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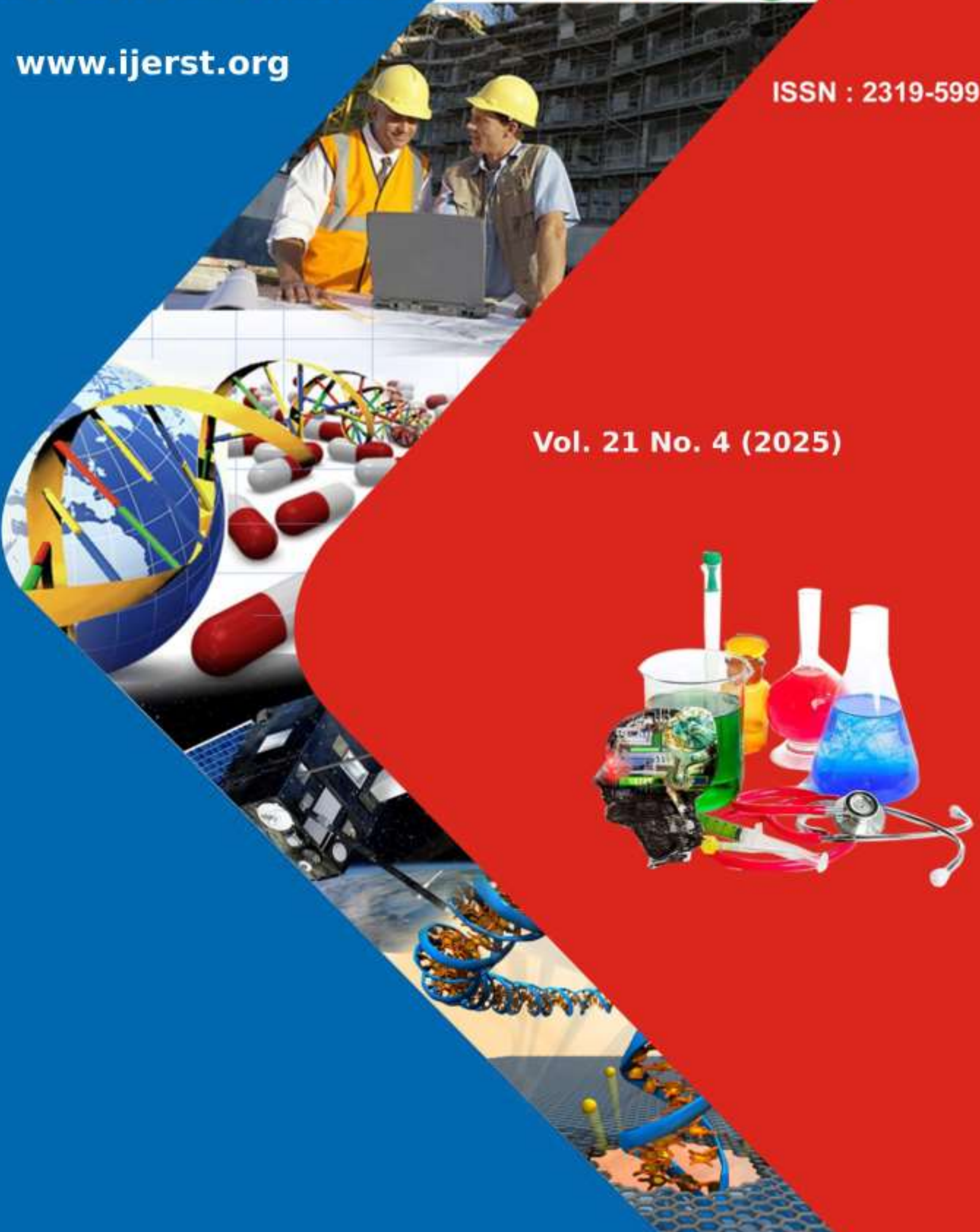

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Research Paper

CONTRIBUTION TO THE ASSESSMENT OF METEOROLOGICAL PARAMETERS (SOLAR RADIATION, TEMPERATURE, AND HUMIDITY) AT THE MAMOU HIGHER INSTITUTE OF TECHNOLOGY SITE FOR OPTIMAL EXPLOITATION OF SOLAR POTENTIAL

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ABSTRACT: Accurate assessment of incident solar energy at a given site is a key factor in evaluating the profitability of any photovoltaic project. Acquiring data on solar potential remains difficult. Such data is obtained through direct measurements, calculations based on empirical formulas, or satellite data. The main objective of this study is to assess the solar potential of the Mamou Higher Institute of Technology site through direct in situ measurements of irradiation, temperature, and air humidity using a mini station during the period from May 26 to November 22, 2025. In this study, we used information on radiation, air temperature, and humidity recorded at the mini station of the Mamou Higher Institute of Technology. In the data analysis phase, we set the production threshold at 50W/m² and found: a maximum monthly average of 206.14 W/m² in October compared to a minimum of 157.29W/m² in July for irradiation and corresponding temperature and humidity values, standard deviations and correlation coefficients and their interpretations. The cumulative number of hours of sunshine during the study period was 1,770.25 hours, with a daily average of 9.73 hours. Excel and Python software were used for pre-processing, processing, analysis, and graphical representation of the information, respectively. The daily and monthly averages were 1090 W/m² and 179.18 W/m² for irradiation, 26.31 °C and 23.33 °C for temperature, and 97.78% and 99.59% for humidity, respectively. Irradiation had a high standard deviation (283.60); low values for temperature (4.421) and 1.587 for humidity. The remarkable values of the correlation matrix (0.224 and -0.275) indicate low dependencies between temperature and radiation on the one hand and negative correlations between humidity and radiation on the other. The results obtained show a dispersion of irradiation values and little variation in humidity, reflecting remarkable variability in sunshine during the day and a generally stable climate.

Keywords: Solar potential, irradiation, temperature, humidity, Mamou site

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I. INTRODUCTION

Faced with climate change caused by polluting energies in a context of growing energy demand and insufficient access to stable and constant electricity, renewable energies, particularly solar photovoltaic (PV) energy, are seen as one of the best alternatives for energy transition [1]. To take advantage of this accessible and sustainable solution, it is essential to understand its potential. Accurate knowledge of the solar energy incident on the ground at a given site is a major factor in assessing the profitability of solar installation projects [2]. The availability of reliable solar radiation data would make it possible to size and predict the output of photovoltaic or thermodynamic solar power plants with sufficient accuracy to develop optimization and control strategies for optimal energy mix management [3].

Known as irradiation, photovoltaic potential is free and inexhaustible; it is the basic information for the design, simulation, and performance testing of solar energy projects [4]; its accurate measurement using equipment and its collection from specialized platforms are subject to material constraints that can sometimes be costly and require skilled labor. Due to the cost and difficulties associated with measuring, transmitting, and storing these meteorological parameters, access to this information remains difficult in many countries and regions of the world [5]. In the Republic of Guinea, the lack of weather stations for the construction of an effective database and the risks associated with the storage of information pose a problem; solar potential is theoretically estimated at a national average of 4.8 kWh/m²/day [6]. To overcome these difficulties, many researchers have focused their studies on mathematical models adapted to specific sites for estimating and predicting solar potential [7, 8, 9, 10, 11].

To estimate solar irradiation on the coast of southern Cameroon in the absence of meteorological data, [12] used models provided for ArcGIS. In 2014, [13] examined the performance of global radiation models for the Ghardaïa site by digitally integrating the solar irradiance measured by two fixed pyranometers. Estimating solar radiation using meteorological variables and empirical models is useful for obtaining data on a global scale [14]. However, assessing potential using models has limitations due to its sensitivity to local atmospheric conditions (clouds and pollution) and the uncertainty associated with certain types of climates [15]. Like solar irradiation, some studies conducted in various tropical locations have focused on temperature for photovoltaic energy production. [16, 17, 18] have stated that ambient temperature values do not always correspond to the standard test conditions (STC) for photovoltaic panels. However, solar panels can withstand temperatures between 25°C and 35°C [19]. In testing a mini station for measuring irradiation, temperature, and humidity, [20] established the influence of temperature and humidity on solar irradiation. According to [21] in 2016, the module operates efficiently not only at ambient temperatures above 25°C, but also well above 40°C. A study conducted in northeastern Nigeria proved that photovoltaic panels could experience significant losses due to higher-than-normal temperatures but would still produce the required efficient energy [22].

The objective of this study is to evaluate solar potential, taking into account the influence of temperature and humidity based on measurements taken on site at the Mamou Higher Institute of Technology during the experimental period (May 26 to November 22, 2025), analyzing daily, monthly, and partial seasonal variability by identifying periods with high or low values, and evaluating the impact of temperature and humidity on irradiation. The information used in this work has already been validated by the previous article on the design and construction of a mini power plant for measuring irradiation, temperature, and humidity at the Mamou Institute of Technology [20]. Our major contribution was the introduction of the concept of daily, monthly, and seasonal variability, the correlation matrix to define the dependence of meteorological parameters and its interpretation to define the degree of this dependence, as well as the standard deviations to assess the dispersion of variable measurements.

II. MATERIALS AND METHODS

Presentation of the study area

The Mamou Higher Institute of Technology is a Guinean public higher education institution. Founded on August 25, 2004, it is located more than 4 km from the city center, in the Télico district of the urban commune of Mamou. The Mamou prefecture, where it is located, is in the center-west of the country, between 9°54' and 11°10' north latitude and 11°25' and 12°26' west longitude, with an average altitude of 700 m. The climate is of the Foutanian type, characterized by two seasons of equal length, a dry season from November to April and a rainy season with an average temperature of 25°C and an average annual potential of 4.8 kWh/m²/day [6].

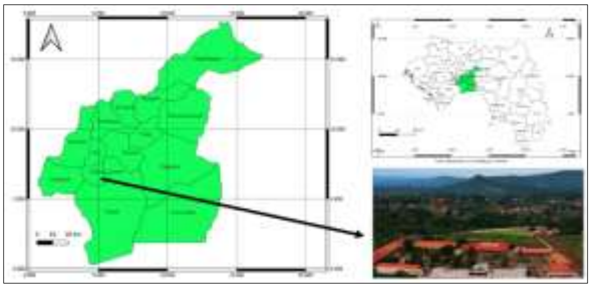

Figure 1: Administrative map of Mamou Prefecture / View of the Higher Institute of Technology

MATERIALS

The data used in this study were measured using the mini station at the Mamou Higher Institute of Technology [20]. It comprises a 2-meter mast carrying a pyranometer, a temperature and humidity sensor, two data loggers, and a photovoltaic system that provides continuous power to the system (Figure 2).

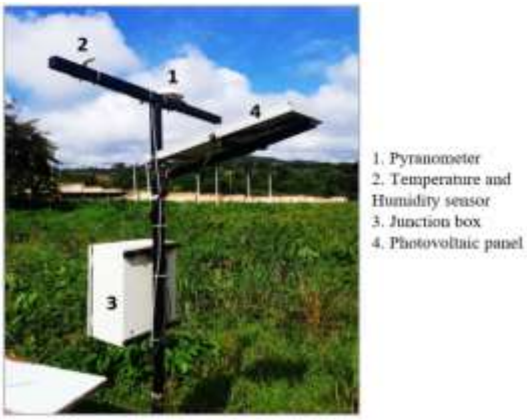

Figure 2: Mini station of the Mamou Higher Institute of Technology

METHOD

In this study, we use information on radiation, air temperature, and humidity from day/night readings taken by the Higher Institute of Technology mini weather station in Mamou. The equipment is located 2 m above the ground and calibrated for 15-minute intervals between two consecutive measurements during the period from May 26, 2024, to November 11. The data is collected in Excel and text files via two data loggers and their software [20]. When processing the information, we set a radiation threshold of 50W/m² to avoid false statistics by using the obvious (zero) values from the nighttime recordings. To qualify the dependence between irradiation and the measured meteorological parameters on the one hand, and to evaluate the variations in the daily averages of these parameters on the other, we introduced a correlation matrix, daily and monthly averages, and standard deviations. Excel and Python software were used for pre-processing, processing, graphical representations, and analysis of the information, respectively. In the data analysis, we determined the daily and monthly averages for radiation, temperature, and humidity, as well as the duration of sunshine and standard deviations to evaluate the dispersion of measurements relative to their averages during the experimental period.

III. RESULTS ET DISCUSSIONS

In this section, we present the daily and monthly averages, cumulative sunshine duration, energy production, and optimal meteorological parameters measured during the study period. Through detailed analyses, we discuss the impacts of temperature and humidity on irradiation.

RESULTS

This study, entitled "Assessment of Solar Photovoltaic Potential at the Mamou Higher Institute of Technology," covered the period from May 26 to November 22, 2025, and yielded the following results: Figures 3, 4, 5, 6, and 7 show the day/night readings taken using the mini station. 7,375 lines of information on irradiation, temperature, and humidity in a five-column Excel table; 1,770.25 hours of sunshine were recorded.

The months of May, June, and October were sunnier, with a maximum of 1619 W/m² observed on June 17 at 12:12 P.M. (Figure 3) and a daily average of 191.03 W/m². The maximum monthly average irradiation measurement was 1619 W/m² on the same date, with a threshold set at 50W/m² reached almost every day at sunrise and sunset, with high standard deviations (256.85 to 318.47). For temperature, we recorded a minimum of 14°C on November 17 and a maximum of

40°C on October 7 (Figure 4). Humidity varied little on average (76.5%, 99.9%) throughout the study period (Figure 6). Monthly average temperatures varied between 22.1°C and 24.8°C, with average humidity values between 98.8% and 99.9% for low standard deviations of 4.42°C and 1.58%. In terms of sunshine duration, we recorded a maximum of 11.50 hours on June 18 and 19 and a minimum of 64 hours in May, with a daily and monthly average of 9.73 hours and 252.89 hours (Figure 8).

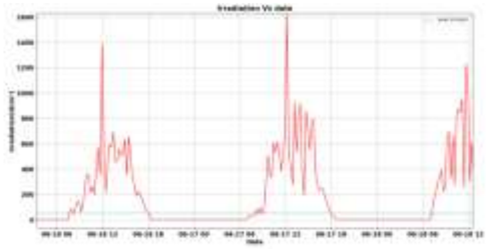

Figure 3: Maximum of radiation recorded on June 17

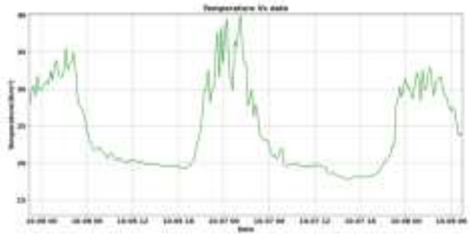

Figure 4: Maximum of temperature recorded on October 07

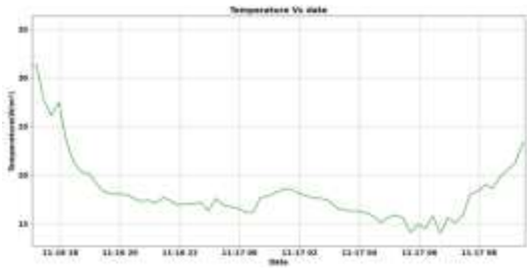

Figure 5: Lowest temperature recorded on November 17

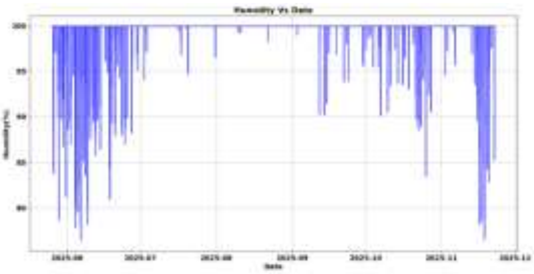

Figure 6: Humidity values recorded from May 25 to November 22

Daily Averages

During the study period, the IST mini station recorded 17,375 lines of data (date, irradiation, temperature, and humidity). In terms of daily averages, June 17 was the sunniest day with 1,619 W/m², and July 24 was the least sunny (346 W/m²). The maximum and minimum temperatures were recorded on October 7 and November 17 (40°C and 14°C) with an average of 26.31°C. The maximum humidity was almost constant (99.9%) and the minimum was 76.4%, observed on June 6. Over 182 days, a total of 1,770.25 hours of sunshine were recorded, with an average of 9.73 hours/day and a maximum of 11.50 hours/day (Figure 9).

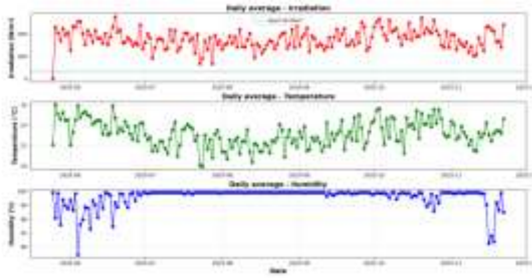

Figure 7 : Daily averages of radiation, temperature, and humidity

Irradiation had an average daily amplitude of 1084.01 W/m² with an absolute maximum of 1619 W/m². Temperature and humidity were recorded at low amplitudes (15.08°C and 4.23%) with absolute maximums and minimums of 40°C, 16.1°C, and 99.90%, 76.40%, respectively (Figure 8. a, b, and c).

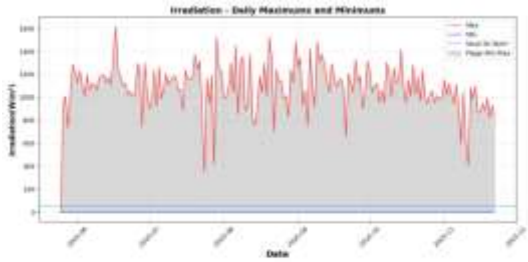

Figure 8. a) Average daily range of irradiation

(Threshold = 50W/m²)

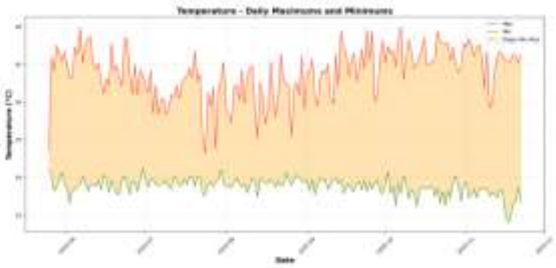

Figure 8. b) Average daily range of temperature

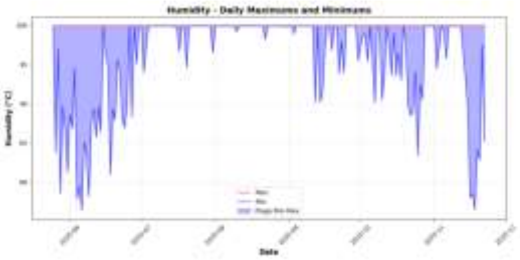

Figure 8. c) Average daily range of humidity

Sunshine duration

During the study period, we recorded 1,770.25 hours of sunshine, with a daily maximum of 11.50 hours and an average of 9.73 hours (Table 1). The sunniest month was June (310 hours) and the least sunny was May (64 hours). The average duration of sunshine is 252.89 hours/month.

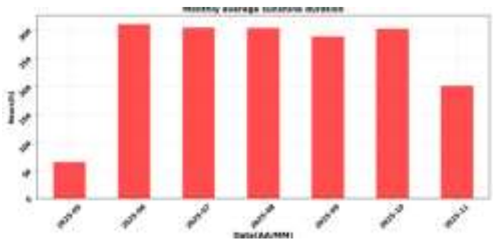

Figure 9: Monthly average sunshine duration

Monthly analyses

According to monthly averages, July, August, and September recorded low levels of solar radiation; October was sunnier (206.14W/m²) on average, with a maximum recorded value of 1412W/m²; July was the least sunny month with an average of 157.29W/m² and a maximum of 1527W/m². During May and August, the temperature dropped from 24.88°C to 22.09°C with a maximum and minimum of 40°C and 14°C. Average humidity was virtually constant at around 99%, with a minimum of 76.5% observed in November and a maximum average value of 99.9% during the study period (Figure 7). In terms of sunshine duration, June was the sunniest month (310 hours) and May was the least sunny (64 hours), with a monthly average of 252 hours. The average standard deviations were 283.60 (irradiation), 4.2, and 1.51 for temperature and humidity.

Correlation Matrix

To characterize the dependence between solar potential and measured meteorological parameters, we introduced a correlation matrix with notable values of 0.224, -0.275, -0.398 (Table 2), indicating a weak positive correlation (0.224) between temperature and irradiation, and a weak negative correlation (-0.275) between global irradiation and humidity.

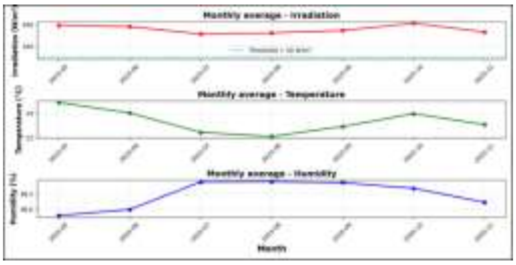

Figure 10: Monthly averages for solar irradiation, temperature, and humidity

Table 2: Correlation matric for the rainy season

	Irradiation	Temperature	Humidity
Irradiation	1,00	0,224	-0,275
Temperature	0,224	1,00	-0.398
Humidity	-0,275	-0,398	1,00

DISCUSSIONS

During the study period from May 26 to November 22, with 17,375 lines of information on radiation, temperature, and humidity, the total hourly volume of sunshine was 1,770.25 hours. Solar radiation is affected by temperature and humidity; a high radiation amplitude (1084.01 W/m²) indicating that the weather was very variable was found during this study period. However, the low temperature and humidity ranges (15.08°C and 4.23%) reflect cloudy weather with humid air and relative atmospheric stability. In terms of sunshine duration, it has been proven that the irradiation value is not necessarily due to the duration of sunshine.

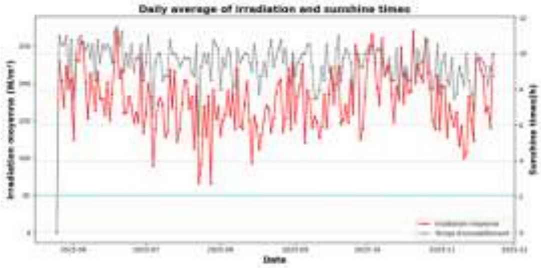

Figure 11: Variation in average irradiation relative to average sunshine duration

Impact of temperature

On average, the months of June to August show a decline in irradiation (from 191.03W/m² to 157.29W/m²) and temperature (from 24.03°C to 22.1°C); an increase in irradiation and temperature values from September to October follows a positive trend. However, November (incomplete) has very low irradiation (166.61W/m²) and a relatively moderate temperature (23.07°C), similar to September (22.9°C) with stronger irradiation of 173.3W/m².

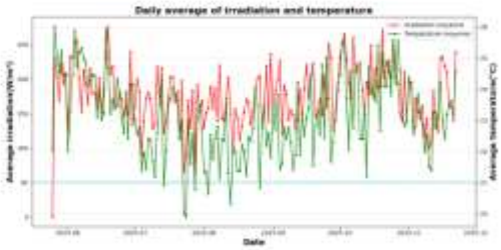

Figure 12 : Variation of irradiation with temperature

Impact of humidity

July and August recorded the highest humidity (99.89%, 99.9%) and lowest solar radiation (157.29W/m²). Conversely, May and October, when humidity is slightly lower (98.8% to 99.68%), correspond to peaks in solar radiation (197.83W/m² and 206.14W/m²).

The joint analysis confirms that humidity is the main limiting factor for irradiation in this context. The periods of very high humidity in July, August, and September (99.89%, 99.9%, and 99.87%) see a decrease in irradiation despite temperatures that could be favorable for good sunshine.

High temperatures combined with high humidity (as in May and June) lead to significant cloud cover or thunderstorms, preventing radiation from reaching its maximum. A slight drop in temperature in July and August, coupled with peak humidity, causes constantly overcast skies, resulting in the lowest radiation levels. However, a slight drop in humidity with high temperatures (as in October 99.68%; 23.96°C) would produce fairly significant radiation (206.14W/m²) compared to June (191.03W/m²).

Based on data recorded between May 26 and November 22, humidity is the factor that has the greatest influence on radiation levels. Its inverse relationship is strong and consistent: the closer the relative humidity is to saturation, the lower the radiation.

Temperature alone has a weak and non-determining influence. Its apparent effect is often masked and controlled by the effect of humidity with which it interacts. The combined effect (temperature and humidity) shows that to obtain high radiation, moderate to high temperatures must be combined with a significant drop in relative humidity (October). Conversely, high temperatures with high humidity (May, June) or moderate temperatures with very high humidity (July, August) lead to low radiation.

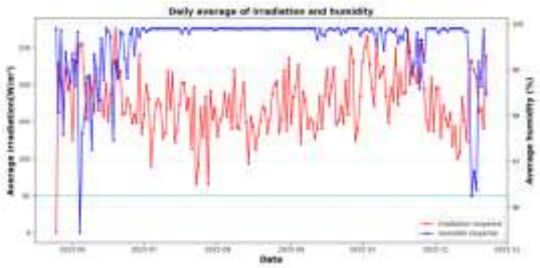

Figure 13: Variation of irradiation with humidity

From these values, we deduce that during this study period, the climate was relatively stable, with a dispersion of irradiation values reflecting remarkable variability in sunshine during the day. This proves that temperature alone cannot be a reliable predictor of irradiation, as the irradiation value is not necessarily due to the duration of sunshine. Very high relative humidity is a strong indicator of reduced irradiation. Thus, we have proven the obvious impact of humidity, which, during this study, seems to have a greater impact on irradiation than ambient temperature.

The limitation of this study is the in-depth analysis of seasonal variability, which requires information covering a period of at least two (2) to three (3) years across both seasons. However, we plan to conduct a more detailed study of the solar potential at the Mamou site, combining rainfall data, wind speed and direction data, and standard test conditions (STC) for photovoltaic panels at the Mamou Higher Institute of Technology.

IV. CONCLUSION

It is important to assess meteorological parameters such as irradiation, temperature, and humidity in a given location before embarking on renewable energy projects in general, and solar photovoltaic projects in particular. Taking this reality into account, the objective of this study was to determine, based on the observations recorded by the mini station, the global irradiation, temperature, and ambient humidity data at the Mamou Higher Institute of Technology for analysis and interpretation. This study made it possible to determine: the maximum, average, and minimum values for irradiation (1619W/m², 179.18 W/m²), temperature (40°C, 23.33°C, 14°C), and humidity (99.9%, 99.48%, 76.5%) with average standard deviations for radiation (283.6W/m²), temperature (4.42) and humidity (1.58). Sunshine lasted 1770.25 hours, with an average of 9.73 hours and a maximum of 11.5 hours. Average daily amplitudes of 1084.01W/m², 15.08°C and 4.23% for irradiation, temperature and humidity, respectively; weak positive correlation between irradiation and temperature (-0.224) and moderate negative correlation with humidity (0.275).

The information processed in this study constitutes an effective database for projects aimed at optimizing the solar potential at the Mamou site.

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