

A PRELIMINARY STUDY OF THE MEASUREMENT OF SOLAR RADIATION TO EVALUATE THE SOLAR ENERGY POTENTIAL OF THE UNIVERSITY OF PERADENIYA AREA

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Introduction

Solar radiation is an important climate variable because it is usually the largest input of energy to the surface and hence drives the surface energy balance. It also controls the temperature of the surface and the atmosphere and, therefore, influences the atmospheric moisture content and processes associated with the hydrological cycle such as convection, cloud formation and precipitation. Therefore, solar radiation is important for a wide range of physical processes in the environment.

The energy demand of the country is continually increasing. Solar energy is the most abundant of all energy resources, so it has great potential as a sustainable source of energy to meet the needs of society. Solar energy is renewable, its utilization has little environmental burden and it is an excellent method of mitigating climate change. Adopting solar energy conversion technologies have a positive impact on the environment because they can reduce greenhouse gas emissions by decreasing the use of fossil fuels. However, utilization of solar energy requires detailed knowledge of the solar energy distribution (Poudyal et al. 2015).

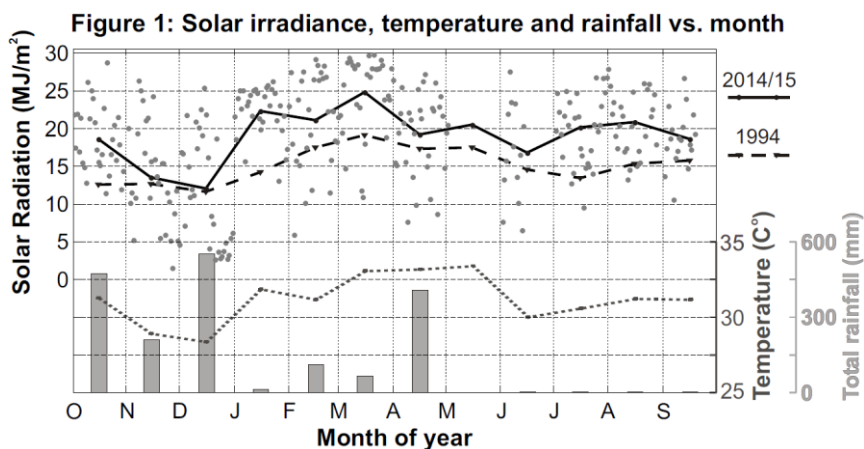
The most detailed study on sunshine conditions of the island is found in Domroes (1974). This study was based on sunshine records from 39 stations in Sri Lanka between 1962 and 1971. Despite the limitation of using sunshine hours for the study, the spatial (e.g., highland versus lowland) and temporal variability in the island's distribution of solar radiation was captured. However, because irradiance measurements were lacking, an assessment of the energy that could be extracted from solar radiation input was not possible. The current study presents an initial analysis of solar radiation irradiances measured using a silicon pyranometer to assess the potential of solar radiation as an alternative energy source.

Methodology

An automatic weather station (Watch-Dog 2000 series) was installed near the Department of Geography, University of Peradeniya. The silicon pyranometer of the weather station measures the solar radiation spectrum in the 0.3 and 11.0 μm wavelength band. The Watch-Dog's data logger records the downward radiation (irradiance) from the solar spectrum in units of W/m^2 at 15-minute intervals, thus enabling the creation of solar irradiance curves as a function of time for each day. The analysis of solar radiation data spanning a period of approximately one year – October 2014 to September 2015 – is presented.

Results and Discussion

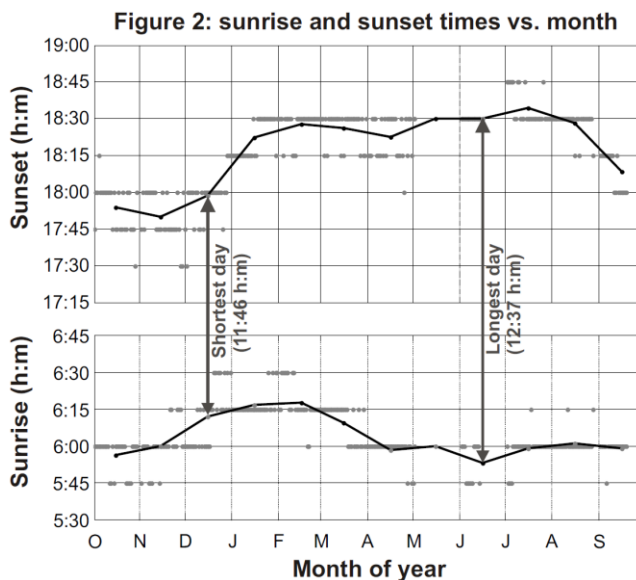
In Fig.1, the grey coloured dots represent the daily irradiance values computed from the pyranometer of the University of Peradeniya. The black solid line represents the monthly mean solar radiation, estimated from the daily observations. The black dashed curve plots the monthly mean data from Peradeniya for 1994, obtained from the data published in Nakagawa et al. (1995). The figure reveals that the lowest solar irradiances were measured in the month of December 2014, whereas the highest irradiances were observed in March 2015.



The grey colored dotted line represents the monthly mean values of the maximum daily temperature. It suggests that higher temperatures occurred during greater levels of incoming solar radiation. The grey colored vertical bars depict the monthly total rainfall. Lower rainfall values are associated with higher solar insolation because thin tenuous

clouds produce little rainfall, but cause greater solar irradiance on the ground. The figure also reveals that the period May-September in 2015 was exceptionally dry despite being the South West Monsoon period, the climatological rainy period in Peradeniya.

Fig. 2 shows the sunrise and sunset times and their monthly mean values for an entire year. The distance between the two curves represents the length of the day, the period during which solar radiation is available. The mean sunrise time occurs between 5:53 a.m. and 6:18 a.m. during the course of the year, so the sunrise time fluctuates only by about 25 minutes. In contrast, the sunset time varies by about 44 minutes. The length of day computed in the above manner reveals that the shortest days occur in December when the latitude of the sub-solar point is located furthest from Sri Lanka. Peradeniya received more than 12 hours of solar radiation except for some days in October and November and most of the days in December. Besides calculating day light hours, the pyranometer data can also be used to calculate the mean number of sunshine hours in each month where the irradiance exceeds a user defined threshold value (e.g., bright sunshine hours).



The correlation coefficient estimates from the time series of daily solar irradiances and mean daytime temperatures, and daily solar irradiances and daily rainfall were 0.86 and 0.35, respectively. Solar radiation is a

primary factor that controls the surface and air temperatures, so one expects a strong correlation between solar radiation and the air temperature, but solar radiation influences rainfall in an indirect manner.

The monthly irradiance measurements for the University of Peradeniya area were in agreement with 1994 data for Peradeniya. Although the analysis in Domroes (1974) was conducted with sunshine recorder cards, which records the daily hours of sunshine, there is general agreement between the two results: i.e., smaller amounts of energy are received during the calendar months of November and December.

Conclusion

The pyranometer data captured the annual solar radiation distribution for the weather station at University of Peradeniya. The monthly irradiance measurements were in agreement with 1994 data for Peradeniya. Despite being in the highland region with the possibility of significant cloud cover, the University area receives on average of over 15 MJ/m² of solar energy per day most of the time, except in November and December; this daily value is in agreement with values obtained by Samuel and Srikanthan (1982). Since, the length of day does not change significantly from 12 hours in Peradeniya, the variability in solar radiation caused by monthly changes in the cloud cover must be studied to assess the solar energy potential.

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