# An Investigation to Evaluate How Ambient Soil Temperature and Atmospheric Temperature Varies with Time as it Affects Thermal Resistivity Measurement 

Collins C. Chiemeke

Physics Department Federal University Otuoke, Bayelsa State, Nigeria
Email: chiemekecc@fuotuoke.edu.ng or collinsabugeo@yahoo.com
Phone: +2348035780638 or +2348078907930


#### Abstract

It has been established that ambient soil temperature influences the results of thermal resistivity survey measured at the same point, using the same equipment. Hence, the need to investigate how ambient soil temperature and atmospheric temperature varies with time is of utmost necessity. To achieve this, the temperature of a specific point in the soil was measured for a period of 24 hours. The same measurement was repeated at the same point after two days interval, under different weather conditions for 24 hours. The results were plotted for the purpose of comparison. Thermal resistivity measurements were also carried out at the same spot, targeting the extreme points of the ambient soil temperature values from the preliminary results, to confirm their effect on the measured thermal resistivity results. The results of the experiment revealed that the atmospheric temperature is a function of the sun intensity, which rises when the sun intensity is goes high, and drops rapidly when the sun intensity is lowered. It also revealed that the soil ambient temperature is not directly related to the sun intensity, it keep increasing even when the sun intensity decrease appreciably, and maintains its values even during rainfall. The ambient soil temperature remains steady between 6 am to 8 am , then increases at about 9 am , gets to the peak at about 3 pm and decrease gradually until 6 am the next morning. The result of the thermal resistivity measurement gave a clear confirmation that the value of thermal resistivity measurement determined at low ambient soil temperature is less than the thermal resistivity measurement determined at higher ambient soil temperature, in line with previous research work. The results of the ambient soil temperature survey have also shown that more consistent results of thermal resistivity measurement will be achievable in regions with more stable ambient soil temperature. This imply that, to eliminate completely the effect of ambient soil temperature variation, and get consistent results, thermal resistivity measurement should be carried out only within the acquisition time frame at depth of 0.5 m to handle the effect of daily variation, and at 6 m below the surface, to handle the effect of yearly variation. This is in line with previous research findings, which reported that, as the depth of soil increases, amplitude of temperature decreases, and that after a depth of 0.4 m , there is no diurnal variation of soil temperature, while annual variation is up to 4 m of depth, which implies also that there is no annual variation of soil temperature at a depth of 6 m .


Keywords Soil Ambient Temperature, Thermal Resistivity, Atmospheric Temperature

## Introduction

Since soil ambient temperature affect the measured results of thermal resistivity, it has therefore become very necessary to investigate how soil ambient temperature and atmospheric temperature varies with time, and how these variations affect thermal resistivity measurement. To achieve these results, the ambient soil temperature of the soil was measured at an interval of every 1 hour, for 24 hour, in 2 separate days. To confirm their effect on
thermal resistivity as reported by [2]., two thermal resistivity profiles were carried out at the same point, base on the inference derived from the results of ambient soil temperature versus time, were extremes of temperature are known to occur. The examination of previous work carried out by other researchers has shown that, ground temperature is a physical parameter that shows daily, seasonal and yearly variations, following air temperature variations. This variation is higher close to ground surface and decrease at higher depths, [8].
As the depth of soil increases, amplitude of temperature decreases. After a depth of 0.4 m , there is no diurnal variation of soil temperature. Diurnal variation of soil temperature is found up to depth of 0.4 m , whereas annual variation is up to 4 m of depth [7].
The amplitude of the diurnal variation decreases rapidly with depth and that the effect of rainfall is to decrease both the amplitude of the diurnal wave and the mean daily ground temperatures near the surface [3].
The instruments used for this survey include high precision Digital thermometer with probe, 0.08 m heating element probe, 12 volts battery, multichannel multimeter, digital stopwatch timer and a small drilling tool.

## 2. Location of study area

The study area is located at Yenagoa Bayelsa State Nigeria, with latitude $4^{\circ} 55^{\prime} 30.00{ }^{\prime \prime} \mathrm{N}$ and longitude $6^{\circ} 17^{\prime} 56.00$ " E , with an average elevation of 15 m , above sea level, after [1]. The imagery map indicating the sampled points is shown in figure 1.


Figure 1: Imagery Map showing the location of the study area

## Geology of the area

The Formation of the present Niger Delta started during Early Paleocene as a result of the built up of fine grained sediments eroded and transported to the area by the River Niger and its tributaries. The regional geology of the Niger Delta consists of three lithostratigraphic units; Akata, Agbada and Benin Formations, overlain by various types of Quaternary Deposits [6]., [9]., [4]. These Quaternary Sediments, according to [5]. are largely alluvial and hydromorphic soils and lacustrine sediments of Pleistocene age.

## 3. Data Acquisition

A specific point was identified for the purpose of this research. The humus layer was excavated to a depth of 0.1 m to reveal a fresh soil. The point was drilled to be able to accommodate the probe of the digital thermometer. The temperature of the atmosphere was determined by holding up the probe of the digital thermometer in the air for exactly 3 minutes. This is to enable the digital thermometer to sample and measure accurately the temperature of the atmosphere. The measured temperature of the atmosphere was noted. The probe of the digital thermometer was inserted into the drilled hole, and left for 3 minutes, and the resulting temperature of the soil measured with the digital thermometer was noted and recorded. The same process was repeated at interval of 1 hour, for 24 hours. For each time the ambient temperature of the soil and the corresponding atmospheric temperature were recorded.
Thermal resistivity measurements were carried at the time ( 6 am and 3 pm ) where extremes of temperature were recorded in the preliminary results of the ambient soil temperature measurement analysis. The Thermal resistivity measurements Started by excavating out the top soil majorly composed of humus organic material. The soil was dug up to a depth of 0.1 m with a shovel, followed by drilling of a hole of about 0.1 m deep. The probe made up of the thermocouple digital thermometer and heating element was inserted into the hole, and good contact between the hole and the probe was ensured. The current flowing in the circuit and voltage of the battery was measured and recorded with the help of the Digital Multimeter. The ambient temperature of the soil was recorded when the reading on the digital thermometer was steady. The circuit was completed by connecting the terminals of the heating element to the battery, at the same time the stop watch was started simultaneously. The readings on the digital thermometer after $0,5,10,15,30,45$ and 60 s were noted and recorded, subsequently readings were taken every 30 s up to 30 minutes. The recorded data were taken to the laboratory for further processing.

## 4. Data Processing

The values of the measured ambient soil temperature and atmospheric temperature with time are tabulated in table 1 and 2. The ambient soil temperature and atmospheric temperature measured at every 1 hour interval for 24 hours were plotted against time, to ascertain how they vary with time, the resulting chart are shown in figure 2 to 3 .
The data processing for thermal resistivity measurement started by entering the recorded temperature increase with time in a spreadsheet and used to plot a graph of temperature increase versus time for the two readings shown in figure 4 and 5 . The measured resistance and current flowing in the circuit were used to calculate the heat input. The heat input was used to calculate the thermal resistivity of the earth material making use of the temperature at 12 and 24 minutes respectively, that falls within the steady state of the graph. The determined thermal resistivity values were compared for magnitude.

## 5. Results

A consideration of the graphs of ambient soil temperature and atmospheric temperature versus time, shown in figure 2 , indicates that the measured atmospheric temperature at the starting point of the graph registered a value of $24.6{ }^{\circ} \mathrm{C}$ at 6 am in the morning. It then increased rapidly and unevenly because of the fluctuation of the Sun intensity until atmospheric temperature attained a maximum value of $34.6{ }^{\circ} \mathrm{C}$ after 7 hours at 1 pm . The atmospheric temperature then decreased rapidly until it dropped to a temperature of $28.5^{\circ} \mathrm{C}$ after 12 hours, at 5 pm . The atmospheric temperature then decreased gradually with slight fluctuation until it attains a temperature of $24.1^{\circ} \mathrm{C}$ after 24 hours at 6 am .

The second graph of atmospheric temperature against time started with a temperature of $24.8{ }^{\circ} \mathrm{C}$ at 5 am , it then decreased to $24.2{ }^{\circ} \mathrm{C}$ at 6 am after an hour, and increased rapidly as usual and attains an atmospheric temperature of $35.5^{\circ} \mathrm{C}$ after 5 hours at 11 am . As a result of the cloudy weather which resulted to low sun intensity, the atmospheric temperature fluctuated rapidly over an interval of 5 hours, and attained a maximum temperature of $36.7^{\circ} \mathrm{C}$ after 10 hours at 3 pm . It then decreased rapidly during a very cloudy weather, followed by a heavy rainfall to an atmospheric temperature of $23.3{ }^{\circ} \mathrm{C}$ after 12 hours at 5 pm . The atmospheric temperature then decreased steadily with an initial little fluctuation until it dropped to a temperature of $23.1^{\circ} \mathrm{C}$ after 24 hours at 5 am .
These analysis from both graph (Fig. 2 and 3), have revealed that the atmospheric temperature is majorly a function of the Sun intensity. It increases rapidly at the early hours, get to the peak temperature after an average time of 9 hours and decrease rapidly within the space of 4 hours, and taper out gradually (when the Sun is completely set) from the late evening to early part of the morning.
A close examination of figure 2 revealed that the ambient soil temperature of $27.3^{\circ} \mathrm{C}$ remained steady from the starting point of the graph, at 6 am for over a period of 2 hours. It then experienced a uniform increase at 9 am , with a consistent gradient. It then attained a maximum ambient soil temperature of $30.6{ }^{\circ} \mathrm{C}$ after 9 hours, at 3 pm . After which, the ambient soil temperature continuously moved down hill at a very steady rate with uniform gradient until the ambient soil temperature dropped to $27.3^{\circ} \mathrm{C}$.
Figure 3 registered a soil ambient temperature of $26.9^{\circ} \mathrm{C}$ at 5 am in the morning, which decreased as usual to $26.8^{\circ} \mathrm{C}$ at 6 am . A steady ambient soil temperature of $26.7^{\circ} \mathrm{C}$ was maintained from 7 am to 8 am . After which it increased steadily with a uniform slope until it attained a temperature of $30.3^{\circ} \mathrm{C}$ after 10 hours at same 3 pm . After which, the ambient soil temperature decreased at a steady rate (despite sharp drop in atmospheric temperature after a heavy rainfall), to a value of $25.6^{\circ} \mathrm{C}$ after 24 hours.
Table 1: Measured ambient soil temperature and atmospheric temperature with time, on 30th November 2019.

| Time of Measurement <br> (hrs) | Time <br> $(\mathbf{h r s})$ | Ambient Soil Temp <br> ${ }^{\mathbf{o}} \mathbf{C}$ | Atmospheric Temp <br> ${ }^{\mathbf{0}} \mathbf{C}$ | Remark |
| :--- | :--- | :--- | :--- | :--- |
| 6:00 AM | 0 | 27.3 | 24.6 | Cloudy Morning Sky |
| 7:00 AM | 1 | 27.3 | 25.1 | Sunny |
| 8:00 AM | 2 | 27.3 | 27.1 | Sunny |
| 9:00 AM | 3 | 27.6 | 30.4 | Sunny |
| 10:00 AM | 4 | 28.1 | 31.2 | Sunny |
| 11:00 AM | 5 | 28.5 | 33.4 | Sunny |
| 12:00 PM | 6 | 29.5 | 30.8 | Cloudy |
| 1:00 PM | 7 | 29.9 | 34.6 | Sunny |
| 2:00 PM | 8 | 30.5 | 34.3 | Cloudy |
| 3:00 PM | 9 | 30.6 | 33.2 | Cloudy |
| 4:00 PM | 10 | 30.3 | 31.9 | Slight Drizzling |
| 5:00 PM | 11 | 29.9 | 32.2 | Cloudy |
| 6:00 PM | 12 | 29.5 | 28.5 | Cloudy |
| 7:00 PM | 13 | 29.2 | 27.7 | Cloudy Night Sky |
| 8:00 PM | 14 | 28.9 | 27.3 | Cloudy Night Sky |
| 9:00 PM | 15 | 28.5 | 26.8 | Cloudy Night Sky |
| 10:00 PM | 16 | 28.4 | 26.5 | Cloudy Night Sky |
| 11:00 PM | 17 | 28.2 | 26.2 | Cloudy Night Sky |
| 12:00 AM | 18 | 28.1 | 26.0 | Cloudy Morning Sky |
| 1:00 AM | 19 | 27.9 | 25.8 | Cloudy Morning Sky |
| 2:00 AM | 20 | 27.8 | 25.2 | Cloudy Morning Sky |
| 3:00 AM | 21 | 27.6 | 25.3 | Cloudy Morning Sky |
| 4:00 AM | 22 | 27.5 | 25.3 | Cloudy Morning Sky |
| 5:00 AM | 23 | 27.4 | 24.9 | Cloudy Morning Sky |
| 6:00 AM | 24 | 27.3 | 25.1 |  |

Table 2: Measured ambient soil temperature and atmospheric temperature with time, on 3rd December.

| Time of Measurement <br> (hrs) | Time <br> $(\mathbf{h r s})$ | Ambient Soil Temp <br> ${ }^{\mathbf{o}} \mathbf{C}$ | Atmospheric Temp <br> ${ }^{\mathbf{0}} \mathbf{C}$ | Remark |
| :--- | :--- | :--- | :--- | :--- |
| 5:00 AM | 0 | 26.9 | 24.8 |  |
| 6:00 AM | 1 | 26.8 | 24.2 | Cloudy Morning Sky |
| 7:00 AM | 2 | 26.7 | 25.3 | Cloudy Morning Sky |
| 8:00 AM | 3 | 26.7 | 27.3 | Sunny |
| 9:00 AM | 4 | 27.1 | 30.3 | Sunny |
| 10:00 AM | 5 | 27.5 | 35.5 | Sunny |
| 11:00 AM | 6 | 28.2 | 32.3 | Sunny |
| 12:00 PM | 7 | 29.1 | 35.6 | Cloudy |
| 1:00 PM | 8 | 29.6 | 34.8 | Very Sunny |
| 2:00 PM | 9 | 30.1 | 32.1 | Cloudy |
| 3:00 PM | 10 | 30.3 | 36.7 | Cloudy |
| 4:00 PM | 11 | 30.1 | 31.8 | Very Sunny |
| 5:00 PM | 12 | 28.8 | 23.3 | Very Cloudy |
| 6:00 PM | 13 | 28.3 | 23.4 | After heavy Rain |
| 7:00 PM | 14 | 27.4 | 24.4 | Drizzling |
| 8:00 PM | 15 | 27.3 | 23.1 | Cloudy Night Sky |
| 9:00 PM | 16 | 26.9 | 24.2 | Cloudy Night Sky |
| 10:00 PM | 17 | 26.9 | 24.1 | Cloudy Night Sky |
| 11:00 PM | 18 | 26.6 | 24.1 | Cloudy Night Sky |
| 12:00 AM | 19 | 26.5 | 23.8 | Cloudy Night Sky |
| 1:00 AM | 20 | 26.4 | 23.6 | Cloudy Morning Sky |
| 2:00 AM | 21 | 26.3 | 23.5 | Cloudy Morning Sky |
| 3:00 AM | 22 | 26.1 | 23.4 | Cloudy Morning Sky |
| 4:00 AM | 23 | 25.8 | 23.2 | Cloudy Morning Sky |
| 5:00 AM | 24 | 25.6 | Cloudy Morning Sky |  |

The analysis of both graphs (Fig. 2 and 3) for ambient soil temperature has revealed that, the ambient soil temperature is not a direct function of the Sun intensity, unlike the atmospheric temperature which increases when the Sun intensity increases and vise versa. It also depicts that the ambient soil temperature from 6 am remain steady for 2 hours and then undergoes a uniform increase that climax after 9 hours at especially 3 pm , and decrease gradually through the evenings and the early morning. It was obvious that the activity of rainfall does not lower the ambient soil temperature appreciably.


Figure 2: Graph of ambient soil temperature and atmospheric temperature versus time, for table 1, on 30th November 2019.


Figure 3: Graph of ambient soil temperature and atmospheric temperature versus time, for table 2, on 3rd December 2019
The results of the thermal resistivity measurement carried out to ascertain the effect of ambient temperature on the measured thermal resistivity value is shown in Table 3 to 6 , and in figure 4 and 5 . The value of the measured Thermal Resistivity for TR1, which was measured at 6 am in the morning is $0.230811642{ }^{\circ} \mathrm{Cm} / \mathrm{W}$, while that of TR2 measured at 3 pm in the late afternoon is $0.372969243{ }^{\circ} \mathrm{Cm} / \mathrm{W}$. The difference between the two thermal resistivity determined at different time, but in the same place, using the same instrument without moving the instrument is $0.142157601{ }^{\circ} \mathrm{Cm} / \mathrm{W}$. It was obvious that the thermal resistivity TR2 determined at an ambient soil temperature of $25.9^{\circ} \mathrm{C}$ was higher than the thermal resistivity value determined at a temperature of $23.7^{\circ} \mathrm{C}$ by a value of $0.142157601^{\circ} \mathrm{Cm} / \mathrm{W}$.

Table 3: Data Acquisition Parameters for TR1

| Heat Input Parameters | Heat Input Parameters Values |  |
| :--- | ---: | ---: |
| Current (A) | 0.1604 |  |
| Resistance (Ohms) | 73.3 |  |
| Voltage (V) | 12.46 |  |
| Length of probe (m) | Heat Input q (W/m) |  |
|  |  | 23.5734266 |
| Heat input Calc using Current and Resistance | $6 \mathrm{th} / 12 / 2019$ |  |
| Date | 27.3 |  |
| Ambient Soil Temperature | 6 am |  |
| Time of Recording |  |  |

Table 4: Measured temperature increase with time for TR1

| $\mathbf{S} / \mathbf{N}$ | Time <br> $(\mathbf{s})$ | Temperature <br> ${ }^{\mathbf{0}} \mathbf{C}$ | $\mathbf{S} / \mathbf{N}$ | Time (s) | Temperature ${ }^{\mathbf{0} \mathbf{C}}$ | $\mathbf{S} / \mathbf{N}$ | Time <br> $(\mathbf{s})$ | Temperature <br> ${ }^{\mathbf{0}} \mathbf{C}$ |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| 1 | 0 | 23.7 | 23 | 540 | 25.9 | 45 | 1200 | 26.3 |
| 2 | 5 | 23.7 | 24 | 570 | 25.9 | 46 | 1230 | 26.3 |
| 3 | 10 | 23.7 | 25 | 600 | 25.9 | 47 | 1260 | 26.3 |
| 4 | 15 | 23.9 | 26 | 630 | 26.0 | 48 | 1290 | 26.3 |
| 5 | 30 | 24.1 | 27 | 660 | 26.0 | 49 | 1320 | 26.3 |
| 6 | 45 | 24.1 | 28 | 690 | 26.0 | 50 | 1350 | 26.4 |
| 7 | 60 | 24.3 | 29 | 720 | 26.1 | 51 | 1380 | 26.4 |
| 8 | 90 | 24.7 | 30 | 750 | 26.1 | 52 | 1410 | 26.4 |
| 9 | 120 | 24.9 | 31 | 780 | 26.1 | 53 | 1440 | 26.4 |
| 10 | 150 | 25.0 | 32 | 810 | 26.1 | 54 | 1470 | 26.4 |
| 11 | 180 | 25.1 | 33 | 840 | 26.1 | 55 | 1500 | 26.5 |
| 12 | 210 | 25.2 | 34 | 870 | 26.1 | 56 | 1530 | 26.5 |

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| 13 | 240 | 25.3 | 35 | 900 | 26.1 | 57 | 1560 | 26.5 |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| 14 | 270 | 25.4 | 36 | 930 | 26.1 | 58 | 1590 | 26.5 |
| 15 | 300 | 25.6 | 37 | 960 | 26.1 | 59 | 1620 | 26.5 |
| 16 | 330 | 25.6 | 38 | 990 | 26.3 | 60 | 1650 | 26.6 |
| 17 | 360 | 25.6 | 39 | 1020 | 26.3 | 61 | 1680 | 26.6 |
| 18 | 390 | 25.7 | 40 | 1050 | 26.3 | 62 | 1710 | 26.6 |
| 19 | 420 | 25.7 | 41 | 1080 | 26.3 | 63 | 1740 | 26.6 |
| 20 | 450 | 25.8 | 42 | 1110 | 26.3 | 64 | 1770 | 26.7 |
| 21 | 480 | 25.8 | 43 | 1140 | 26.3 | 65 | 1800 | 26.7 |
| 22 | 510 | 25.8 | 44 | 1170 | 26.3 | Thermal Resistivity $0.230811642{ }^{\circ} \mathrm{Cm} / \mathrm{W}$ |  |  |



Figure 4: Graph of Temperature ${ }^{\circ} \mathrm{C}$ versus time for TR1.

Table 5: Data Acquisition Parameters for TR2

| Heat Input Parameters | Heat Input Parameters Values |
| :--- | :--- |
| Current (A) | 0.1629 |
| Resistance (Ohms) | 73.3 |
| Voltage (V) | 12.46 |
| Length of probe (m) | 0.08 |
|  | Heat Input q (W/m) |
| Heat input Calc using Current and Resistance | 24.31398566 |
| Date | $6 \mathrm{th} / 12 / 2019$ |
| Ambient Soil Temperature | $25.9^{\circ} \mathrm{C}$ |
| Time of Recording | 3 pm |

Table 6: Measured temperature increase with time for TR2

| S/N | Time <br> $(\mathbf{s})$ | Temperature <br> ${ }^{\mathbf{0}} \mathbf{C}$ | $\mathbf{S / N}$ | Time (s) | Temperature ${ }^{\mathbf{}} \mathbf{C} \mathbf{C}$ | S/N | Time <br> $(\mathbf{s})$ | Temperature <br> ${ }^{\mathbf{o}} \mathbf{C}$ |
| :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- | :--- |
| 1 | 0 | 25.9 | 23 | 540 | 28.1 | 45 | 1200 | 28.6 |
| 2 | 5 | 25.9 | 24 | 570 | 28.2 | 46 | 1230 | 28.6 |
| 3 | 10 | 25.9 | 25 | 600 | 28.2 | 47 | 1260 | 28.6 |
| 4 | 15 | 26.0 | 26 | 630 | 28.2 | 48 | 1290 | 28.6 |
| 5 | 30 | 26.3 | 27 | 660 | 28.2 | 49 | 1320 | 28.8 |
| 6 | 45 | 26.6 | 28 | 690 | 28.3 | 50 | 1350 | 28.8 |
| 7 | 60 | 26.8 | 29 | 720 | 28.3 | 51 | 1380 | 28.8 |
| 8 | 90 | 27.1 | 30 | 750 | 28.3 | 52 | 1410 | 28.8 |
| 9 | 120 | 27.3 | 31 | 780 | 28.3 | 53 | 1440 | 28.8 |
| 10 | 150 | 27.5 | 32 | 810 | 28.4 | 54 | 1470 | 28.8 |
| 11 | 180 | 27.5 | 33 | 840 | 28.4 | 55 | 1500 | 28.8 |
| 12 | 210 | 27.7 | 34 | 870 | 28.4 | 56 | 1530 | 28.8 |
| 13 | 240 | 27.7 | 35 | 900 | 28.4 | 57 | 1560 | 28.8 |
| 14 | 270 | 27.8 | 36 | 930 | 28.5 | 58 | 1590 | 28.8 |
| 15 | 300 | 27.8 | 37 | 960 | 28.5 | 59 | 1620 | 28.8 |
| 16 | 330 | 27.9 | 38 | 990 | 28.5 | 60 | 1650 | 28.8 |
| 17 | 360 | 27.9 | 39 | 1020 | 28.5 | 61 | 1680 | 28.8 |
| 18 | 390 | 27.9 | 40 | 1050 | 28.5 | 62 | 1710 | 28.8 |
| 19 | 420 | 28.1 | 41 | 1080 | 28.5 | 63 | 1740 | 28.8 |
| 20 | 450 | 28.1 | 42 | 1110 | 28.5 | 64 | 1770 | 28.8 |
| 21 | 480 | 28.1 | 43 | 1140 | 28.5 | 65 | 1800 | 28.8 |
| 22 | 510 | 28.1 | 44 | 1170 | 28.6 |  | Thermal Resistivity | $0.372969243{ }^{\circ}{ }^{\circ} \mathrm{Cm} / \mathrm{W}$ |



Figure 5: Graph of Temperature ${ }^{\circ}$ C versus time for TR2

## 6. Conclusion

This Research has shown that atmospheric temperature is majorly a function of the Sun intensity, it increases when the Sun intensity is high and decrease rapidly when the Sun intensity is low. It has also revealed that the soil ambient temperature is not a direct function of the Sun intensity, it keep increasing and maintain its value even when the intensity of the Sun drop appreciably, or during rainfall. The ambient soil temperature remains steady between 6 am to 8 am , then increases at about 9 am , gets to the peak at about 3 pm and decrease gradually until 6 am the next morning. The result of the thermal resistivity measurement confirmed that the value of thermal resistivity measured at low soil ambient temperature is lower than the equivalent thermal resistivity value measured at high temperature in line with the findings of [2]. The results of the ambient soil temperature survey have also shown that more consistent results of thermal resistivity measurement will be achievable in regions with more stable ambient soil temperature. This connote that, to eliminate completely the effect of ambient soil temperature variation, and get consistent results, thermal resistivity measurement should be carried out only within the acquisition time frame at depth of 0.5 m to handle the effect of daily variation, and at 6 m below the surface, to handle the effect of yearly variation. This is in line with the report of [7]., which reported that, as the depth of soil increases, amplitude of temperature decreases, and that after a depth of 0.4 m , there is no diurnal variation of soil temperature, while annual variation is up to 4 m of depth, which implies also that there is no annual variation at depth of 6 m .

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