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ORIGINAL ARTICLE

Mapping of Soil Temperature at Various Depths using Satellite imagery (Case study TUYSERKAN Basin)

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ABSTRACT
Soil temperature and how it changes over time and space is one of the most important factors that not only affect the exchange of matter and energy in the soil but the magnitude and direction of all physical processes of soil temperature are directly related to. In addition, evapotranspiration, germination, soil conditioners, plant growth, root activity and soil micro-organisms are the temperature function to estimate soil temperature. For study of different depths (5,10,20, 30, 50,100 cm) soil in TUYSERKAN station in 2014 and was carried out in may month. This article has been using satellite imagery bands of MODIS images at first determine soil surface temperature (LST) and then use the formula to calculate the temperature; soil temperature at different depths of soil depth map is drawn. Its relationship with surface temperature and soil type are examined. Results indicate that the soil temperature at a depth of 5 cm has a maximum and 100 cm depth changes due to the remoteness of the lowest elements of climate .
Keywords: soil temperature, soil heat flux, net radiation, surface temperature, TUYSERKAN

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INTRODUCTION

Soil temperature influenced by several factors, including topography, radiation, moisture, soil type and soil thermal properties such as heat capacity, thermal conductivity and specific heat is a factor. Soil temperature and how it changes over time and space is one of the most important factors that not only affect the exchange of matter and energy in the soil., but the magnitude and direction of all physical processes of soil temperature are directly related to. In addition, evapotranspiration, germination, soil conditioners, plant growth, root activity and soil micro-organisms that is temperature dependent. Growing plants takes place only within a certain range of temperature and temperature are favorable to any grassy area. The optimum temperature varies depending on the stage of plant growth. Effect of soil temperature on soil interactions has been demonstrated. Chemical and biological activity in the soil cool is very slowly. Soil temperature at any time depends on the amount of energy absorbed and dissipated. Differences of seasonal temperatures, even in the depths of the soil may be appear but underneath the surface layers of soil temperature fluctuations greater than indicated. Overall, the average soil temperature at a depth of 15 cm in each season of the year warmer than air. But in spring and summer and it is contrary to the thermal conductivity is slowly being carried out. The daily data suggests the soil is greater than the air temperature changes. Changes in soil temperature is gradual except in the case of air may be more temperature in a short time. Temperature changes than soil how time and the work is not the most important factor that affects not only the exchange of matter and energy in the soil, but also can be said for all levels and soil physical processes related to temperature directly and indirectly involved. Soil temperature and the processes of evaporation transpiration, soil conditioner, seed

germination, plant growth, root development and activity of soil microorganisms play an important role. [1]. Well as the soil temperature is closely related to the depth of frost penetration.
Measurement temperature soil at stations with types different sensors and or ordinary thermometers form develops. but measure temperature soil the sensor cost on been and to force human skilled and continuous monitoring need there. for determination changes place temperature soil deep different several sensors and or thermometer different need it is. Therefore, offer methods statistical experimental that able to offer results available accept at determine soil temperature , its can way solution is good the estimate this variable at points lacking size making [2].

MATERIALS AND METHODS

Specifications of area case study

Area case study field is Tuyserkan basin. The area was a station synoptic to registration data of temperature level available 's. Satellite data used to determine the surface temperature is in May 2014. Whose raw images were downloaded and processed the initial area of the website includes the reference bands of MODIS images, cloud, eliminating errors were performed on an image overlay.

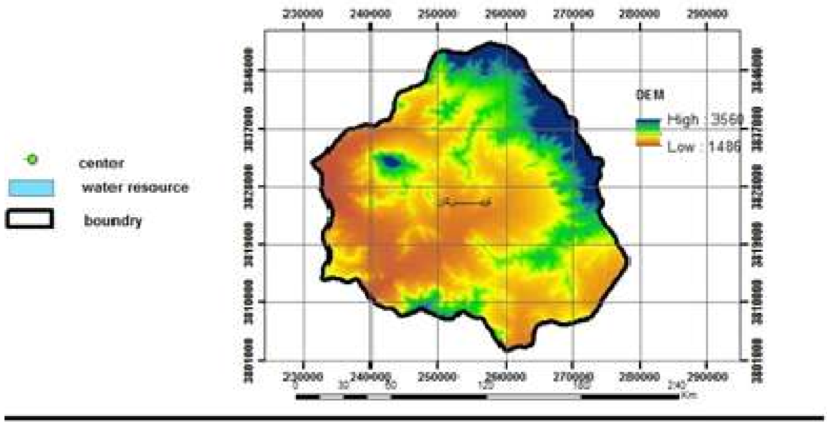

Fig 1: location of the study area

At area of watershed temperature level on information station data synoptic and climatology and the stati - on of evaporation poll measurable conclusion the be, with Attention to distribution a few points station data always determine temperature at allareas areaproblem a difficult and of accuracy acceptable have is not.Application data remotesensing at extraction information climatic measuresis the recently case attent ion researchers from are.Info result of satelliteimages a with attention to cover spatial it levels differentar ea absence information spatial andno accuracy at estimate parameters climatic remove the makes.'s the Research temperature level some method on based information off poll tuyserkan area calculation and case analysis analysis be from.

Surface temperature

Temperature level results balance thermodynamic conditions is the by balance energy between atmosphere, level and layer subsurface soil effect energy radiation level to atmosphere the release capability called and the related composition roughness level and parameters physical level, such as of moisture control it is. Therefore estimate the exact and quantitative of temperature level the need to effects separate temperature and radiation at radiance reached to sensor it is. Waves reached to the sensor the at size conclusion of air and space available access is usually brightness temperature called it is. Ago of the brightness temperature case use be is should to radiation waves of level earth calibration be. Bands of MODIS imagery to estimate surface temperature and terra satellites were used.

Table 1: information about the use of satellite imagery (bands of modis website)

Satellite	Sensor	Shooting date	Time imaging
Terra	MODIS	8 may 2014	8:30

In order to estimate the surface temperature is needed for the correction of geometric and atmospheric corrections are applied on the image. SEBAL model of actual evapotranspiration using satellite imagery and ground-based minimum data required to calculate the energy balance equation. Since satellite images can provide information on the satellite pass time so SEBAL model can flux amount of dirt, flux, net radiation and sensible heat flux estimates at the time the image.

λ et = RN - G - H (1)

In the above equation, λ e latent heat flux (w/m2), rn the net radiation flux at the surface (w/m2), soil heat flux (w/m2), h the sensible heat flux (w/m2) is.

According to studies and research conducted by other researchers in relation to the earth's surface temperature is estimated to be between 5 and surface temperature estimation algorithm, the algorithm of cosilis et al cole [3] has better results than the surface temperature is estimated by the proposed algorithm. This purpose in the research algorithms used. Since the atmosphere at different wavelengths, different reactions to the show or daily multi-band method to remove atmospheric widely separated, is used. Due to the existence of two close to each other thermal band (thirty-one of the bands, 32), the bands of modis images can be corrects the image sensor can also be used. Surface temperature is needed to estimate the brightness temperature for the thermal bands (bands 31 and 32) is calculated. Temperature, lighting, temperature, radiant energy from the corresponding level is a phenomenon by the sensor. Temperature due to diffusion and absorption phenomena in the atmosphere is less than the temperature at ground level. Reverse the value of Planck equation .is calculated as follows [4]:

(2) $t_{b-n} = \frac{C_2}{\Lambda \ln(1+\frac{c_1}{\Lambda^5 L_{\lambda n}}}$

In this equation n bond issue, tb-n-band brightness temperature n (k), lλ spectral emission band n, λ is the mean wavelength thermal infrared band n (μm), c1 = 1.191066 * 108 and c2 = 1.438 * 104 be.

Spectral irradiance in each band (LΛ) is to be calculated using the following equation.(3) $l_{\lambda} = \text{radiance\_scale}(si - \text{radiance \_offset})$

Radiance-scale values and radiance-offset and re-suspended metadata files that accompany the various bands of MODIS images to be obtained in respect of MATLAB software. SI is raw amount of image .

Surface temperature using equation was calculated as follows:

(4) $lst = 0.39t_{31}^2 + 2.34t_{31} - 0.78t_{31}T_{32} - 1.34t_{32} + 0.39t_{32}^2 + 0.56$

In the above equation, t is the kelvin temperature of the light bands 31 and 32.

Calculation of deep temperatures

Temperature, surface temperature can be calculated by using the depth is important because the temperature of the thermal remote sensing of land surface temperature measured at the depth is very important. If the soil temperature at any time of day or night in the depth of the soil surface to compute z [t (z, t)], we use the following equation.

(5) t (z, t) = tavg + a. [sin (ω t-(z / d)] e (-z / d)

Tavg = average surface temperature a, = amplitude of temperature change t, = time = ω, the angular frequency of the actual frequency is equal to π 2.'s ω = 2 π/86400 = 7.27 * 10-5 sec., this equation has two factors z depth and the death depth. Deep depth is the temperature during the day and night temperature changes at the surface are 0.37. [5]. Depths damped oscillation frequency depends on temperature and soil thermal features and is calculated according to the following equation:

(6) d = [2k/cv (ω)] $^{0.5}$ = 92dh / ω) 0.5

In this regard, the heat diffusion coefficient dh, k thermal conductivity, cv is the specific heat, temperature fluctuations in the volume and frequency ω.

Soil heat flux:

Soil heat flux heat transfer rate at the molecular conductivity of soil and vegetation. Than the direct calculation of soil heat flux using satellite SEBAL first problem is the way towards the G/ RN half by using the on empirical equation submitted by BASTYANSN (2000) was calculated as follows [6]:

(7) $\frac{g}{rn} = \frac{Ts}{\alpha}(0.0038\alpha + 0.0074\alpha^2)(1 - 0.98ndvi^4)$

The above equation is the surface temperature and α is surface albedo. G /RN is obtained by multiplying the above ratio. NDVI value less than zero if the surface water is considered equal to the ratio of 0.5 to be considered.

Results

According to equations and algorithms listed below the map was drawn., one of the most important cases in this study, mapping the spatial distribution of land surface temperature in the region in figure is evidenced by the minimum and maximum surface temperature tuyserkan area of 288 -318 degrees kelvin. Temperature according to the type of ground cover (3) and land use and soil type is a difference. In areas where vegetation is the difference between the highest surface temperature is about 305 degrees Kelvin. NDVI index in this region is greater than 0.5., in areas where the NDVI index is less than 0.2 at higher surface temperatures in the highlands of the temperature gradient surface temperature reaches a minimum of about 288 degrees Kelvin. In NDVI greater than 0.5 in this study was defined as areas with dense vegetation. Drawn as is evident from the images and maps of vegetation has caused temperatures in the region.

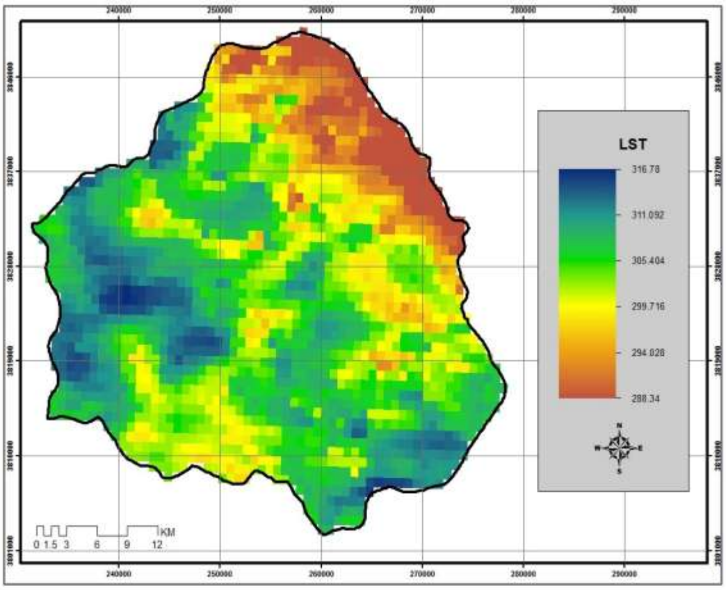

Fig (2) maps of land surface temperature for may 2014

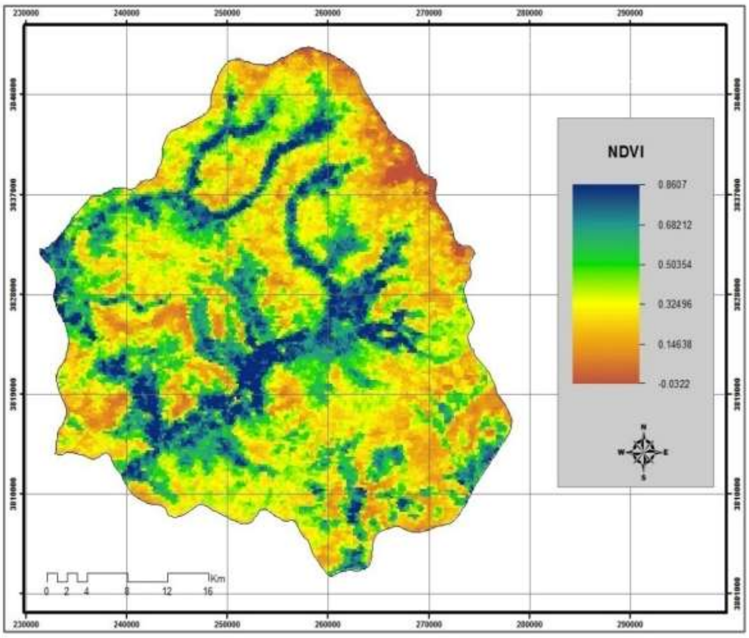

Fig 3 Normalized difference vegetation index map, may 2014

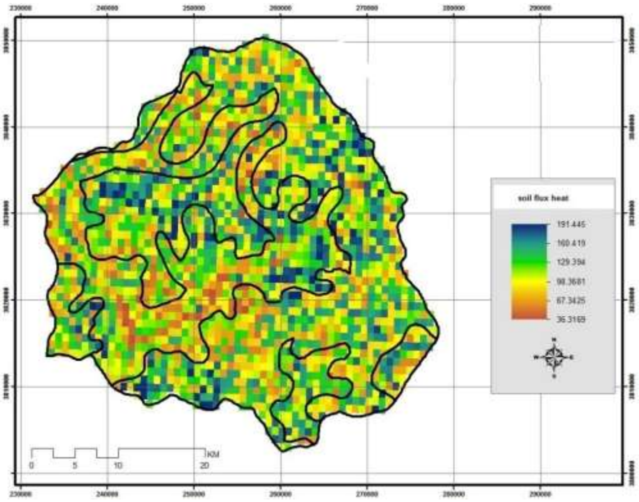

Fig (4) the spatial distribution of soil heat flux

Soil flux heat map using the values of the net radiation and surface vegetation index (NDVI) are achieved. Figure (4).

Soil heat flux is a function of surface temperature, the higher the temperature difference between surface and sub-surface soil temperature increases., which increases the amount of soil heat flux. Figure (4) low values indicate colder soil flux heat of the earth's surface to heat the soil in these areas. Figure is observed at lower temperatures are mountainous areas around the region. From a height of this and the lack of coverage plant in these areas lower than 0.3. Within the area we're seeing lower levels, which is probably due to soil moisture. Referring to the drawings can be seen that the surface temperature of the areas we lower surface, the heat flux values are lower.

Curve reflection spectral more soil thanks, other of soil clay with plan general and uniform the is and with increase length wave of reflection the increments. Curve soil clay at bands absorption water with drop severe reflection been and the state of property soil clay at maintenance humidity, due the showed. If soil containing materials organic is to cause dark be at spectrum visible with reflection small will was [7]. Hourly changes in surface temperature, changes since the solar energy reaching the soil surface to a depth of each phase, but we are slower to change. So that there are similar variations during many days. And the slow process of change is observed in the same night. Changes in air temperature at a height of 120 cm from the soil surface temperature swing changes, especially after sunset and a night. Temperature of the soil surface temperature in the depths of the same changes soil., but compare the curve changes with temperature indicates that the deep temperature drop of the temperature fluctuations have decreased with increasing depth, and time delay, respectively, at a depth of 40 cm. In depth, temperature soil, is a constant 3 yards.

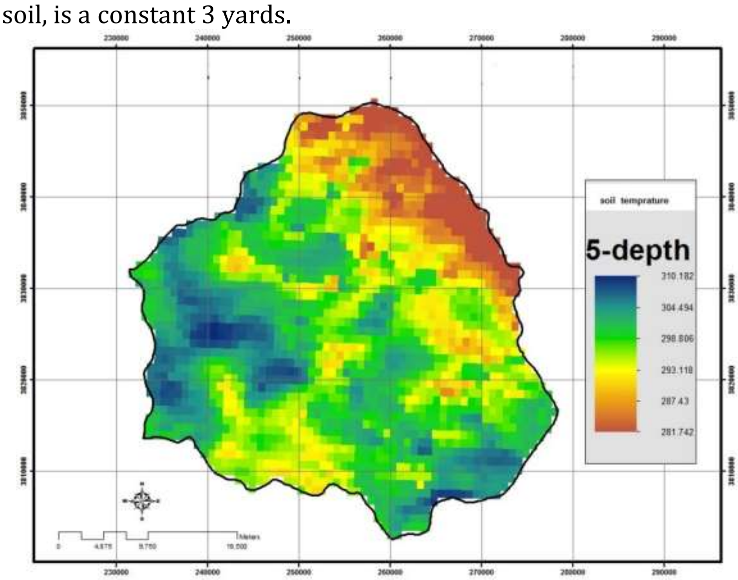

Figure (6) maps, soil temperature at 5 cm depth

According to figure 2 and map the distribution of surface temperature, soil temperature at 5 cm depth is the greatest changes to the surface .minimum and maximum soil temperature in the region reaches 284-312 degrees Kelvin., which is to change the surface temperature of 5 degrees Kelvin.

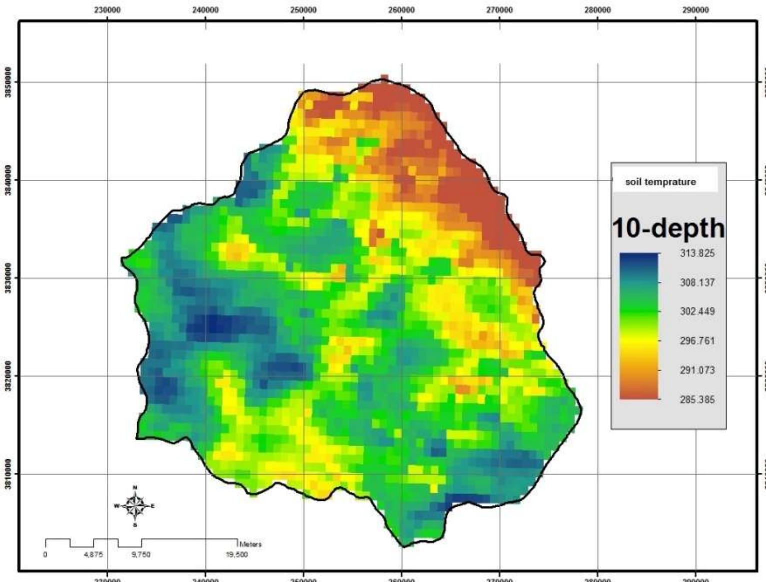

Figure (7) maps, soil temperature at a depth of 10 cm.

Changes in soil temperature at various depths are plotted in figures 6-10. Due to the earth's surface temperature map (fig. 2) and map 5-100 cm soil temperature at a depth of 5 cm and a maximum variation of mf 10-20-30-50 and 100, respectively, with minimal temperature variations over the surface temperature be.

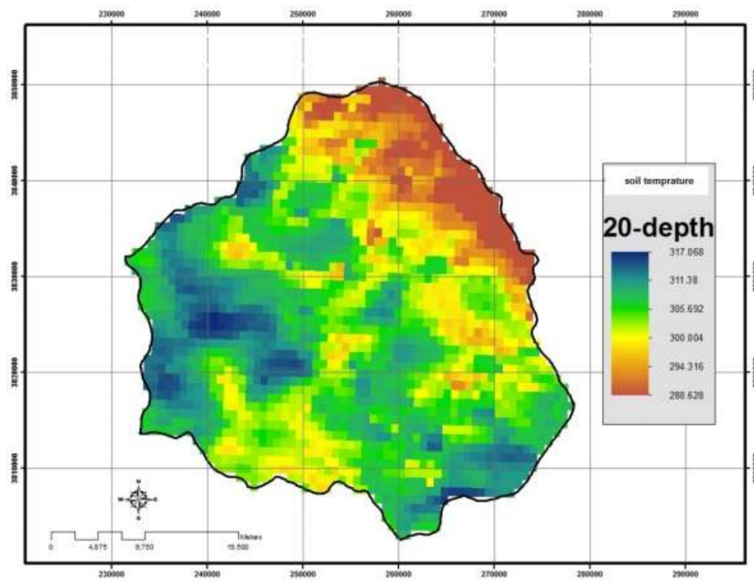

Figure (8) soil temperature at 20 cm depth

Soil temperature at any time depends on the amount of energy absorbed and dissipated. Differences of seasonal temperatures, even in the depths of the soil may be there but underneath the surface layers of soil temperature fluctuations greater than indicated. Overall, the average soil temperature at a depth of 15 cm in each season of the year warmer than air, but in spring and summer and it is contrary to the thermal conductivity is slowly being carried out. The daily data suggests the soil is greater than the air temperature changes. Changes in soil temperature is gradual except in the case of air may be more temperature in a short time.

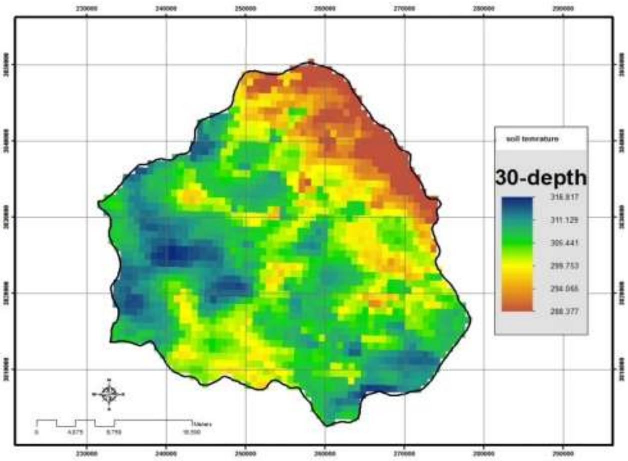

Fig (6) Soil temperature at a depth of 30 cm.

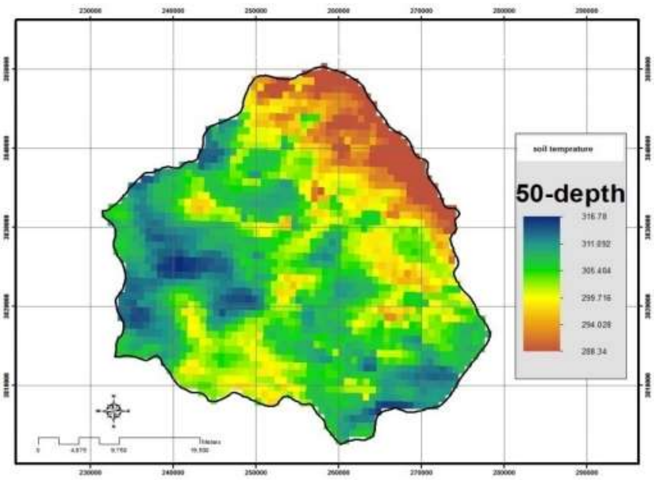

Fig (9) 50 cm soil depth, temperature maps

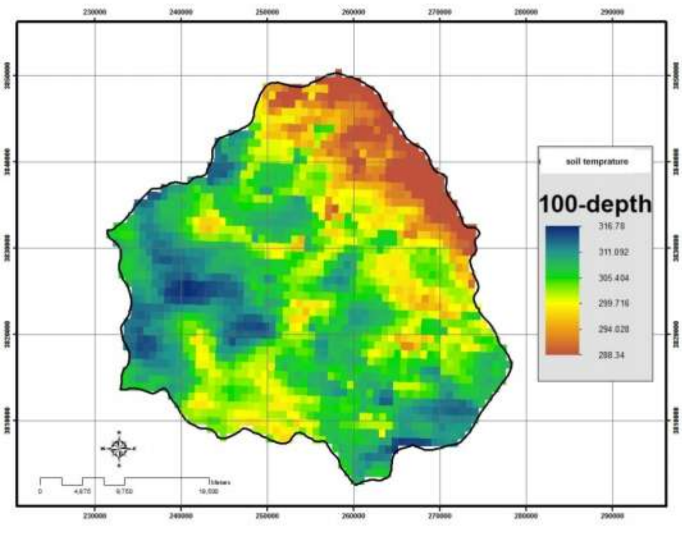

Fig (10), map 100 cm soil depth temperature

Table (2) the soil temperature at various depths is shown as can be seen in table highest temperature changes at a depth of 5 cm and 100 cm soil depth k is the most important change. This decrease is due to less impact on climate parameters are soil surface.

Table (2) changes in soil temperature at various depths

Soil depth	5	10	20	30	50	100
Soil temperature	-5.568	-2.954	0.288	0.0373	0.00015	0.0000202

DISCUSSION

Check changes average temperature annual air and soil temperature at depths different at period case view shown in TUYSERKAN that with reduction temperature air temperature soil at depths case check reduction results. Where most of the energy absorbed by the soil, air, and some of the energy is absorbed by the soil rather than the air, part of the heat energy absorbed by the soil depth is shifted to lower [10]. Was also showed the greatest rate of temperature change is related to the depth of 5 and 10cm. Due to insulate the upper layers of the soil rouge, temperature, soil depth is less affected by temperature fluctuations. Other words, their response to temperature change is very slow, so that the speed of the response surface is high.

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