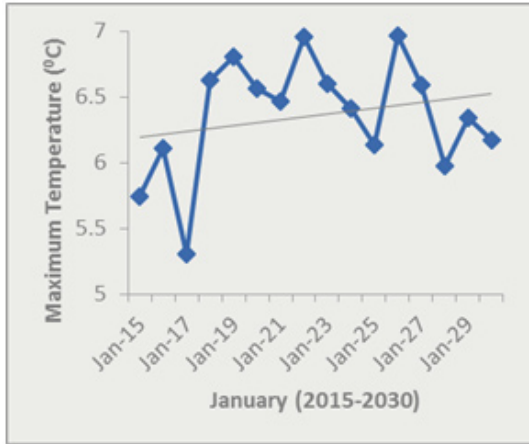


Table 1: Comparison of indices obtained by MLR, ANN and SDSM

Parameter	Model	MSE	RMSE	R ²	AAD
Maximum Temperature	MLR	8.587	2.930	0.874	16.289
	ANN	6.884	2.624	0.899	14.303
	SDSM	3.589	1.894	0.947	9.486
Minimum Temperature	MLR	4.940	2.223	0.893	5.590
	ANN	3.748	1.936	0.919	6.841
	SDSM	1.556	1.247	0.966	0.535
Average Temperature	MLR	5.038	2.244	0.908	17.703
	ANN	4.013	2.003	0.927	13.995
	SDSM	1.607	1.268	0.971	7.503
Precipitation	MLR	2.763	1.662	0.078	173.661
	ANN	2.861	1.692	0.045	107.493
	SDSM	2.3-44	1.531	0.218	101.273

Maximum Temperature



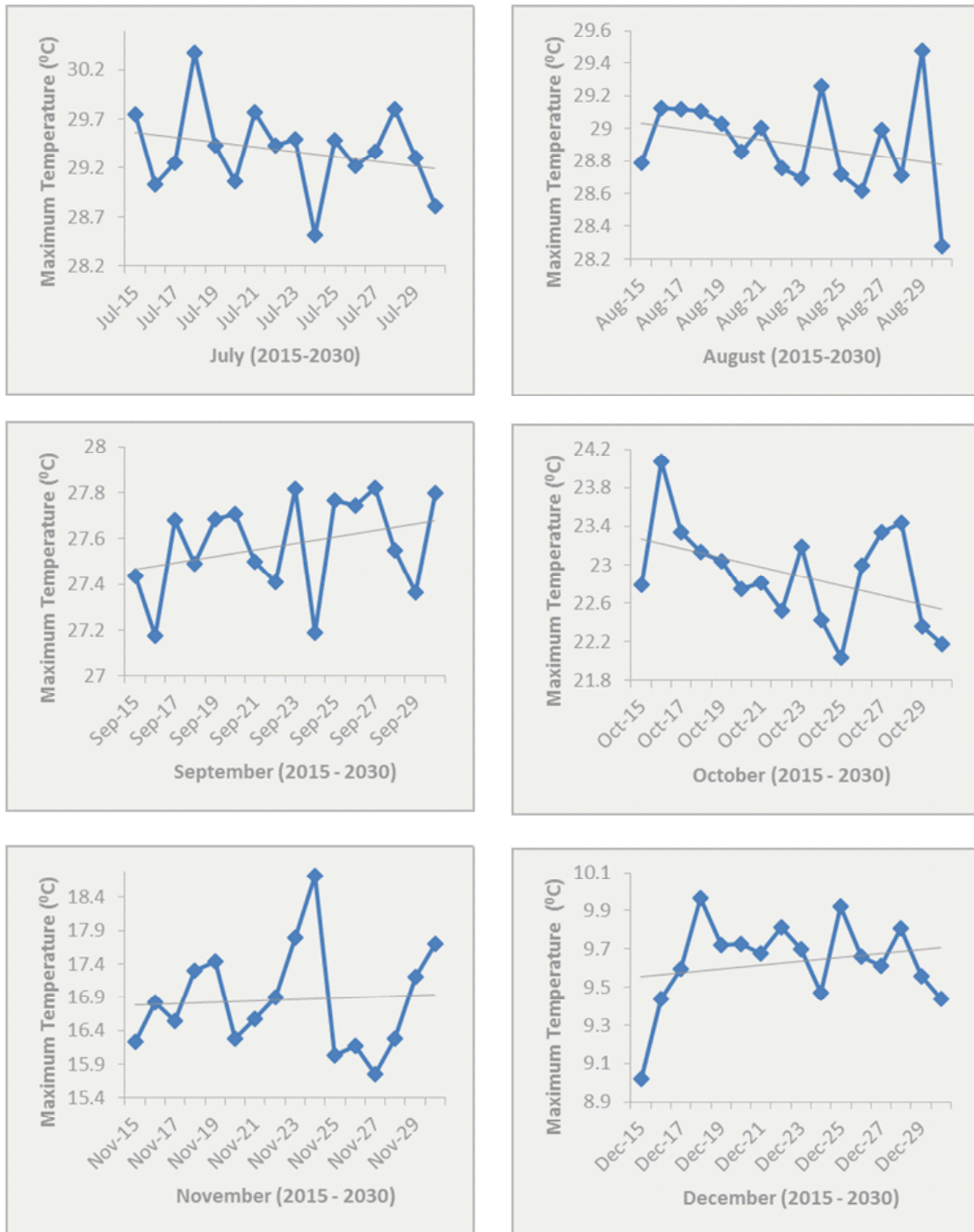


Fig. 6: Change anomalies of monthly Maximum Temperature for July-December (2015-2030)

Minimum Temperature

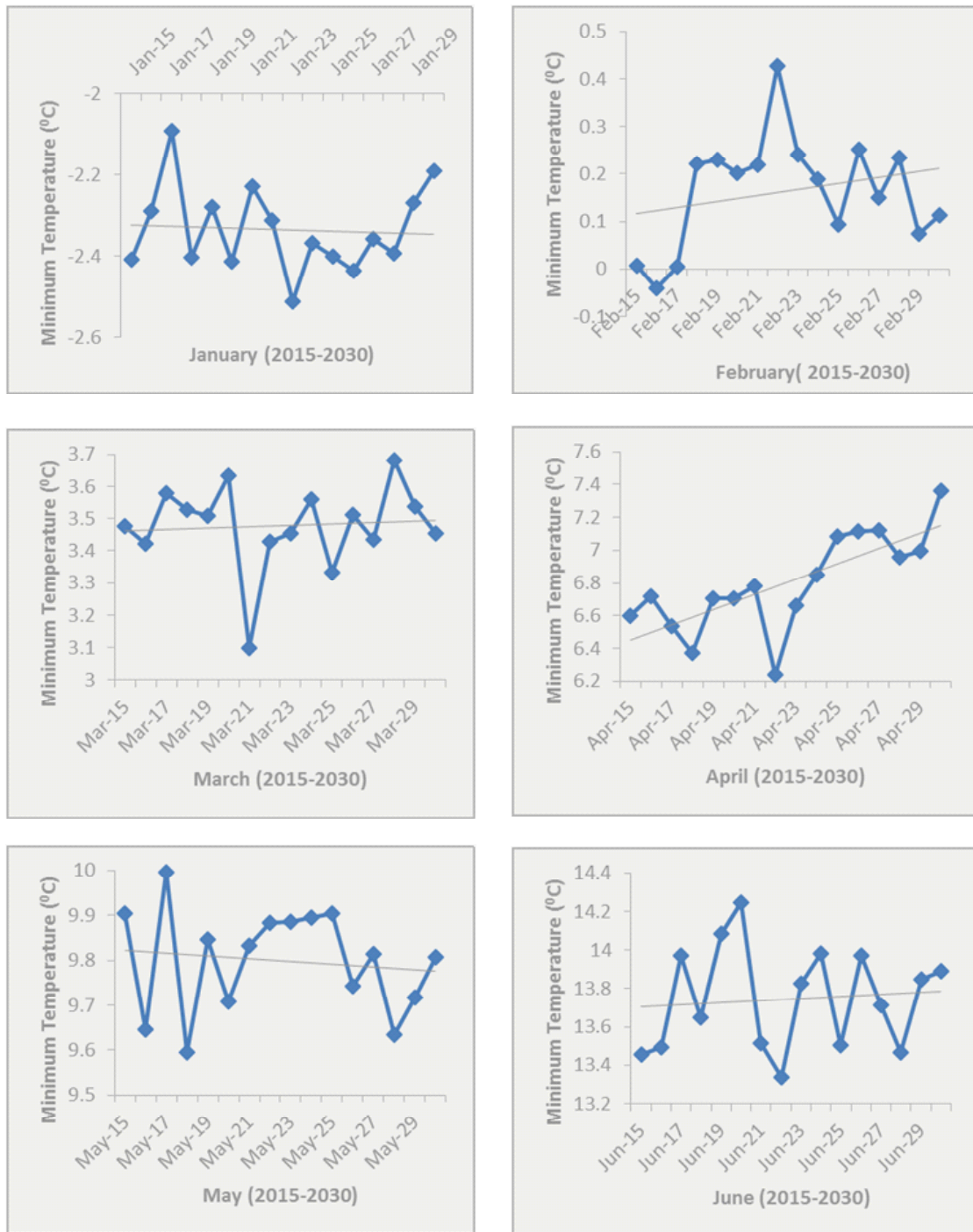


Fig. 7: Change anomalies of monthly Minimum Temperature for January -June (2015-2030).



Fig. 8: Change anomalies of monthly Minimum Temperature for July-December (2015-2030)

Monthly Precipitation

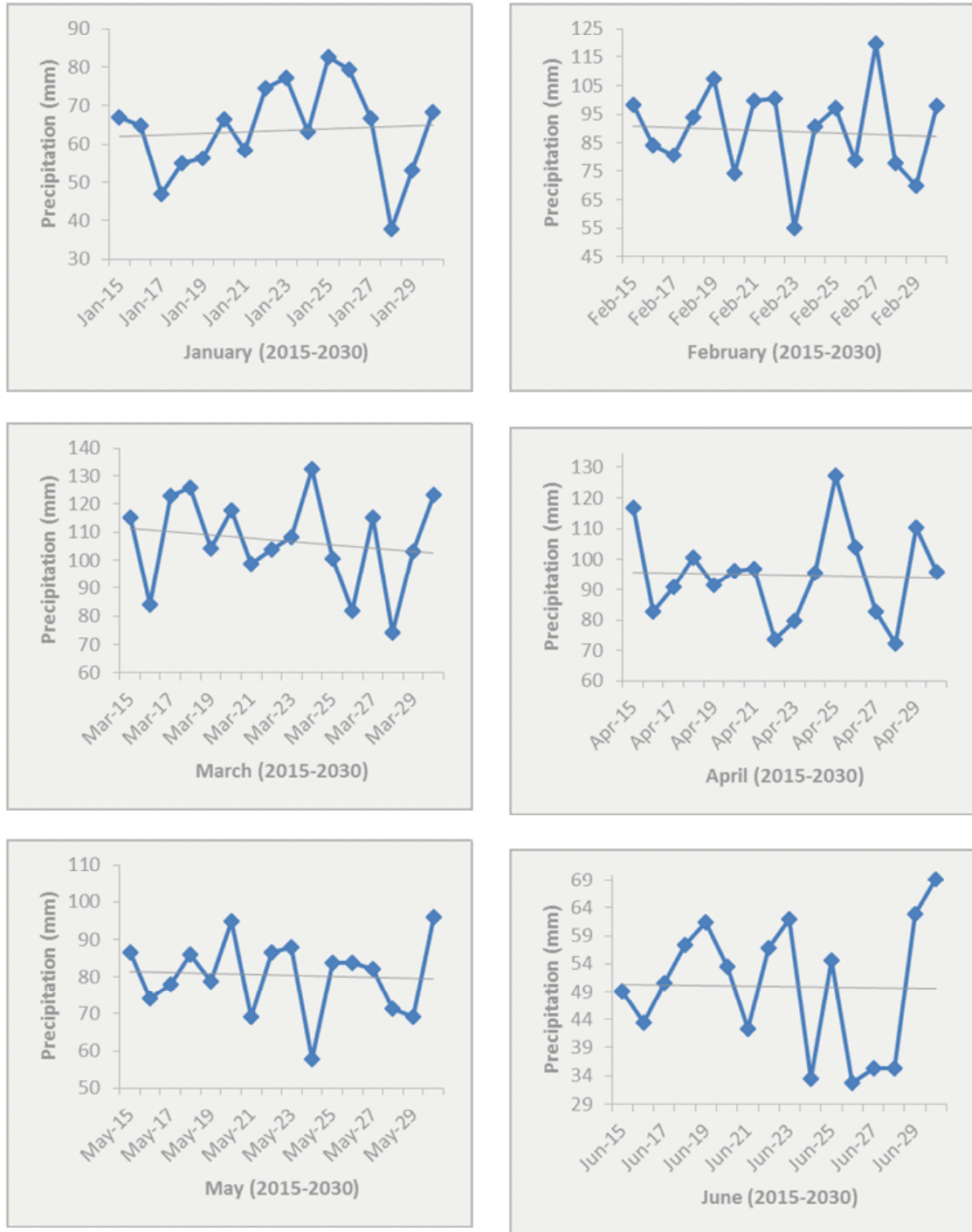


Fig. 9: Change anomalies of monthly Precipitation for January-June (2015-2030)



Fig. 10: Change anomalies of monthly Precipitation for July-December (2015-2030)

catchment is 720 mm. Winter season in the area lasts from November to March during which the catchment remains mostly under snow. January is the coldest month with minimum temperatures reeling below the freezing point. The temperature ranges from a maximum of 35 °C in July to a minimum of -7 °C in January. The information regarding the study area and SKUAST-Kashmir weather station is represented from Figures 1-4.

MATERIALS AND METHODS

Measured daily highest possible temperature, lowest possible temperature, average temperature and precipitation data from 1985 to 2011 were selected from the daily observation data from SKUAST-Kashmir station. SDSM predictors were obtained for the same area from the Canadian Climate Impacts Scenarios Group (CCISC) data portal. Predictors were from the available GCM (HadCM3), for the given geographical coordinates of the nearest grid-box to the study area. All of the data files, were then downloaded directly for immediate deployment by MLR, MATLAB & SDSM.

A comparison was first made between the observed data and predictor data obtained from CCISC to check the best fit model amongst MLR, ANN & SDSM using statistical indices like Coefficient of Determination (R^2), Mean Square Error (MSE), Root Mean Square Error (RMSE) and Absolute Average Deviation (AAD). After determining the best fit model, that particular model was used for climate scenario generation to predict the climate change for the period 2015-2030.

The term anomaly means a deviation of future climate condition from a baseline period (1985-2011) climate condition. In the present study, the climatic conditions in the baseline period were analyzed which were based on the meteorological station records of the study area. The anomaly of monthly precipitation was calculated as the difference from future monthly average precipitation to the baseline period (1985-2011) monthly average precipitation values. Similarly the anomaly of monthly temperature was calculated.

RESULTS AND DISCUSSION

The observed values of daily maximum temperature, minimum temperature, average temperature and precipitation were fitted in the MLR, ANN & SDSM models respectively, which showed a good fit with high values of R^2 for each model. The corresponding error values were found to be in the acceptable limit. The accuracy of these models as well as their ability to predict the target values was determined with help of statistical indices like MSE, RMSE, and AAD. The indices from each of these models were then compared to determine the best fit model amongst the three. The comparison between the indices of these models for each of the parameters was given in Table 1.

Based on the above indices, SDSM was found to be the best model for projecting the climate change in the catchment with the highest values of R^2 and least values of MSE, RMSE and AAD for each of the parameters. SDSM was therefore used to project the climate change for the catchment.

An overall increasing pattern (0.46%) in the monthly maximum temperature was noted particularly in January (3.25%) and June (1.74%), while a consistently decreasing pattern was noted for the month of February (-1.27%). An overall increasing pattern (1.96%) in the monthly minimum temperature was noted particularly in February (45.45%) and November (7.21%), while a consistently decreasing pattern was noted for the month of December (-11.19%).

An overall increasing pattern (0.95%) in the monthly average temperature was noted particularly in January (6.25%) and October (3.08%), while a consistently decreasing pattern was noted for the month of July (-0.69%). A general increasing pattern (2.66%) in the monthly precipitation was noted especially in September (8.34%) and April (7.56%), while a consistently decreasing pattern was noted for the month of December (-7.61%).

CONCLUSIONS

The simulated values of the selected parameters obtained by the MLR, ANN and SDSM

modelling were close to each other as well as to original values. The highest value of Coefficient of Determination was obtained from SDSM which was then used to predict the climate change for a period of 15 years. The SDSM projections indicate an overall

increase in the daily maximum temperature and minimum temperature. The projected precipitation was also higher than the baseline precipitation with an uneven pattern of distribution.

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