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Research Article

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Survey of the Most Suitable Site for Solar Station Using Satellite Images

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Abstract The overall goal of this work is to find the most suitable site in Mubi metropolis for optimal performance of solar devices. By using ENVI 4.5 software, thermal band 6.2 were used for the estimation of solar parameters (solar radiant, surface reflectance and surface temperature), from Landsat7 ETM+ imagery sensors acquire as a digital number (DN) range from 0 - 255 in thermal band, firstly the DNs was converted to radiance values ($W/m^2/sr/\mu m$) using the bias and gain values specify to the individual pixel. Secondly the radiance was converted to surface reflectance, and the third process is to convert surface reflectance to surface temperature (Kelvin).This research reveals the most suitable site for solar station in Mubi town, and these areas are suggested because they have interested solar parameters in the whole season within year of the study, such areas are; Along Lokuwa Areas ($10^o15' 23.86" N, 13^o16' 41.47" E$), Near Gella Junction ($10^o15' 48.76" N, 13^o16' 30.24" E$), Along Shuwari Area ($10^o15' 63.84" N, 13^o16' 12.51" E$) and Kabban Area ($10^o16' 09.52" N, 13^o15' 11.65" E$). For efficient performance of solar station in other to achieved long last solution for effective used in our days to day's activities.

Keywords Solar Station. Temperature, Radiance, Reflectance and Satellite Images.

Introduction

It is very important to know the site-depended solar parameter available and also important are the patterns of seasonal availability, variability of irradiation, and surface temperature on site. Due to significant inter-annual variability of weather conditions across a year, such measurements must be generated over the four seasons within a year. the fact that the number of meteorological stations are limited especially in developing countries and inefficient recording of data due to device malfunctions constitute another limitation in obtaining Solar parameters data. Thus, these limitations forced researchers toward a tendency to develop alternative estimation methods and find more reliable data sources for the regions where solar parameter data cannot be directly measured or stations are insufficient. In recent years, satellite-based techniques are widely used as an accurate method and as a data source for solar parameter estimations. One of the most important advantages of satellite is that it is a reliable and fast method for obtaining up-to-date and continuous information about large geographical areas. In addition to this, satellite provides opportunity to perform solar parameters estimations in rural, mountainous, and remote places where meteorological stations are insufficient.

This research emphasize the need to survey the most suitable site for solar station in Mubi town using satellite image for efficient performance of solar station in other to achieved efficient and long last solution of solar station for effective used in our days to day's activities. Knowledge of the solar parameter is needed for many environmental studies such as, radiative transfer studies, soil conditions etc. [1].

It can also provide important information about the surface physical properties and climate which plays a role in many environmental processes [2].

Many methods have been devised by the researchers in estimating solar parameters for both urban and rural areas using data of ground based metrological stations these methods take a long processing time and need many meteorological parameters.

Determination of solar parameters using data of space based (satellite) sensors might be a better alternative to the ground based methods [3].

The advantages of using remotely sensed data are the availability of high resolution, consistent and repetitive coverage and capability of measurements of earth surface conditions [3].

Digital data is the present technology that is use around the world of our generation. Image in a continuous grey colour, like a photograph is called an analog image, on the other hand, a portion of small element, with integer values of average intensity is called a digital image [4]. An individual divided element is called a pixel (picture element). The shape of the element is usually square for easy use in a computer, though triangular or hexagonal can also be considered. In short, it is a raster image file in a format that can be used by computer system with the capability of handling images.

A satellite can be defined as a Strong transmitter with transponders positioned streamline in the orbit. They amplify, separate signals. Unlike wireless ground repeaters which relay signals between two known positions; satellite interconnect many locations position, both stationary and dynamic over a wide range area. It receives microwave signals from source on the earth in a given frequency band (uplink) and retransmits them at a different frequency to earth stations (downlink) [4]).

The Landsat Enhanced Thematic Mapper Plus (ETM+) sensor on board the Landsat 7 satellite has acquired images of the Earth nearly continuously since July 1999, with a 16-day repeat cycle. Landsat 7 images are referenced to the Worldwide Reference System-2. The Scan Line Corrector (SLC) on the instrument failed in May of 2003. All bands can collect one of two gain settings (high or low) for increased radiometric sensitivity and dynamic range, while Band 6 collects both high and low gain for all scenes [5].

This study was concentrated using Landsat ETM+ data for the measurement of spectral radiance, surface reflectance and Temperature of Mubi town study area.Band 6 (thermal IR) is useful in heat-mapping applications, e.g., estimates of soil moisture, identifying different types of rocks, detecting thermal pollution in water bodies and etc.

Landsat, ETM+ (Enhanced Thematic Mapper Plus) data is composed in a unit of scene with a size of 200 *200 Km. each scene is coded with path number and row number, based on what is called WRS (World Reference System). Image data are recorded with respect to each pixel with a numerical value (DN) of 8-bits (0-255)

The aim of this research is to survey the most suitable site for solar station in Mubi town using satellite imagesin other to achieve the aim of this research; the following objectives have been formulated;to determine the spatial variation of solar radiant, to determine the spatial variation of surface reflectance, to determine the spatial variation of surface temperature, to determine the region with highest values of the above solar parameters as the most suitable site for solar station

Method

Study area

The study area is geographically located between at 10°27'N and Longitudes 13°27'E, North of the GMT. It lies on the bank of Yedzaram River due to west, which flows through north into Lake Chad basin, and it situated along the side of Mountains which mostly form its drainage and relief. The area is in boundary internationally with Cameroon due to North and within the state by Michika, Hong and Maiha to the east, west, and south respectively as shown in Fig.1 Also, it occupies an area of 2,327km^2 and has a population of 265,109 according to National Population commission Census 2006.

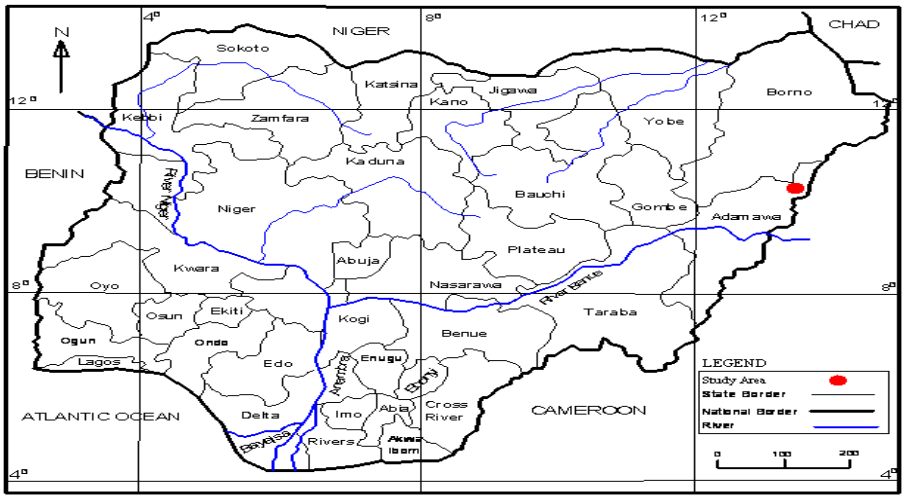

Figure 1: Map of Nigeria showing the study area

Data Processing

The first process is to convert the DNs to radiance values using the bias and gain values specific to the individual pixel. The second process is to convert the radiance data to surface reflectance and the third processes is to convert the surface reflectance to temperature in Kelvin. The temperature obtained from the spectral radiance is called effective sensor temperature. Plank's inverse function and surface emissivity of the study area were used to retrieve the Surface Temperature. The task will be carried out using ENVI 4.5 software. Figure 2 shows the steps to be followed in order to estimate three depended solar parameters, for the suitable site for solar station in Mubi Town using satellite image

Results

The main goal of this research is to find the area with highest solar parameters as the suitable site for solar station. Based on the results above, here are areas that have highest solar parameters (solar radiant, surface reflectance and surface temperature) in all of the four prominent seasons within year of study.

Table 1: Mean solar parameter along Lokuwa Area

Along Lokuwa Area (10°15′ 23.86″ N, 13o16 41.47E)			
Saesons	**$L_\lambda(Wm^{-2}sr^{-1}\mu m)$**	***r***	**T_s (K)**
Vernal	22.20	0.312	310
Summer	20.02	0.214	308
Autumnal	15.40	0.176	305
Winter	16.92	0.168	302

Table 2: Mean solar parameter Near Gella Junction

Near Gella Junction (10°15′ 48.76″ N, 13°16′ 30.24″ E),			
Saesons	**$L_\lambda(Wm^{-2}sr^{-1}\mu m)$**	***r***	**T_s (K)**
Vernal	23.01	0.287	311
Summer	17.41	0.174	306
Autumnal	15.12	0.211	303
Winter	13.80	0.143	299

Table 3: Mean solar parameters along Shuwari Area

Along Shuwari Area (10°15′ 63.84″ N, 13°16′ 12.51″ E)			
Saesons	$L_\lambda(Wm^{-2}sr^{-1}\mu m)$	*r*	T_s (K)
Vernal	18.16	0.268	308
Summer	18.40	0.201	310
Autumnal	16.80	0.189	300
Winter	15.80	0.232	297

Table 4: Mean solar parameters in Kabban Area

Kabban Area (10°16′ 09.52″ N, 13°15′ 11.65″ E)			
Saesons	**$L_\lambda(Wm^{-2}sr^{-1}\mu m)$**	***r***	**T_s (K)**
Vernal	21.80	0.327	310
Summer	18.67	0.282	306
Autumnal	15.50	0.266	303
Winter	15.11	0.220	298

Figure 1: below shows those regions that these researches recommend as the most suitable site for solar station in Mubi Metropolitan. Here are the addresses of the regions with highest solar parameters; Lokuwa (10°15′ 23.86″ N, 13°16 41.47E), Near Gella Junction (10°15′ 48.76″ N, 13°16′ 30.24″ E), along Shuwari Area (10°15′ 63.84″ N, 13°16′ 12.51″ E) and Kabban Area (10°16′ 09.52″ N, 13°15′ 11.65″ E)

The seasonal solar parameters are needed for many land surface studies. Only satellites can provide the needed measurements. The survey of the most suitable site for solar station in Mubi town was done using satellite images, for the optimal performance of solar devices to the values of three site depended solar parameters of four different seasons within year.

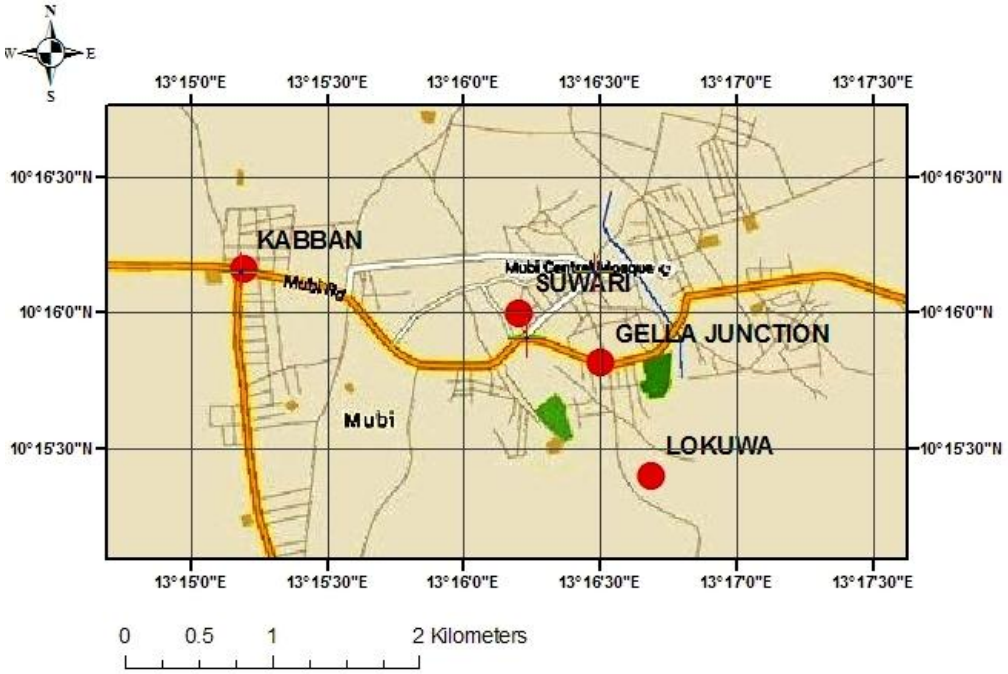

Figure 2: The region with highest solar parameters in Mubi town

Conclusion

Base on this research some area within Mubi town with the highest values of solar parameters such as; Along Lokuwa Areas ($10^{o}15'23.86''$ N, $13^{o}16$ 41.47E), Near Gella Junction ($10^{o}15'$ 48.76'' N, $13^{o}16'30.24''$ E), along Shuwari Area ($10^{o}15'63.84''$ N, $13^{o}16'12.51''$ E) and Kabban Area ($10^{o}16'09.52''$ N, $13^{o}15'11.65''$ E) were selected as the most suitable site for solar station in Mubi town

The values of solar parameters of these areas are showed in table (1-4). All these results correspond well with the local environmental conditions of the respective regions. It can be recommended from the study that this method can be utilized for determination of solar parameters for Mubi.

Finally, it can be concluded that the best method to estimate solar parameters are by using satellite images data. The methodology originated by this study in Mubi Metropolitan can be applied in any other region owing to the fact that this proposal is maintained by using satellite images.

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