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CORRELATION BETWEEN SOIL TEMPERATURE AND PLANT GROWTH IN LOWER ZARAFSHAN (DESERTIFICATION PROBLEMS)

Abstract. *The paper describe that soil temperature of two meteorological stations located in the Lower Zarafshan region was studied for the purpose of desertification. Furthermore, the soil temperature was analyzed to demonstrate the impact of increasing temperature on floral activities. Our objective was to commonly compare the soil temperature data to find the anomalies as well as consistent rises in the soil temperature.*

Keywords: *soil temperature, solar radiation, average temperature, average minimum temperature, soil moisture, desertification, plants grow,*

Introduction. Soil temperature is undoubtedly a key factor in assessing energy and mass exchange with the atmosphere. Dominantly, it regulates the water balance and ecohydrological processes viz., evapotranspiration and water uptake by plants (Lozano-Parra et al., 2018). In addition, soil works as a significant energy conduit to receive heat during the daytime and provide surface heat at night. Furthermore, Geiger et al. (2003) concluded that it absorbs heat during the hot season and releases it during the cold. The soil temperature depends on the ratio of

the energy absorbed to that lost from the soil. This energy fluctuates daily, seasonally, and annually, affected by the variability in the air temperature, solar radiation, and length of days (Wu and Nofzigger, 1999). The most important factor influencing how plants grow is the soil's temperature. The temperature of the soil has an impact on plant availability, transmission, and retention of water.

Study area: The Lower Zarafshan mainly includes the Bukhara and Karakol deltas in the lower part of the Zarafshan River. on average, it is 170 km from west to east, and 150 km from north to south, the total area is more than 28000 sq. km. constitutes. It is located between 380 91' - 400 81' North latitudes, 630 00' - 650 13' East longitudes. The Avtobach and Azkamar plateaus, considered the western continuation of the Karatov and Ziyovuddin mountains, are approaching, forming the Khazar corridor with an average width of 4-5 km. Then, there is the Bukhara oasis (Total area about 3,971 km. sq.) with a length of more than 90 km from north to south and an average width of 40-45 km from west to east. In the east of the Lower Zarafshan area, Dengizkol (243 meters) and Jargoq plateaus (392 meters) are located. Sandukli sands, Kimrakkum sands, and Yakkachaka sands are located in the southern and southwestern parts of the region. The sands of the Kyzylkum desert surround the western part of the region. From the northern part, Tuzkuy Mountain (366 meters), Beltov Mountain, Kuljuktov Mountain (785 meters), Ayogitma bog separates it from the Kyzylkum desert. The absolute height of the

Bukhara delta is

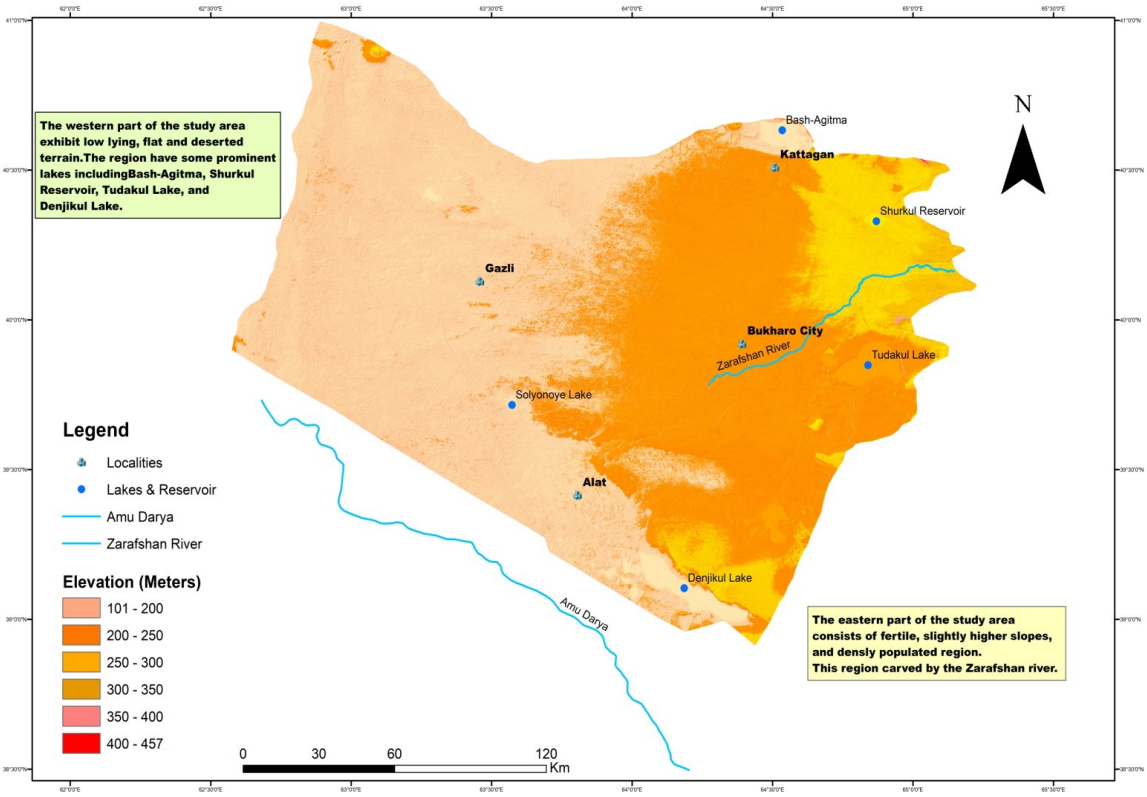

Figure1. Maps of Lower Zarafshan

200-250 m, it decreases and narrows towards the southwest, and the Karakol plateau approaches on both sides. The Zarafshan Valley expands to the southwest after the Karakol Corridor and its area is 832 km. sq. forms the Karakol delta, The absolute height of the delta is 200 m in the north-east, 180 m in the south-west, and 178 m in the part adjacent to the Amudarya valley. In winter, the average temperature in southern region is about to zero degree celcius while in summer it increases up to 45 degree celsius in the Lower Zarafshan. Because of relatively cold winters, this season is excluded from the vegetation growth, notwithstanding some exceptions. During spring season, the study area receives optimal rainfall, needed for plant growth. The region receives very less rainfall, it is limited to 100 mm in the Central Kyzlkum desert and southwest of Aral Sea. The Study area

consists of different soil types viz., Alkali clay and loamy soil, Desert sand, Desert sand alkali soil, Desert soil, Gray-brown salty soil, Gray-brown alkali loamy soil, Gray-brown alkali, and loamy soil, Gray-brown alkali sandy soil, meadow soil and sand.

Data and Methods: The current study focuses on how plant growth is affected by the temporal variation of soil temperature in various study areas. Data on soil temperature was gathered from the Republic of Uzbekistan's Department of Hydrometeorology in order to complete this task. Since the Soviet era, the nation has developed a widely dispersed network of weather stations. Based on the assumption that the data input for this study would be representative of the study area, four weather stations—Bukhara, Karakul —were chosen to obtain soil temperature data. Soil temperature data obtained from 1980- 2020 to display the monthly temperature variation in different regions. The soil temperature data was classified into yearly average temperature, yearly average maximum temperature, and yearly average minimum temperature. Further, the analyzed data was integrated and interpreted with different soil parameters viz., slope of terrain, moisture, soil types, and solar radiation. For this purpose, the ASTER digital elevation model (DEM) was obtained from usgs.gov.in. Furthermore, digital elevation data was put into a GIS environment to calculate different thematic layers viz. slope and elevation statistics (Khan et al., 2023).

Bukhara hydro-meteorological station: It is located close to Bukhara city and collects weather data including soil temperature. Average soil temperature ranges between 17.65 degrees Celsius (1980) and 18.3 degrees Celsius (2020). Soil temperature of Bukhara station shows considerable yearly fluctuation. The average soil temperature was 16.3 degrees Celsius (lowest) in 1994 while it was the highest in 2010 (19.3 degrees Celsius). Further, the soil temperature was categorized into four categories, based on 10-year intervals to integrate the anthropogenic and natural factors. Further, the temperature data was split into four decades to demonstrate the decadal variation (figure

03). The average temperature from 1980 to 1989 was 17.99 degrees Celsius, from 1990 to 1999 was 17.8 degrees Celsius, from 2000 to 2009 was 18.55 degrees Celsius and from 2010 to 2020 was 18.7 degrees Celsius. It indicates an almost 1-degree increase in the average temperature.

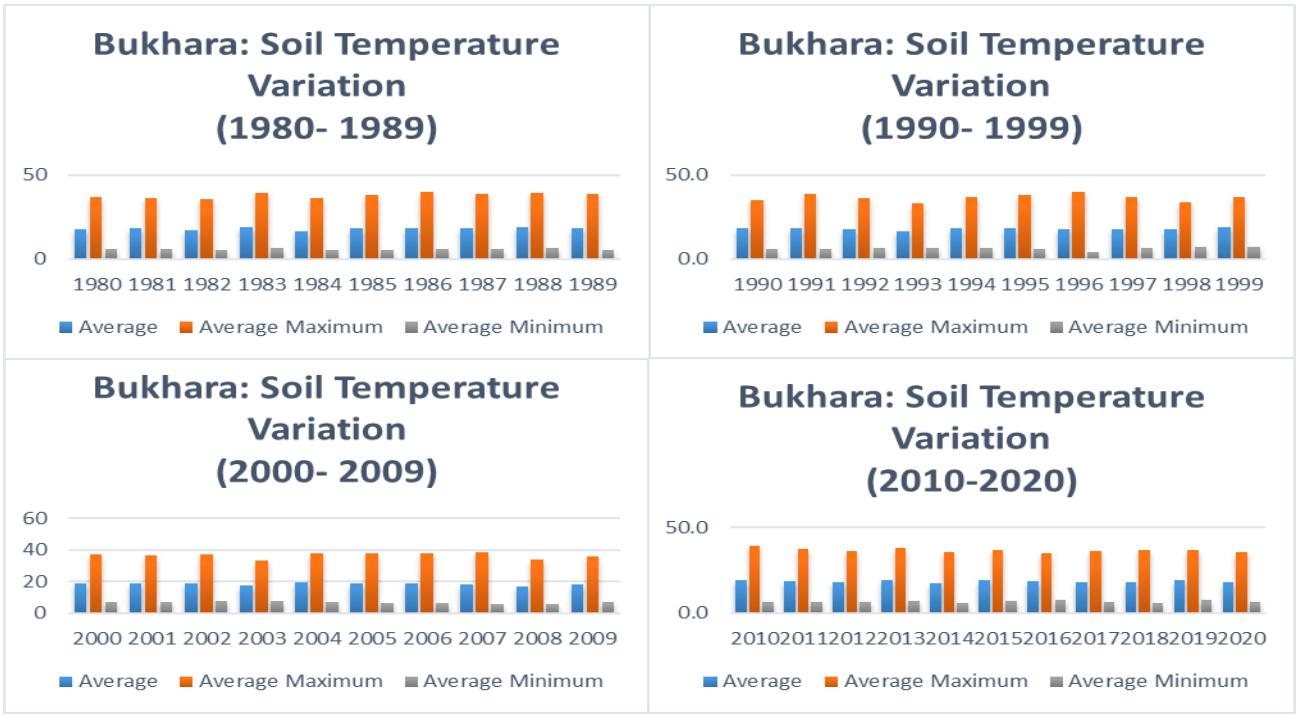

Figure 2. Soil temperature variation from 1980 to 2020 in Bukhara station.

Karakul hydro-meteorological station: Karakul station is located in the southernmost part of the study area near Dengizkol lake. The soil temperature was collected from 1980 to 2020 and displays a range between 17.3 degrees Celsius (1984) and 20.1 degrees Celsius (2019). Soil temperature data reveals that the temperature increased consistently except few years while some years have recorded low average temperatures. The average temperature has increased by almost 2 degrees Celsius in the region. For detailed analysis and estimating the trend, the temperature data was classified into four sections. These sections are based on decadal change in the average temperature, average minimum temperature, and average maximum temperature. In 1980, the average maximum temperature was 36.3 degree

Celsius while it was 39.3 degrees Celsius in 2020. It means average maximum temperature was changed by 3 degrees. Average minimum temperature was 7 degrees Celsius in 1980 while it was not increased. It indicates that local phenomena impact average minimum temperature.

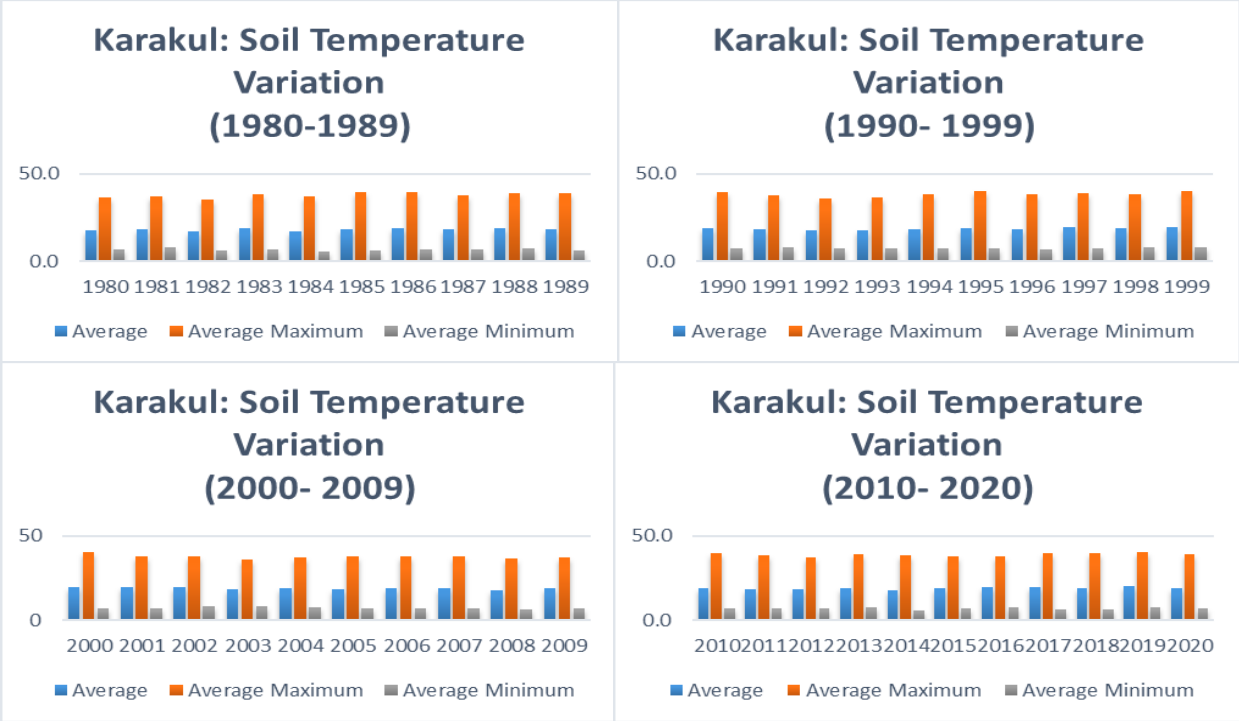

Figure 3 Soil temperature variation from 1980 to 2020 in Karakul station

Discussion: Two stations' soil temperature data indicate rising in the temperature from 1980 to 2020. It also indicates that the average maximum temperature and average minimum temperature also increased during the last 40 years. This increase in soil temperature adversely affects the physical, chemical, and biological activities and different processes, responsible for optimum plant growth in the Lower Zarafshan. In the below graph, average, average maximum, and average minimum soil temperatures are portrayed to exhibit the temporal variation in the last 40 years. On the basis of soil temperature data analysis, it was observed that the soil temperature unequivocally increased during last 40 years. It

impacted significantly the plant growth in the region. Continuously growing soil temperature can be a considerable cause of land degradation and desertification.

It was observed that the soil temperature has increased in the last 40 years in the Lower Zarafshan. It means the region experiences consequences of rising temperature which adversely affects plant growth and leads to infertility of soil. To visualize the impact of soil temperature variation on plant growth the different properties of plants have been considered. The average minimum and maximum temperature at four hydro-meteorological stations increased in the last 40 years.

Table 1. shows the average minimum, average maximum, and average temperature at four meteorological stations.

	Temperature Measurement Unit: Celsius Period: 1980- 2020			
Name of Station	Average	Average Maximum	Average Minimum	Average Increase
Bukhara	17.1- 19.1	33.2- 39.3	4.3- 7.9	+1
Karakul	16.8- 20.3	35.4- 40.3	5.4- 8.5	+1.8

Data reveal that the region went through different anthropogenic and natural disturbances where anthropogenic activities are dominant to increase the temperature.

The plant takes its nutrition, water, and other necessary elements from the soil. Therefore, soil temperature is the most significant parameter for attaining optimal growth. High soil temperature promotes plant growth through higher nutrient and water uptake while low soil temperature diminishes the growth of plants by reducing the nutrient and water uptake. Further, it slows down the photosynthesis

process in the plants. It was observed that the Bukhara region experiences low soil temperature for a considerable period every year during winter. It implies that plant growth is very minimal or nonexistent during the winter.

The influence of soil temperature on plant growth is related to the fact that warmth promotes crop development through increased water and nutrient uptake, while cold inhibits water uptake due to lower water viscosity and slows down the process of photosynthesis. It was observed that the increasing temperature has changed the pattern and regime of evapotranspiration in the study area.

Conclusion: The soil is essential to the survival of plant life and provides water, nutrients, and mechanical support. It stores heat to activate the different life-supporting processes and many biological activities are temperature dependent. The temperature of the soil affects the plants' growth and concentration of nutrients. The temperature of the soil increased steadily in the study area. It prevents the growth of plants and causes desertification. However, the effect of rising temperatures on plant growth depends on the types of soil and the availability of soil moisture. Additionally, the area's southeast was found to have a greater negative influence on plant growth than its northeastern counterpart due to high temperatures. Furthermore, in order to determine the more plausible and trustworthy variables for evaluating the declining agricultural productivity and rising desertification, a thorough investigation is required.

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