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Research Article

STATISTICAL DOWNSCALING OF MINIMUM TEMPERATURE OF HOSHANGABAD (M.P.) INDIA

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ABSTRACT

General Circulation Models (GCMs), CGCM3 and CanESM2 have been used to downscale the minimum temperature for Hoshangabad region, Madhya Pradesh, India. The region encompasses an area of 6704 km^2. The predictor variables for CGCM3 were ncepmslpas, ncepp500gl, ncepp850gl and predictor variables for CanESM2 model were ncepmslpgl, ncepp500gl, ncepp850gl. The total period of study was from the years 1979 - 2001. The two GCMs, CGCM3 and CanESM2 were checked for their capability in downscaling the minimum temperature climatic parameter. The GCM outputs were evaluated on Nash Sutcliffe Efficiency (NSE) and coefficient of determination (r^2) criterias. The period of calibration was taken to be 1979-1995 and 1996-2001 was chosen as the period of validation. GCM CanESM2 obtained NSE of 0.82, 0.84 and r^2 of 0.88, 0.88 during the periods of calibration and validation respectively. It was concluded that CanESM2 model is found comparatively more suitable for downscaling of minimum temperature for Hoshangabad region. The GCM can be further employed to generate the future scenario of minimum temperature in the region.

INTRODUCTION

Climate change in IPCC (Intergovernmental Panel on Climate Change) usage refers to a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the United Nations Framework Convention on Climate Change (UNFCCC), where climate change refers to a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods (IPCC Fourth Assessment Report: Climate Change, 2007). Downscaling plays an important role in assessment of climate change impacts on crop water requirement. Parekh and Prajapati (2013) employed HADCM3 (Hadley centre Unified Model 3) scenario file for the estimation of crop water requirement of crops in Vadodra Gujarat. Shukla *et al*. (2015) conducted a study to downscale rainfall and temperature from GCMs. The data from single station located in the Indira Sagar canal command area at Madhya Pradesh, India were used as input of the SDSM. The area lies between 74° 46' to 76° 29' E longitude and 21° 46' and 22° 19' of north latitude and covers an area of about 3550 km^2. The study included calibration and validation with large-scale atmospheric variables encompassing the NCEP reanalysis data, the future estimation due to a climate scenario, which is HadCM3.A2. Results of the downscaling experiment demonstrate that during the calibration and validation stages, the SDSM model was very well acceptable regarding its performance in the downscaling of daily rainfall and temperature. For a future period (2010-2099), the SDSM model estimated an increase in total average annual rainfall and annual average temperature for station. *Kundu et al. (2017)* conducted a study to determine the Future changes in rainfall, temperature and reference evapotranspiration in the central India by least square support vector machine (LS-SVM). In the study, changes in the future rainfall, minimum and maximum temperature, and ET0 have been shown by downscaling the HadCM3 (Hadley Centre Coupled Model version 3) model dataThe area covers parts of Betul, Hoshangabad and Raisen districts with area about 12,290 km^2. Results showed an increase in the future rainfall, temperatures and ET0. It was concluded that the variation in these parameters due to climate change have an impact on the future water resource of the study area, which is mainly an agricultural based region, and climate study will help in proper planning and management.

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Jaiswal *et al*. (2018) conducted a research study to forecast the minimum temperature of Raipur C.G. using Canadian Global Climate Model (GCM). The statistical downscaling technique SDSM was employed for three future periods, predictors for A1B and A2 climate forcing conditions. The forecasted minimum temperature was of future periods FP-1 (2020-2035), FP-2 (2046-2064), and FP-3 (2081-2100).

The present study deals with the calibration and validation of GCMs CGCM3 and Can ESM2 using the Statistical Downscaling Model (SDSM) with minimum temperature climatic parameter for Hoshangabad region of Madhya Pradesh India.

Study Area

Hoshangabad is a city and a municipality in Hoshangabad district in the Indian state of Madhya Pradesh. It is located in the central India region, on the south bank of the Narmada River Basin. It is located at 22.75°N latitudes 77.72° E longitudes (figure 1).

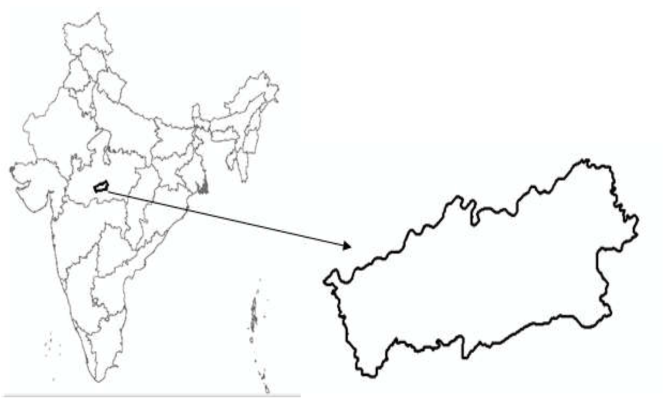

Figure 1 Study area Hoshangabad, India

Climatic & Soil Information of Study Area

Rainfall and climate: The normal annual rainfall of Hoshangabad district is 1340 mm. The Maximum rainfall is received by the Hoshangabad district by southwest monsoon during the period from June to September.

Temperature: The average minimum and maximum temperature of the region is 19^0 C & 40^0 C respectively.

Available Soils: Most common type of soil that is founded in whole are is black cotton soils with heavy to light texture. The soil group are basically of hydrologic soil group C and D which indicates that the soil possess less rates of infiltration.

METHODOLOGY

Statistical Downscaling Model (SDSM)

Statistical downscaling involves the establishment of empirical relationships between historical and/or current large-scale atmospheric and local climate variables. Once a relationship has been determined and validated, future atmospheric variables that GCMs project are used to predict future local climate variables. Statistical downscaling can produce site-specific climate projections, which RCMs cannot provide since they are computationally limited to a 20-50 kms spatial resolution. (STARDEX, 2005, Fowler *et al*., 2007, Wilby *et al*., 2009, and Daniels *et al*., 2012).

The historical temperature data from 1979-2001 was utilized for the downscaling of the GCM CGCM3 and CanESM2. The working steps of statistical downscaling technique is illustrated in figure 2 shown ahead.

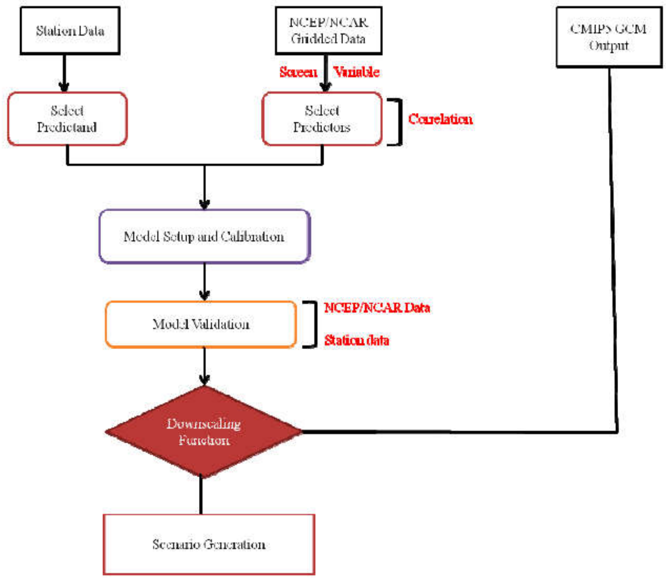

Figure 2 Flowchart of SDSM

Working Steps

- Quality control
- Screening of downscaling predictor variables
- Model calibration
- Generation of current weather data using observed data for validation
- Generation of future weather using GCM-derived predictors (Wilby and Dawson, 2007)

The technique was applied and the best predictors for the two GCMs were finalized. The predictor variables for CGCM3 were ncepmslpas, ncepp500gl, ncepp850gl and predictor variables for CanESM2 model were ncepmslpgl, ncepp500gl, ncepp850gl.

Evaluation of models

Coefficient of Determination, r^2

The squared value of the coefficient of correlation is termed as coefficient of determination. Mathematically it is expressed as follows:

$$r^2 = \left(\frac{\sum_{i=1}^{n}(O_i - \bar{O})(P_i - \bar{P})}{\sqrt{\sum_{i=1}^{n}(O_i - \bar{O})^2}\sqrt{\sum_{i=1}^{n}(P_i - \bar{P})^2}} \right)^2 \quad \ldots\ldots (i)$$

Where, O and P are observed and Predicted values respectively.

The range of this evaluation parameter lies between 0 and 1 which describes how much of the observed dispersion is explained by the prediction. A value of zero means no correlation at all while a value of 1 means that the distribution of the prediction is equal to that of the observation. A model which steadily over predicts or under-predicts all the time will give outcome as good r^2.

Nash Sutcliffe criteria

The efficiency E or η was proposed by Nash and Sutcliffe in the year 1970. It is defined as 'one minus the sum of the absolute squared differences between the calculated and observed values normalized by the variance of the observed values' during the period of study.

Mathematically the formula is expressed as:

$$E = 1 - \frac{\sum_1^n (O_i - P_i)^2}{\sum_1^n (O_i - \bar{O})^2} \qquad \ldots..(ii)$$

Where, O_i is the observed data,
P_i is the modeled data,
$\bar{O}$ is the mean of the observed data.

RESULTS AND DISCUSSIONS

The SDSM tool was employed for the GCM minimum temperature downscaling of the study region. The total period of study considered here was from the years 1979 to 2001 out of which years 1979-1995 was calibration period and 1996-2001 was chosen as validation of the model. The individual parameters outputs are compared with the historical data and evaluated on the basis of coefficient of determination and Nash Sutcliffe criteria.

Results on the basis of Coefficient of Determination

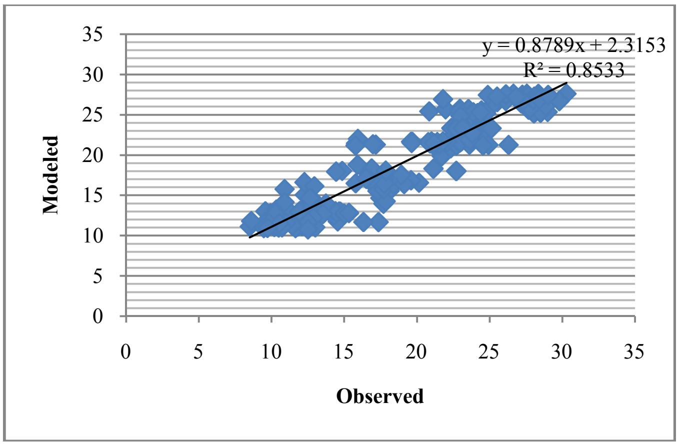

Figure 3 CGCM3 Coefficient of determination chart for calibration period 1979-1995

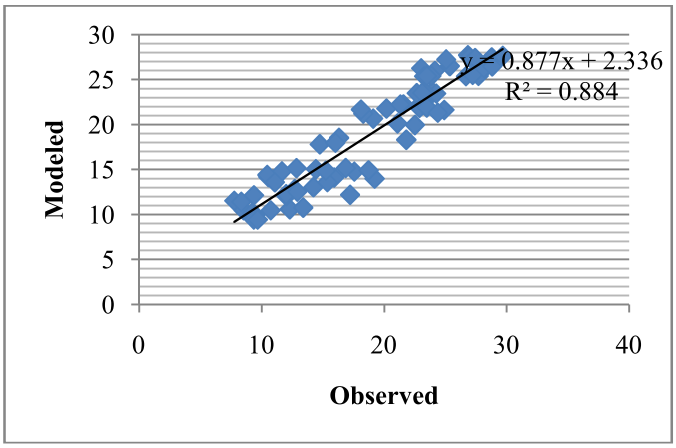

Figure 4 CGCM3 Coefficient of determination chart for validation period 1996-2001

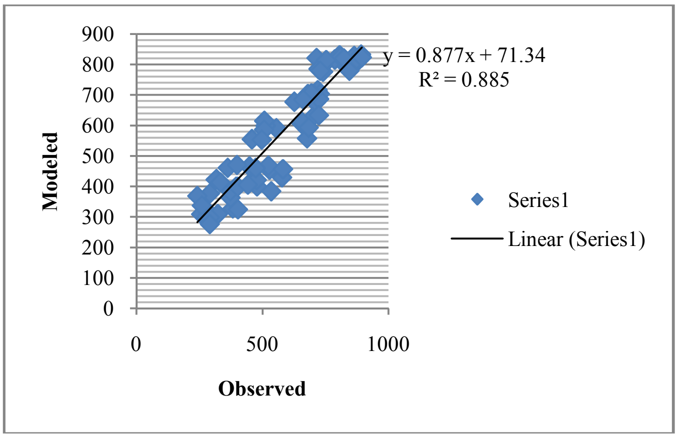

Figure 5 CanESM2 Coefficient of determination chart for calibration period 1979-1995

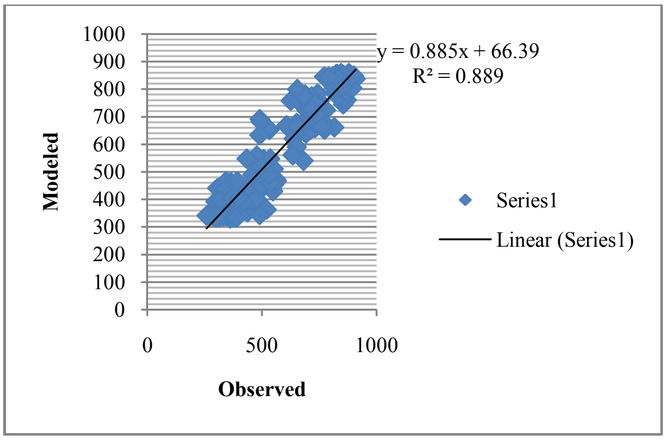

Figure 6 CanESM2 Coefficient of determination chart for validation period 1996-2001

Table 1 NSE and R^2 Results of GCMs

Parameter	Performance Criteria	CGCM3		CanESM2	
		Cali.	Vali.	Cali.	Vali.
Min Temperature	N.S.E.	0.78	0.80	0.82	0.84
	R^2	0.85	0.88	0.88	0.88

CONCLUSION

The two GCMs, CGCM3 and CanESM2 were checked for their capability in downscaling the minimum temperature climatic parameter. The GCM outputs were evaluated on Nash Sutcliffe Efficiency (NSE) and coefficient of determination (r^2) criterias. GCM CanESM2 obtained NSE of 0.82, 0.84 and r^2 of 0.88, 0.88 during the periods of calibration and validation respectively (Table 1). It was concluded that CanESM2 model is found comparatively more suitable for downscaling of minimum temperature for Hoshangabad region. The GCM can be further employed to generate the future scenario of minimum temperature in the region. The data thus generated can be utilized for proper planning and management of the water resources and agriculture prevailing in the region.

References

Daniels, A. E., Morrison, J. F., Joyce, L. A., Crookston, N. L., Chen, S. C., and McNully, S. G. (2012), Climate Projections General Technical Report, Fort Collins, CO, U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 1-32.

Fowler, H. J., Blenkinsop, S., and Tebaldi, C. (2007), Linking Climate Change Modelling to Impacts Studies: Recent Advances in Downscaling Techniques for Hydrological Modelling, *International Journal of Climatology* 27(12), 1547-1578.

IPCC (2007), Summary for Policymakers. In: Climate Change 2007: The Physical Science Basis, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Jaiswal, R.K., Tiwari, H.L., Lohani, A.K. and Yadava, R.N. (2018), Statistical Downscaling of Minimum Temperature of Raipur (C.G.) India, Climate Change Impacts. Water Science and Technology Library, 82, 35-45.

Kundu, S., Khare, D., and Mondal, A. (2017), Future Changes in Rainfall, Temperature and Reference Evapotranspiration in the Central India by Least Square Support Vector Machine, Geoscience Frontiers, 8(3), 583-596

Parekh, F. and Prajapati, K.P. (2013), Climate Change Impacts on Crop Water Requirement for Sukhi Reservoir Project, *International Journal of Innovative Research in Science, Engineering and Technology*, 2(9), 4285-4292

Shukla, R., Khare, D. and Deo, R. (2015), Statistical Downscaling of Climate Change Scenarios of Rainfall and Temperature over Indira Sagar Canal Command area in Madhya Pradesh, India, IEEE 14th International Conference on Machine Learning and Applications, 313-317.

STARDEX, (2005), Downscaling climate extremes, Final Report: 1-21.

Wilby, R. L., Troni, J., Biot, Y., Tedd, L., Hewitson, B. C., Smith, D. M., and Sutton, R. T. (2009), A Review of Climate Risk Information for Adaptation and Development Planning, *International Journal of Climatology*, 29(9), 1193-1215.

Wilby, R.L. and Dawson, C.W. (2007), A Decision Support Tool for the Assessment of Regional Climate Change Impacts, User Manual, UK.

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