Chapter 7

CONCLUDING REMARKS

In this thesis we have taken the following prediction problems on weather parameter, which are frequently used, in meteorological studies.

Problem I Prediction of weekly soil temperature at 3 depths (i.e. 5 cm, 10 cm and 20 cm).

Problem II Prediction of extreme rainfall and weekly rainfall Probabilities.

Problem III Prediction of amount of annual rainfall (ARF).

Problem IV Prediction of hourly Air temperatures.

Problem: 1: Chapter-3

Here we have predicted soil temperature by employing Multiple Regression (MR), Artificial Neural Networks and Harmonic Analysis. ANN algorithm has been found suitable even when the data size is very large. Therefore, we involve the ANN algorithm for soil temperature prediction.

Mainly, we apply two types of network namely; Mculloch Pitt type generalizes with back propagation algorithm. We have also proved a convergence theorem for generalized window - hoff algorithm by using fixed-point theorem.

It has found that RMSE computed is less when ANN algorithms are used. However, the training of neural network takes time and also achievement of error goal depends upon the speed of the computer used for soil temperature prediction problem. We also used harmonic Analysis technique. It has been found that fluctuation and variations can be explained

by different harmonics in the Fourier series representation of soil temperature function. By computing finite number of harmonics, 26 harmonics we made prediction of soil temperature and it has been found that the Root Mean Square Error and Percentage of Average error are less than 10%.

Problem 2: Chapter- 4

Problem of prediction of return period for highest one day maximum rainfall requires extreme value distributions like Gumbel and Fisher and Tipett Type-II distribution We have employed above said same distribution for prediction of return period of the occurred highest one-day maximum rainfall.

At the same time we have also tried ANN for prediction of return period of observed highest one-day maximum rainfall. Obtained results found significant to the results by extreme value distribution. At some places non-significant results are obtained as the highest one-day maximum rainfall.

One can find good results by using ANN if the ANN is to be trained by actual probabilities of occurred highest one day maximum rainfall of particular station and then to predict the probabilities or returned period for nearby region.

In the same problem we have also computed weekly rainfall probabilities by Gamma Distribution Model and ANN and are compared by

actual weekly rainfall probabilities. These estimated rainfall probabilities are found significant.

ANN is an alternative method to find the rainfall probabilities without finding the parameters of the specific model when large data size is involved.

Problem 3: chapter- 5

Prediction of annual rainfall is made by using Double Variable Fourier series and Artificial Neural Network From the data, one can easily see that Annual rainfall is highly oscillating with May month's maximum air temperature and previous year annual rainfall Because of this oscillating nature of rainfall, we have used Double Fourier Series. We found non-significant difference with actual annual rainfall. Goswami [42, 43, and 44] have used a different kind of ANN. They have used time point as input variable. We have incorporated May month's maximum air temperature and previous year annual rainfall to predict the annual rainfall.

Problem: 4 Chapter- 6

In this problem, . prediction of hourly air temperature (HAT) is done by Daily Extremes and Hourly Extremes. Here we have employed William and Logan Model, double Fourier series and Artificial Neural Network

William [121] has used daily extremes. Obtained results are significant to actual hourly air temperature measured by automatic weather station. We have employed William and Logan Model and found significant results.

Artificial Neural Network is a very useful technique for weather prediction problem.

The following are the interesting problems for future investigation.

1. Neural Network convergence, selection of parameters like momentum, number of hidden neurons, number of hidden layers, learning rate, transfer function etc. are there are still open problems for further investigation.
2. In harmonic analysis, the method required number of harmonics for getting a desired accuracy in prediction is also a problem.
3. In the method of Double Fourier Series, selection of M and N is still an open problem to get the required accuracy.
4 Prediction of rainfall by other weather parameters like Southern Oscillation Index, sea surface temperature could also be interesting.

Our research on these problems resulted in the publication of the following problems.

The work contained in the thesis has resulted in the following publications:

1. **Kulshrestha, M. S.,** George, R. K and Shekh, A. M.: *"Prediction of the rainfall of the Anand station of Gujarat using Artificial Neural Network"* Jr. of Agrometeorology. Special Issue, 6, pp 233-236, (2004).
2. George, R. K., **Kulshrestha, M. S.,** Shekh, A. M. and Jaita, H.: *"Prediction of Soil Temperatures Using Artificial Neural Networks."* Jr. of Agro meteorology.3 1&2: pp 169-173, (2001).
3. **Kulshrestha M. S.** and Shekh, A. M.: *"Estimation of Soil temperature by Harmonic Analysis"* Mausam 52, 2, pp 379-384, (2001).
4. **Kulshrestha, M. S.,** Shekh, A. M. and Parmar, R S.· *"Rainfall probability Analysis using Incomplete Gamma Distribution"* Presented and Published in Proceeding of "International Conference on Managing Natural Resources for Sustainable Agricultural Production in the 21st Century" Held at IARI, New Delhi 14-18. Volume –II pp. 600-603, 2000.
5. **Kulshrestha, M. S.,** Shekh, A. M. and Parmar, R. S.: *"Extreme Value Rainfall Analysis of Gujarat State."* INTROPMET-97,'Asian monsoon& Pollution over the monsoon environment held on Dec. 2-5,1997, IIT, New Delhi, India. Vayu Mandal, pp 45-48, (1999).
6. Shekh, A. M. **Kulshrestha, M. S.** Parmar, R. S., Patel, H. R.: *"Relationship of Mean Temperatures with Screen Temperatures"* "Mausam 49 ,1, pp 21-26 , (1998)
7. **Kulshrestha, M. S.,** Shekh, A. M., Bapuji Rao B and Upadhyay, U. G.." *Extreme Value Analysis of Rainfall of Krishna Godavari Basin, Andhra Pradesh."* Water & Energy 2001 9-12 Oct 1995. **Awarded Merit by Central Board of Irrigation and Power.** pp 96-101,(1995)
8. **Kulshrestha, M. S.,** George, R K. and Shekh, A. M.: *"Application of Double Variable Fourier Series for Prediction of Annual rainfall."* Communicated to the journal Mausam