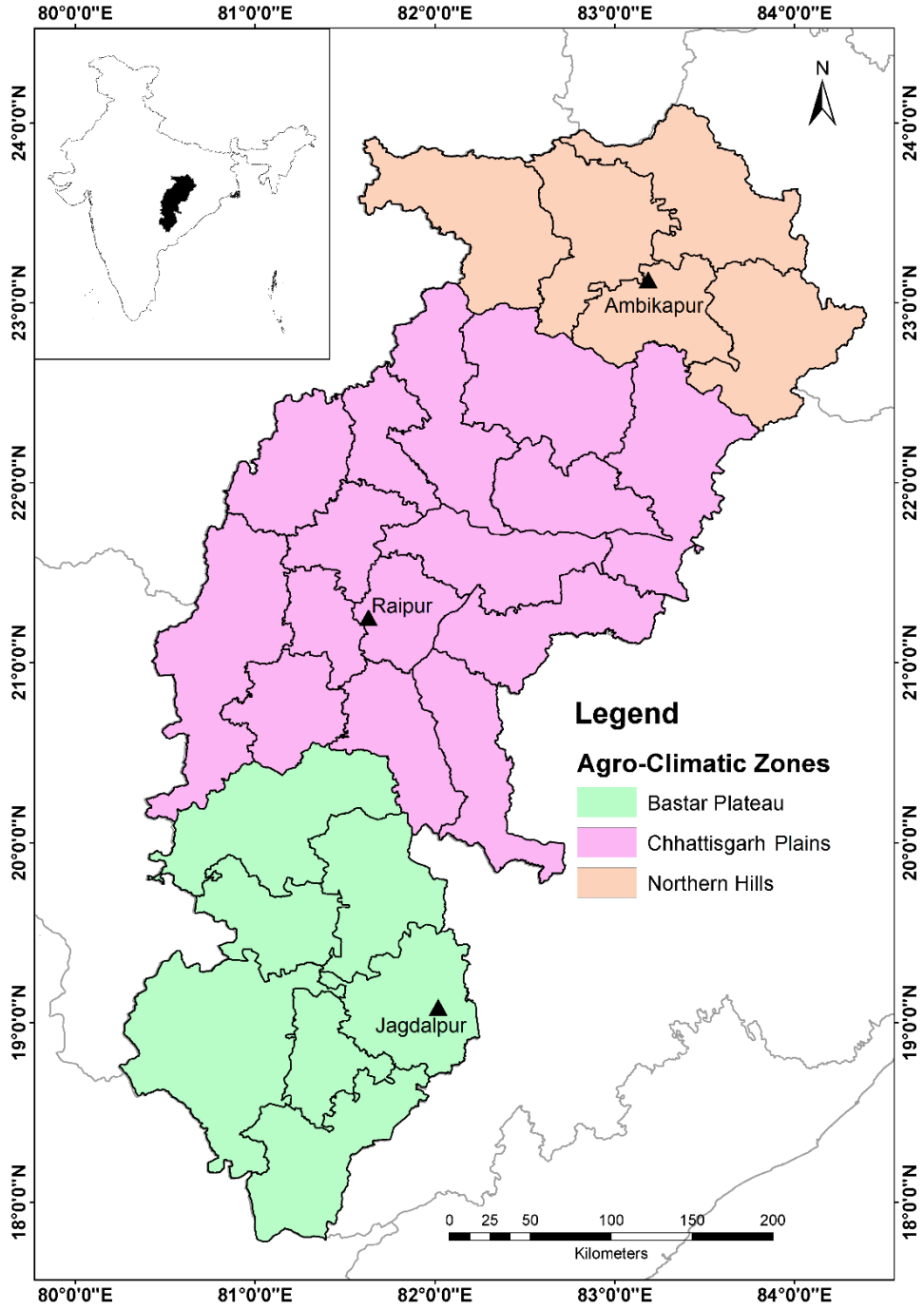
Prediction using MLANN

Agro-meteorolgoical Data

- Daily Metrological data on temperature, humidity, vapor pressure, wind speed, sunshine hours and evaporation were collected for Raipur, Jagdalpur and Ambikapur for the period 1981-2017. Long term daily meteorological parameters are averaged to obtained **Weekly** and **Monthly** time series.

- Data sets are collected from the India Meteorological Department (IMD) certified observatories located in these stations. WMO guidelines for the observational procedure and quality control are adopted uniformly in these surface meteorological observatories while data acquisition, tabulation, and computation.

- The online data entry system, itself has an inbuilt quality control mechanism to test the errors like data format, duplicate records, and incorrect units of measurement, impossible values, extremes, and outliers.



Location map of the study area

Descriptive statistics of meteorological parameters at Raipur, Jagdalpur and Ambikapur

Station	Maximum	Minimum	Range	Mean	SD	CV	R
Maximum Temperature - T_{max} (°C)							
Raipur	47.6	15.4	32.2	32.7	5.3	16.1	0.90
Jagdalpur	44.4	18.0	26.4	30.9	4.3	13.8	0.85
Ambikapur	45.6	15.6	30.0	30.3	5.4	17.9	0.79
Minimum Temperature - T_{min} (°C)							
Raipur	34.1	3.6	30.5	19.8	6.0	30.3	0.49
Jagdalpur	32.5	1.0	31.5	18.3	5.8	31.9	0.31
Ambikapur	31.9	0.4	31.5	17.7	6.6	36.9	0.48
Relative Humidity -I RH_I (%)							
Raipur	100	9	91	79.4	18.8	23.7	-0.86
Jagdalpur	100	21	79	86.3	11.6	13.4	-0.74
Ambikapur	100	19	81	78.9	18.8	23.8	-0.78
Relative Humidity-II - RH_{II} (%)							
Raipur	100	3	97	44.2	24.1	54.5	-0.53
Jagdalpur	100	3	97	49.5	23.1	46.7	-0.54
Ambikapur	100	5	95	46.4	23.9	51.6	-0.49
Wind Speed - WS (kmph)							
Raipur	31.4	0.1	31.3	5.5	3.9	70.7	0.36
Jagdalpur	22.3	0.1	22.2	4.8	2.7	57.1	0.24
Ambikapur	16.3	0.0	16.3	3.6	2.3	63.2	0.38
Bright Sunshine - BSS hours							
Raipur	12.0	0.0	12.0	6.9	3.4	49.2	0.33
Jagdalpur	12.0	0.0	12.0	6.4	3.4	53.8	0.44
Ambikapur	12.3	0.0	12.3	7.2	3.3	45.3	0.34
Pan Evaporation - EP (mm)							
Raipur	21.5	0.1	21.4	5.5	3.5	64.5	1.00

Evaporation estimation using multilayer neural network – A case study for Chhattisgarh plains

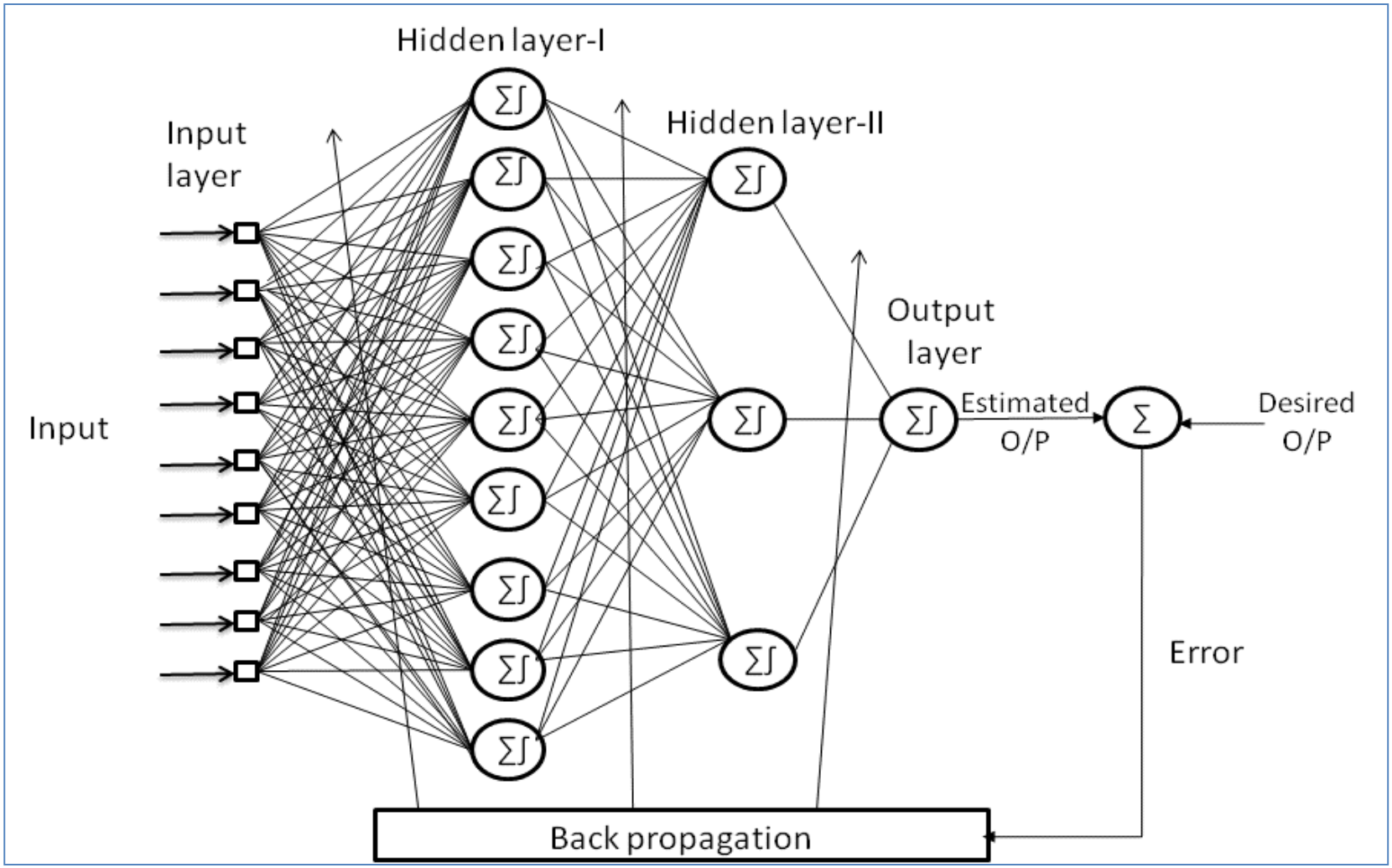
Meteorological data available for training and testing of the proposed models

Temporal scale	Total no. of patterns generated	Total no. of patterns used for training	Period of training dataset	Total no of patterns used for testing	Period of testing data set
Daily	12783 days	10958	1981-2010 (30 years)	1825	2011-2015 (05 years)
Weekly	1820 weeks	1560		260	
Monthly	420 months	360		60	

No. of features: 9

Maximum Temperature, Minimum Temperature, Humidity (Morning), Humidity (Evening), Vapour pressure (Monrning), Vapour pressure (Evening), Wind Speed, Sunshine hours, Evaporation

Design of multilayer neural network as a predictor



Training & testing of the model

- The initial weights of the model are set between -1 to 1.
- The first pattern is applied and output is computed.
- The output is compared with the desired output. The difference between the two is computed to produce error.
- The back propagation algorithm is applied to update weight and biases of each layer of the MLNN.
- This process is repeated and all the remaining input patterns are sequentially fed in to the MLNN.
- In each case error values are obtained after each forward pass and weights and biases are updated in each backward pass using back propagation.

- The above steps constitutes one experiment. The above experiment is repeated 1000 times.

- In each experiment the root mean square error (RMSE) is obtained. When the RMSE settles to a minimum value, the learning process is stopped.

- The weights are then frozen to the final values which represent the model parameters. The adaptive forecasting model is thus designed.

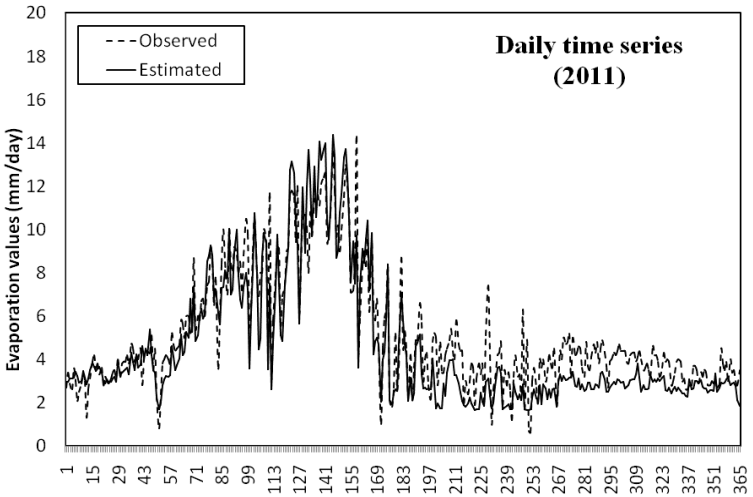
- Test patterns are fed sequentially for testing the model. For each test pattern, estimated output is obtained and compared with the desired values and error is computed. After computing error values for each test pattern, RMSE value is computed to evaluate the model performance.

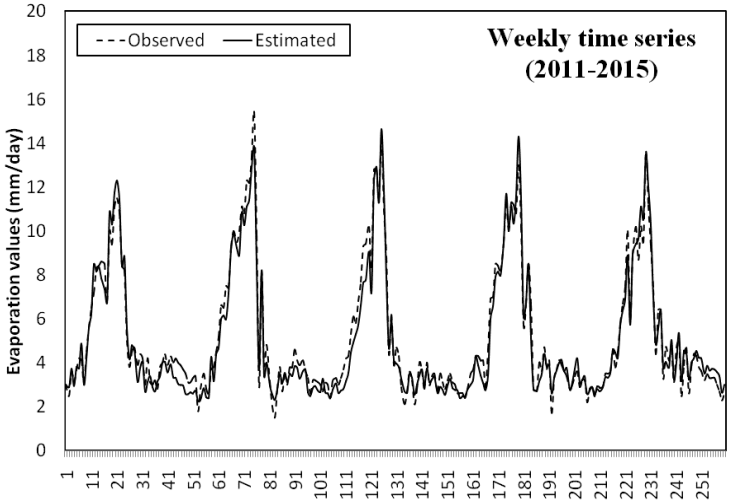
Training and testing performance (RMSE values in mm/day) of MLNN

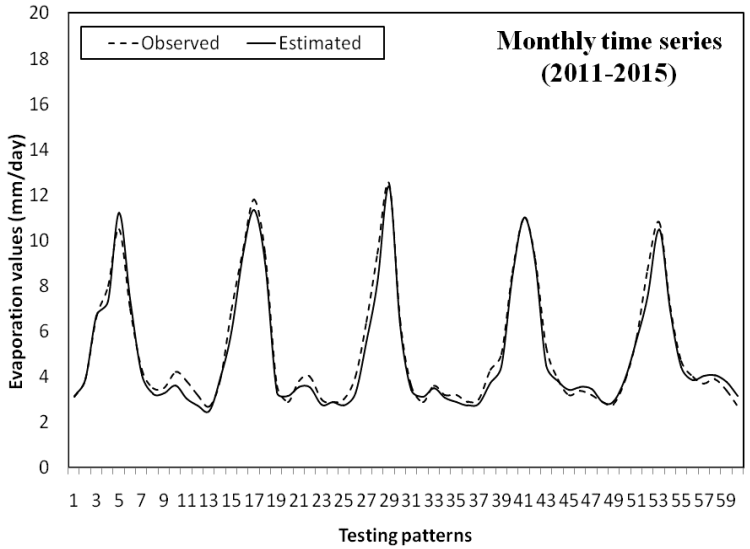
MLNN models	Daily		Weekly		Monthly	
	Training	Testing	Training	Testing	Training	Testing
Model-I	2.00	1.79	0.91	0.69	0.67	0.49
Model-II	1.63	1.45	0.78	0.69	0.65	0.50
Model-III	1.66	1.51	0.78	0.67	0.61	0.50
Model-IV	1.03	1.09	0.50	0.58	0.31	0.47
Model-V	1.05	1.20	0.47	**0.57**	0.30	**0.43**

***Model-I**: Temperature only, **Model-II**: Temperature and humidity, **Model-III**: Temperature, humidity and vapour pressure, **Model-IV**: Temperature, humidity, vapour pressure and wind speed, Model-V: Temperature, humidity, vapour pressure, wind speed and sunshine hours.*

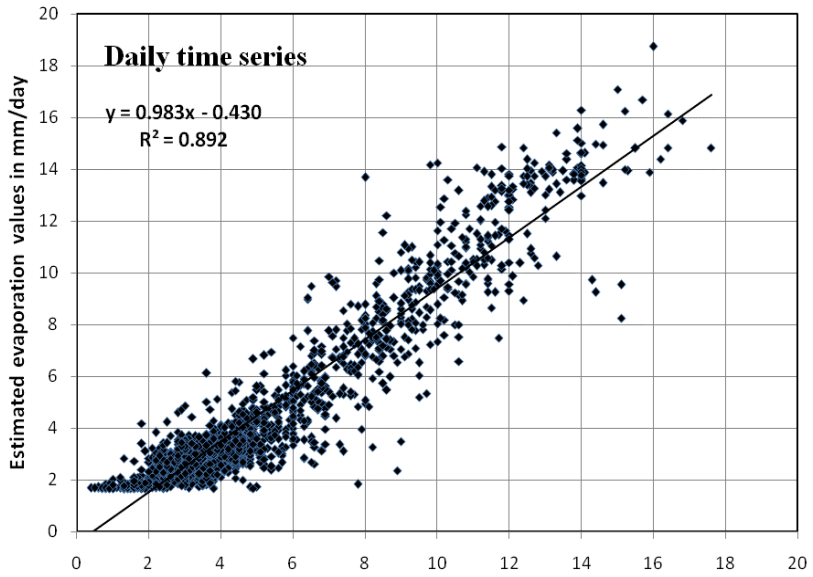
Comparison of actual and predicted values of evaporation with test data set using MLNN

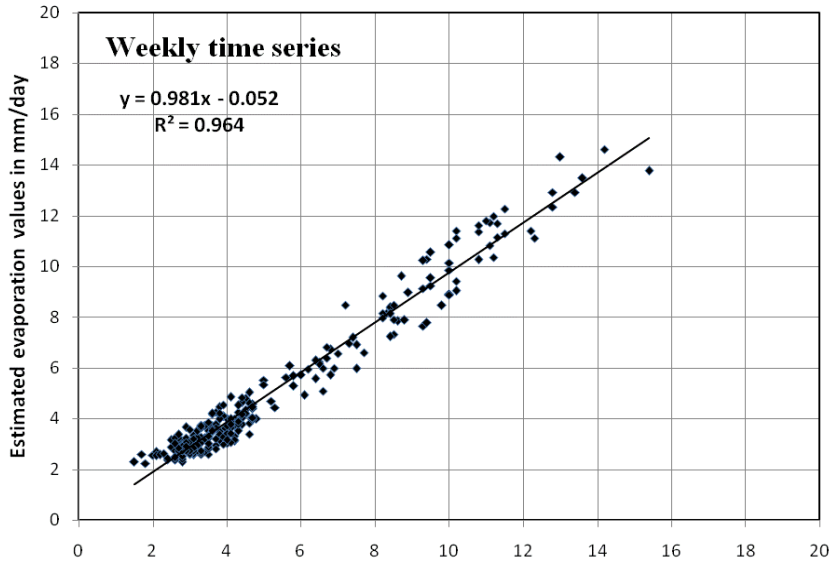


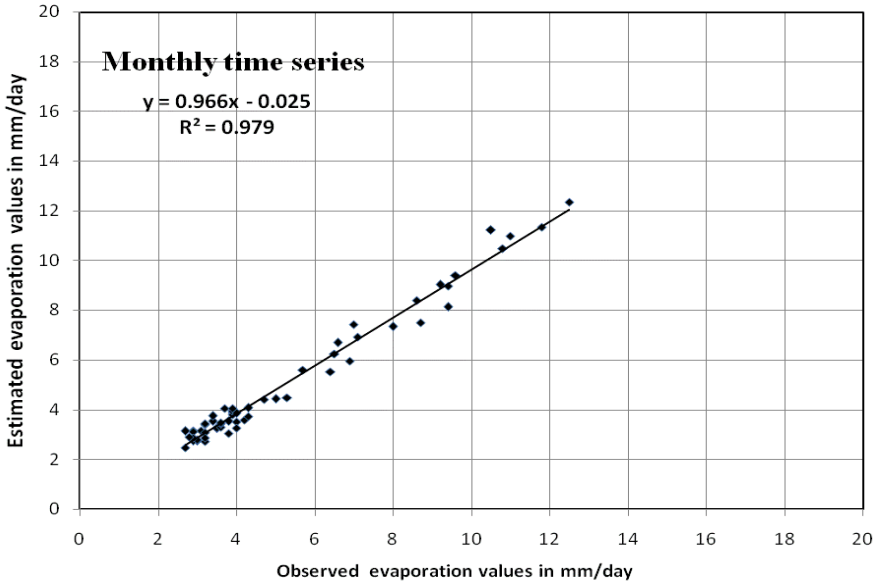




Relationship between observed and predicted evaporation at Raipur







Significant findings

1. It has been observed that the MLNN model is able to estimate the evaporation losses more accurately when all the metrological variables considered for the investigation are included as the input patterns.

2. MLNN model with monthly and weekly time series as input patterns performed better when compared with daily time series.

3. Hence it is suggested that MLNN with back propagation learning can be used to estimate weekly and monthly evaporation with low RMSE values of 0.57 and 0.43 mm/day respectively with temperature, humidity, vapour pressure, wind speed and sunshine data as input combination in Chhattisgarh plains agro-climatice zone of Chhattisgarh state.