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# Estimating Soil temperature from Air temperature in the North, Middle West and South of Iraq

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## **ARTICLE INFO**

ABSTRACT

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### Keywords

Soil temperature, Air temperature, Station Automatic Weather, Correlation.

Estimating soil temperature from air temperature is very necessary in some areas that are difficult to reach for the purpose of measuring soil temperature. In this research There are three Station Automatic Weather were selected in the study areas located in the North (Almosul), Middle (Abu-Ghraib), west (Hadethaa) and South (Alkahlaa) of Iraq (36.33° N, 43.16° E), (33.32° N, 44.23° E), (42.00°N, 34.35°E), (47.19°N, 31.80° E) respectively. The results referred to strong relationships between the averaged daily air temperature and averaged daily soil temperature at the 10 cm depth for sites. The correlations ( $\mathbb{R}^2$ ) values were very high 0.93, 0.939, 0.980, 0.937 in Almosul, Abu-Ghraib, Hadethaa and Alkahlaa sites respectively. Linear equations to estimate soil temperature from air temperature were y=1.274x-6.517 in the north of Iraq, y=1.084x-0.305 in the middle of Iraq, y=1.065x+0.154 in the west of Iraq, y=0.849x+5.14 in the south of Iraq.

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### Introduction

Soil temperature is a factor of primary importance for many physical, chemical, and biological processes. It governs, Evaporation and soil aeration, All kind of chemical processes and reactions within the soil and Biological processes such as seed germination, seedling emergence and growth, root development, microbial activity(Hillel, 1982).

Soil temperature fluctuates annually and daily affected mainly by variations in air temperature and solar radiation. The annual variation of daily average soil temperature at different depths can be estimated using a sinusoidal function (Hillel, 1982; Marshall and Holmes, 1988; Wu and Nofziger, 1999).

Many analyses of soil temperature are based on the theories of heat flow and energy balance (Campbell 1977, Parton 1984, Stathers et al. 1985, Nobel & Geller 1987, Thunholm 1990). The mathematical model suggested from klueneder et al 1993 was used by Alani 1995 to estimated soil temperature in some area of Iraq by the following equation.

Cos sum=  $cos(2\pi/365)$  (Day of year)

 $\sin \text{sum} = \sin(2\pi/365)$  (Day of year)

where  $\cos = \cos in$ ,  $\sin = \sin e$ ,  $\pi = Pi$ .

In the general (or standard) form the linear equation is written as:

$$Ax + By = C,$$

where A and B are not both equal to zero. The equation is usually written so that  $A \ge 0$ , by convention. The graph of the equation is a straight line, and every straight line can be represented by an equation in the above form. If A is nonzero, then the x-intercept, that is, the x-coordinate of the point where the graph crosses the x-axis (where, y is zero), isC/A. If B is nonzero, then the y-intercept, that is the y-coordinate of the point where the graph crosses the y-axis (where x is zero), is C/B, and the slope of the line is -A/B. The general form is ax + by + c = 0sometimes written as:

where a and b are not both equal to zero. The two versions can be converted from one to the other by moving the constant term to the other side of the equal sign, Slope-intercept form y = mx + b,

where m is the slope of the line and b is the y intercept, which is the v coordinate of the location where the line crosses the y axis. This can be seen by letting x = 0, which immediately gives y = b. It may be helpful to think about this in terms of y = b + mx; where the line passes through the point (0, b) and extends to the left and right at a slope of m. Vertical lines, having undefined slope, cannot be represented by this form (Barnett, Ziegler & Byleen 2008). There are few studies on the estimating soil temperature in Iraq, thus this study aims to:

1. Show the relationship between air temperature and soil temperature.

2. Estimating soil temperature by linear equation at a specific air temperature.

#### **Materials and Methods**

#### Description of the Study Area/ Location and area

The study area located in the North, Middle and South of Iraq on longitude 36° 11' 24" North 44° 06' 00" East, 36° 11' 24" North 44° 06' 00" East, 42.00°North, 34.35°East and 35°40'00" North 45°30'0" East, respectively(fig.1).



Figure 1. Shows the study area sites

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#### **Data collection**

There are three Automatic Weather Station were selected north, middle and south of Iraq. data were collected from Iraqi agro meteorology network in ministry of agriculture, daily Air and soil temperature degrees for two years 2013, 2014 then.

- Draw the changes between air temperature degrees monthly.
- Draw the changes between soil temperature degrees monthly.

• Find linear equation between air temperature and soil temperature.

• Test linear equation to estimate soil temperature.

#### **Result and Discussion**

The results referred to strong relationships between the averaged daily air temperature and averaged daily soil temperature at the 10 cm depth for sites. in north of Iraq (Almosul site) High air temperatures were (37.41 C°, 40.55 C°) on August 29 2013, August 19 2014 respectively, high soil temperatures recorded (40.04 C°, 43.11 C°) on July 23 2013, July 4 2014 respectively, While low air temperatures were (4.27C°, 5.53 C°) on January 12 2013, Feb 5 2014 respectively, low soil temperatures recorded (4.60 C°, 6.51 C°) on Feb 5 2013, Feb 7 2014 respectively figures 2, 3, 4, 5. In middle of Iraq (Abu-Ghraib) site, High air temperatures were (37.41 C°, 40.55 C°) on August 29 2013, August 19 2014 respectively, high soil temperatures recorded (39.10 C°, 42.34 C°) on August 2013, August 20 2014 respectively, While low air 15 temperatures were (5.12C°, 5.53C°) on December 17 2013, Feb 5 2014 respectively, low soil temperatures recorded (4.60 C°, 6.51 C°) on Feb 5 2013, Feb 7 2014 respectively figures 6, 7, 8, 9. in west of Iraq (Hadethaa site) High air temperatures were (36.70 C°, 38.09 C°) on July 10 2013, August 18 2014, respectively, high soil temperatures recorded (38.54 C°, 43.11 C°) on July 25 2013, August 19 2014 respectively, figures 10, 11,12,13. While low air temperatures were (3.32 C°, 4.06 C°) on January 11 2013, Feb 5 2014 respectively, low soil temperatures recorded (4.82 C°, 6.51 C°) on January 11 2013, Feb 7 2014 respectively figures 14, 15, 16,17.In south of Iraq (Alkahlaa site) high air temperatures were (41.80 C°, 39.70 C°) on July 17 for each year 2013, 2014(same temperature), high soil temperatures recorded (38.82 C°,36.60 C°) on July 18 2013, July 31 2014 respectively. While low air temperatures were (5.80 C°, 11.84 C°) on January 8 for each year 2013, 2014(same temperature), low soil temperatures recorded (10.35 C°, 5.80 C°) on January 17 2013, January 8 2014 respectively figures 14, 15, 16, 17. these changes between air temperature and soil temperature because Soil temperature changes more slowly than the air temperature, so there is always a lag time between the extremes of air temperatures and soil temperatures. Because of daily temperature fluctuations, the soil could be cooler than the air in the daytime and warmer than the air in the nighttime (http: //www. vernier. Com /products/ books/esv/.). The correlations  $(R^2)$  values were very high 0.93, 0.939, 0.980, 0.937 in Almosul, Abu-Ghraib, Hadethaa and Alkahlaa sites respectively figure (18,19, 20, 21), table(1).



Figure 2. Air temperature average monthly for year 2013



#### North of Iraq air temprature 2014 50.00 40.00 30.00 20.00 10.00 Air temprature 0.00 average 2014 7/21/2014 8/21/2014 9/21/2014 2/21/2014 3/21/2014 5/21/2014 \$/21/2014 0/21/2014 1/21/2014 4/21/2014 2/21/201 121120

Figure 4. Air temperature average monthly for year 2014

North of Iraq soil temprature 2014



Figure 5. Soil temperature average monthly for year 2014







Figure 7. Soil temperature average monthly for year 2013



Figure 12. Air temperature average in west of Iraq



Figure 17. Soil temperature average monthly for year 2014



Figure 18. Air temperature and Soil temperature in north of



Figure 19. Air temperature and Soil temperature in Middle of Iraq



Figure 20. Air temperature and Soil temperature in west of



Figure 21. Air temperature and Soil temperature in south of Iraq

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Linear Equations	correlation	Sites
y=1.274x-6.517	$R^2 = 0.929$	North(Almosul)
y=1.084x-0.305	$R^2 = 0.939$	Middle(Abu-Ghraib)
y=0.849x+5.14	$R^2 = 0.937$	South(Alkahlaa)
y=1.056x+0.154	$R^2 = 0.980$	West(Haditha)

#### Conclusion

Strong relationships between the averaged daily air temperature and averaged daily soil temperature at the 10 cm depth for sites. The correlations were very high between air temperature and soil temperature in Almosul, Abu-Ghraib and Alkahlaa sites. Soil temperature Changes in mid summer and winter very slowly when air temperature change, Linear equations to estimate soil temperature from air temperature y=1.274x-6.517 in the north of Iraq, y=1.084x-0.305 in the middle of Iraq, y=0.849x+5.14 in the south of Iraq. **References** 

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