CHAPTER 6
CONCLUSIONS

In this chapter we summarize our entire research work presented in Chapters 2 to 5. Our work is centered on estimating realistic values of global solar radiation on horizontal surface using measured meteorological data and geographical parameters for India and specially for Uttar Pradesh. In logical development we first consider the problems of day length and extraterrestrial radiation in detail as our literature survey speaks for different formulas for the day length and extraterrestrial radiation. Our work based on measured data of day-length gives justification for using Hay formula in different Indian locations which is generally not used by Indian researchers. We find 1367 W/m² as a widely accepted value of solar constants on basis of recent literature. Different equations used for calculating extraterrestrial radiation have no effect on empirical correlations as difference is negligible. To estimate hourly values of global solar radiation on horizontal surface there are various empirical correlations available in literature. We did a comparative study of different models for Uttar Pradesh region of India which is scarce in literature. Estimation of global radiation on horizontal surface using atmospheric parameters has also been carried out. Different models have been examined using measured data of Uttar Pradesh.

Cooper’s and Hay’s formulas for calculating maximum possible sunshine hours are being used by various research groups across the globe since they appeared in literature. Klein’s proposal for average days of month simplifies complicated and long calculations to determine monthly mean values. Different values of solar constant and different equations are being used by investigators to calculate maximum possible extraterrestrial radiation. We addressed such significant and
important calculative problems in details due to their importance for developing empirical correlation to predict solar radiations. Indian researchers generally used Cooper’s original formula to calculate $S_o$. Our study based on experimental data of sixteen locations of India shows that $S_o$ calculated from Hay’s formula are close to experimental values. A monthly study on clear sky days further confirms the result. There are some locations [190] for which Cooper’s formula predicts values close to experimental values. The value of solar constant $1367 \text{ W/m}^2$ seems to have world wide acceptance as reflected from recent literature. Prediction of $H_o$ using different equations are almost same and have no effect on empirical correlation developed.

A new set of correlation coefficients have been derived for determining monthly mean hourly values of global solar radiation for the Uttar Pradesh which is based on stochastic modeling and have considerable difference from empirical correlations based on deterministic modeling. Stochastic modeling requires maximum value of solar radiation to predict whole day hourly values. Deterministic models are basically based on least square fitting of measured data and consequently require whole day data. In deterministic correlations equal weightage is given to each data while peak values of hourly solar radiation have major contribution and requires more weightage in an empirical correlation. Our empirical correlation based on stochastic method predicts so far better hourly values of solar radiation on horizontal surface for Uttar Pradesh.

Meteorological and geographical parameters do affect the global solar radiation. We compared leading model estimating global solar radiation on horizontal surface using measured meteorological data of Uttar Pradesh. Gopinathan’s model has
been reconsidered and new regression coefficients have been proposed for Uttar Pradesh, India.

A new correlation using sunshine hours have been proposed for India. This correlation is a 6th order polynomial regression coefficients which have been determined from least square fitting of measured data of sixteen cities of India. Regression coefficients of 6th order polynomial is highly site dependent. Proposed correlation predicts extremely good results in comparison to all existing correlations based on sunshine hours only.