



Diurnal Variations in Soil Temperature during Lockdown amid COVID-19 Pandemic in Mid Hills of Rajouri District, Jammu & Kashmir Union Territory, India

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Authors' contributions

This work was carried out in collaboration among all authors. Authors RS and Vishaw Vikas designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors MS and DK managed the analyses of the study. Authors Vikas Sharma and Vishal Sharma managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aim: A preliminary analysis was done to evaluate the impact of lockdown on soil temperature at different depths and comparison with year 2018 and 2019.

Methodology and Results: In order to describe the basic features of the data in study, descriptive statistics method was opted. The deviation in soil temperature from mean value at 5 cm depth

observed during lockdown was -8.58 % and -4.77 % compared to year 2018 and 2019. However the deviation observed from mean value at 10 cm depth was -10.72 % and -9.28 %. The deviation from mean value at 20 cm depth observed was -2.34 % and -1.98 %.

Conclusion: The study concluded that due to lockdown, there was significant change in soil temperature values at variable depths compared to year 2018 and 2019 in the study region.

Keywords: Soil temperature; COVID-19; diurnal variations.

1. INTRODUCTION

Soil temperature erratic fluctuations worldwide are now threatening terrestrial vulnerable species and ecosystems. These unwanted variations have not only caused a deep impact on climate change but also has affected the microbial population in soil ecosystems. So, the unexpected rise and fall of any weather parameter is highly responsible for emergence of diseases in a community, area or region. COVID-19 (Coronavirus disease) can also be considered as an outcome of overexploitation of nature's capability and climate change [1]. Despite several actions and policies framed to curb the menace of over usage of the natural resources, the agencies have still failed to strictly implement the laws and restrictions to reduce the anthropogenic activities. The abrupt increase or decrease in temperature has the ability to alter the environment conditions, thereby affecting weather parameters and ultimately agricultural productivity [2]. As a continuous effect of the dynamic change in atmosphere, it is expected that India might face 6-10 % yield loss by year 2030 causing 1.5 % loss towards GDP [3]. So, the drastically changing climatic pattern and CO₂ trend is a serious cause of concern in 21st century [4].

The trends of soil temperature (°C) are important in studying the aspect of climate change but are barely reported. Significant warming trend has been noticed worldwide by an average increase of about 0.85°C in a century symbolizing the effect of global warming [5]. Soil temperature has been considered as an important factor that influences the processes of gas exchange between soil and atmosphere [6]. The temperature of soil directly affects the organic matter decomposition and other mineralization process of various nutrients [7]. Soil temperature can be affected by various climatic factors, topographic features and gaseous emissions [8]. The parameters above bear tendencies to alter soil temperature regionally and globally but due to lack of observations and spatial coverage, the soil temperature has not received recognition

equal to other weather parameters like air temperature and precipitation [9]. Soil temperature is the function of heat flux in the soil as well as heat exchanges between the soil and atmosphere [10]. The main source of soil temperature is solar radiation and is measured with a soil thermometer. Soil temperature varies seasonally and daily which may result from changes in radiant energy and energy changes taking place through soil surface [11].

COVID-19 (Coronavirus) disease was first identified in Wuhan, China in December 2019 and is highly contagious in nature. The disease has spread in almost every part of the world and has been declared a global pandemic in March 2020 by World Health Organization [12]. The ongoing pandemic of COVID-19 has forced several countries of the world to observe complete lockdown forcing people to live in their homes. India also faced the phase of total lockdown for 21 days (in 1st phase) and subsequent lockdown and unlock down phases to avoid the spread of coronavirus to the maximum possible extent. By this reaction, almost every industrial sector and public transportation movement was prohibited ultimately had a dramatic impact on weather and pollution parameters of mid hill region of Rajouri district of Jammu Kashmir Union Territory, India.

The present study has provided an opportunity to study the change in soil temperature to evaluate the impact of lockdown compared with last 2 year observations. Focusing on the Rajouri district, the study is expected to be a valuable addition to the scientific community by assessing diurnal variation in soil temperature.

2. MATERIALS AND METHODS

Rajouri district occupies an area of about 2630 Sq. kms. with peculiar physical features and lies in between 33.3716° N latitude and 74.3152° E longitude at an elevation of 915 meters above the mean sea level. The District is situated in the west of Jammu Division and is surrounded by the Poonch, Reasi and Jammu Districts. In order to

analyze the change, soil temperature was statistically calculated. The soil temperature at different depths (5, 10, 20 cm) in Morning and Evening was statistically compared with year 2017, 2018 and 2019 data of the lockdown window but the calculation of deviation percentage and graphical comparison was done between 2019 and lockdown data.

The soil temperature (°C) at different depths was observed with Soil Thermometers (5, 10, 20 cm) twice a day. Day soil temperature was recorded at 7:30 AM and evening soil temperature reading was recorded at 5:30 PM during the period. All the thermometers at different depths have been installed at Agrometeorological Field Unit (AMFU), Regional Agriculture Research Station (RARS) Rajouri, J&K.

In order to describe the basic features of the data in study, Descriptive statistics method was opted to find the Highest, Lowest, Mean, Standard Error, Standard Deviation, Coefficient of Variation, Kurtosis and Skewness values and was run in MS-Excel 2010.

3. RESULTS AND DISCUSSION

The results have been incorporated in Table 1 and graphically described in Fig. 1. At 5 cm depth in lockdown, the lowest and highest values observed were 17.59 and 27.02. Standard error and standard deviation observed was 1.98 and 3.97 with C.V 0.18. The kurtosis and Skewness value observed was -0.37 and -0.53. Deviation in soil temperature from mean value at 5 cm depth during lockdown observed was -8.58 % and -4.77 % compared to year 2018 and 2019.

However at 10 cm depth, the lowest and highest value observed was 17.22 and 25.86. The standard error and deviation observed was 1.81

and 3.62 and CV observed was 0.17. The kurtosis and Skewness value observed was 0.57 and 0.51. However the deviation in lockdown from mean value at 10 cm depth compared to year 2018 and 2019 observed was -10.72 % and -9.28 %.

At 20 cm depth, the lowest and highest value observed was 17.52 and 25.79. The standard error and standard deviation observed was 1.73 and 3.46 with CV 0.16. The kurtosis and Skewness value observed was 0.97 and 0.68. Therefore, deviation observed from mean value at 20 cm depth observed compared to year 2018 and 2019 was -2.34 % and -1.98 %.

The changes above or decrease in soil temperature can be attributed to abundant precipitation or lower air or surface temperature due to lockdown in the area [13]. Also decrease in soil temperature can be attributed to higher precipitation rates [14]. The effect of global warming has not only affected the air temperature but also the soil temperature and precipitation patterns [15] and same effect has been observed in the study area due to declination of the global warming effect [13, 4]. [16] have observed a significant trend between soil temperature and air temperature in 58 years study and same can be correlated with the present observations. Also the appearance of inconsistent soil temperatures values in the study area can be corroborated with results of [9]. In Northwest china, when winters are severe and movement is very less, the soil temperature show a decreasing trend while in other seasons show an upward trend [17] and the same restricted vehicular and other anthropogenic movements due to lockdown in study region can be correlated with it [13]. The same results of present study have been noticed in several parts of the world where abrupt change in weather has led to decrease in soil temperature values [9].

Table 1. Descriptive coefficients of Soil Temperature at various depths for the Year 2018- 2020

Soil Temperature	Depth: 5 cm			Depth: 10 cm			Depth: 20 cm		
	2018	2019	2020	2018	2019	2020	2018	2019	2020
Lowest	20.85	19.31	17.59	20.52	19.17	17.22	18.72	17.72	17.52
Highest	29.68	26.14	27.02	29.41	26.38	25.86	26.32	23.88	25.79
Mean	24.00	23.04	21.94	23.77	23.19	21.2	21.73	21.65	21.22
S.E	1.95	1.46	1.98	1.95	1.53	1.81	1.62	1.39	1.73
S.D	3.9	2.93	3.97	3.89	3.07	3.62	3.25	2.78	3.46
CV (%)	0.16	0.13	0.18	0.16	0.13	0.17	0.15	0.13	0.16
Kurtosis	3.05	-0.37	0.3	2.95	0.31	0.57	2.36	1.53	0.97
Skewness	1.66	-0.53	0.49	1.6	-0.71	0.51	1.33	-1.38	0.68

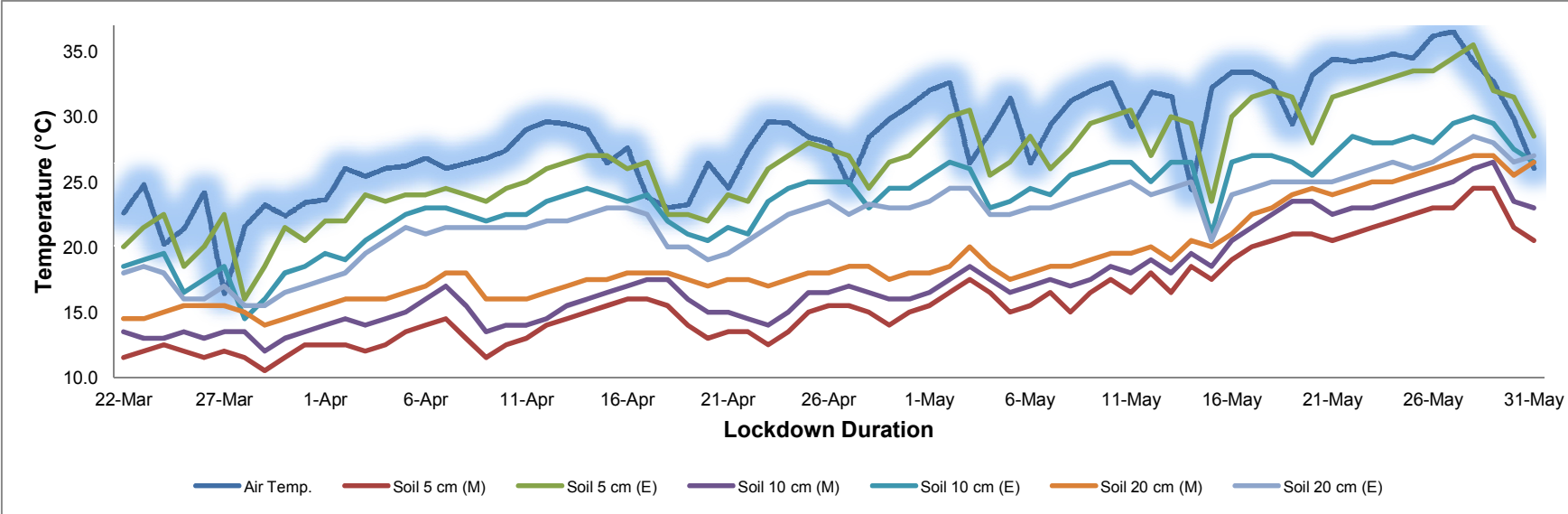


Fig. 1. Diurnal changes in Soil Temperature during lockdown with respect to change in Air Temperature

Table 2. Correlation of coefficients among soil temperature at different depth with air temperature during lockdown period

	Air Temp.	Soil 5 cm (M)	Soil 5 cm (E)	Soil 10 cm (M)	Soil 10 cm (E)	Soil 20 cm (M)
Soil 5 cm (M)	0.81**					
Soil 5 cm (E)	0.86**	0.92**				
Soil 10 cm (M)	0.80**	0.99**	0.90**			
Soil 10 cm (E)	0.85**	0.93**	0.99**	0.92**		
Soil 20 cm (M)	0.81**	0.98**	0.89**	0.99**	0.91**	
Soil 20 cm (E)	0.86**	0.94**	0.95**	0.94**	0.97**	0.94**

**Correlation is significant at 1% level of significance

The Table 2 also defines a clear picture that change in air temperature affected soil temperature values in a significant manner during lockdown.

4. CONCLUSION

Thus, the study concluded that due to lockdown, there has been change in soil temperature values at variable depths and due to this there must have been greater shifts in bioactivities, population of micro and macro organisms and the organic matter decomposition. However, this can be considered as a preliminary study that needs to be researched further to note down the long term implications of lockdown induced abrupt changes in weather parameters on soil physical, chemical and biological properties for framing policies and shaping a sustainable future.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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