Original Article　|　*Peer Reviewed*　|　ⓐ *Open Access*

Scientific Assessment and Sorting of Topological Parameters Affecting Time in Recovering from COVID-19

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Abstract: Coronavirus disease 2019 is a new infectious respiratory disease as named by the World Health Organization. This virus is affecting different individuals in diverse manners. Consequently, studies are going on to identify the factors and parameters disturbing predominantly. According to various studies, the immunity of a person determines the effect of the virus on that individual's health. Thus, immunity is determined by multiple factors like climate, population, geographical location, sanitation facilities. In existing studies, the effect of various climatic factors, such as temperature, relative humidity of diverse countries and areas, on COVID-19 spread is taken. To extend these studies, this paper is an effort to consider almost all the topological parameters of significant countries and different states of India for analysing their effects on the recovery rate due to COVID-19. Finally, these parameters are ranked /sorted as per their impact on recovery rates.

Introduction

COVID-19 has taken the globe by squall, with most nations still being challenged by the novel coronavirus (Jeanne et, al., 2023). As of now 231 countries are affected globally and the Covid-19 pandemic (Nalbandian et al., 2023). Table 1 shows the country's worst hit by Covid-19 pandemic has resulted into 763,740,140 confirmed cases that includes 6,908,554 deaths with 13,337,787,446 vaccine doses been administered as reported to WHO (World Health Organization) whereas specifically, India has recorded almost 44,768,172 Covid-19 confirmed cases with 531,000 deaths and 44223211 recovered cases and administered 2,206,624,273 vaccinations till March 2023 (WHO, 2023; Yilmazkuday et al., 2023).

Symptoms of COVID-19

Some of the main symptoms that are generally seen among most Covid-19 infected people (Alimohamadi et al., 2020; Karia et al., 2020).

- Fever – 99%
- Coughing – 59%
- Congestion/ runny nose –27%
- Loss of smell or taste-
- Trouble breathing or shortness of breath –31%
- Sore throat—65%
- Fatigue – 70%
- Chills, sometimes with shaking- 88%
- Body aches and headache – 35%
- Diarrhea- 45%

This coronavirus can also lead to respiratory failure, heart problems, liver problems, pneumonia, septic shock, and death. Recent reports also show that some people might show signs of strokes due to the COVID-19 (Wang et al., 2020; Lai et al., 2020).

Transmitting Modes of COVID-19

According to the various surveys done by the World Health Organization, the coronavirus can be transmitted either by droplet (respiratory transmission) or airborne

transmission (Tripathi et al., 2020; Wilson et al., 2020). Thus, the droplet transmission lies in the direct spreading category, whereas the airborne transmission lies in an indirect spreading category (Li et al., 2021; Tang et al., 2023).

Table 1. Countries worst hit by Covid-19 pandemic

Rankings	Countries	Cases	Deaths
1	United States	102, 873, 924	1, 118,800
2	Brazil	37, 319, 254	700,556
3	India	44,768,172	531,000
4	Francee	38,791,479	162,176
5	Russian	22,727,542	697,642
6	UK	24,330,379	212,083
7	Italy	25,715,384	189,262
8	Turkiye	17,004,677	101,419
9	Japan	33,523,927	74,096
10	Germany	38,369,891	171,411

Air Borne Transmission

In this transmission mode, the microbes present in the droplet nuclei get transmitted from infected surroundings (>1m) to others as these microbes can remain in the air for a longer duration (Wilson et al., 2020; Borak et al., 2020). The analysis also shows that there were no cases reported in Wuhan of airborne transmission.

Droplet Transmission

This mode of transmission is the transfer of the microbes present in the droplet nuclei of an infected person or a person with the Covid-19 symptoms to another person which comes in direct contact with him/her or when comes in contact with the articles, surfaces, or environment used by the infected person (Example, thermometer or any medical object) (Jayaweera et al., 2020; Medicine, 2020).

Effect of Topological Parameters

A recent study from the Tibet, Bolivia and Ecuador suggested that people living at higher altitudes may provide protection against the SAR-CoV-2 infection (Arias-Reyes et al., 2020). Another case study on Cusco, Peru (3414m height) by (Huamaní et al., 2020) observed that the fatality-rate for covid-19 cases is 0.5% for people living at higher altitudes in Peru whereas the normal fatality rate for covid-19 cases is 2.8%. Firstly, at higher altitudes the low activity of alleles ACE2 populations may prohibit the reproduction of virus in the human body and hence protect them from getting infected (Samaddar et al., 2020; Pun et al., 2020). Secondly at higher altitudes the effect of UV radiation on production of Vitamin D results in the lower rate of

infection (Skutsch et al., 2020; Calvo et al., 2020). Thus this research by (Segovia-Juarez et al., 2020) concluded that the number of deaths and cases are reduced at higher altitudes but the case fatality rate is not altered with varying altitude levels (Castagnetto et al., 2020).

As seen from the various studies that the number of parameters taken for the experiments by different researches is very limited so in order to have a detailed analysis on the recovery rate as per the different parameters this paper is an effort to consider most of the parameters (Altitude, Rainfall, Temperature, Humidity) in order to have a deep impact on recovery rate (Singh et al., 2021; Jha et al., 2021; Mondal et a., 2022). Main points of the proposed work are:

a) 28 states and 8 union territories of India are considered for analysis

b) 189 countries of the world are considered for analysis

c) Wide ranges of topological parameters are taken into consideration for the analysis work are taken into account.

d) After the study and analysis, the ordering of these parameters with respect to their impact on recovery rate is done.

Work Methodology
Data Collection

The data for this study is the data retrieved from (WHO, 2023) between March, 2020 till September 30, 2020 for all 189 countries and for India the data is taken from censusindia.gov.in and https://www.covid19india.org/. These data sources are openly accessible and reliable providing the detailed information about the datasets without any period gap. Apart from these Covid-19 data sets, the data for the four topological parameters that are considered in this study, altitude(m), mean temperature (°C), rainfall (mm) and humidity (%) is also collected from various open sources that are accessible for all, like (Gupta et a., 2020a; Gupta et al., 2020b, Joshi et al., 2023; Nath et al., 2021).

Data Analysis

The analyzation of the above collected data is performed using Microsoft Excel spreadsheets and then given out in the form of tables and graphs and to study the effect of these topological parameters on the Covid-19 recovery rates the correlation analysis is performed using the MATLAB software and the results for these are shown out in the tabular form. After selection of data and making groups for study purpose the next section provides the detailed results and discussion of the analysis.

Table 2. Represents the data collected for all the topological parameters for India

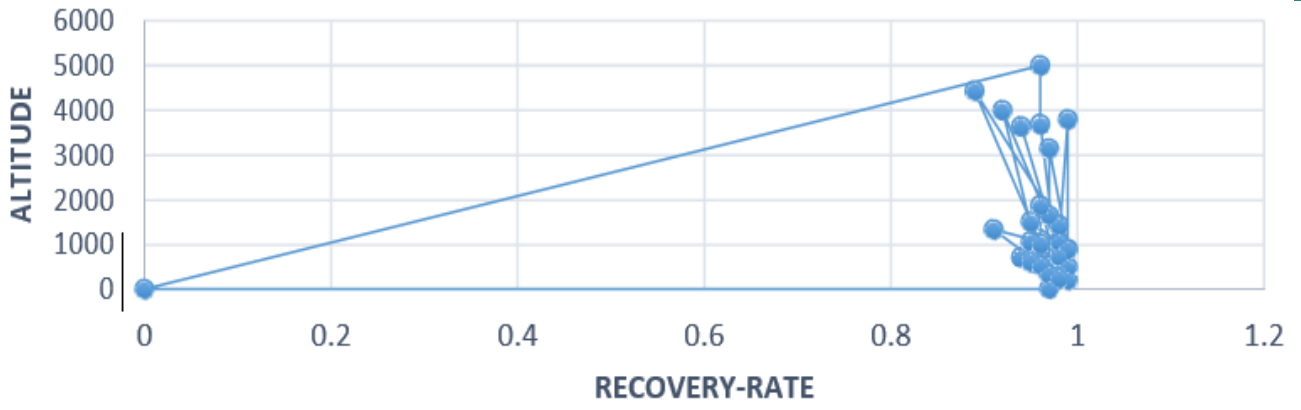| Places	Altitude	Temperature	R-humidity	Rainfall
Andaman & Nicobar Islands	390	26.4	76	2967
Andhra Pradesh	890	27.8	56.3	1008
Arunachal Pradesh	3795	22.5	75	2782
Assam	1003	30	76.6	2818
Bihar	467	26	62	1027.6
Chandigarh	344	24.1	76	617
Chhattisgarh	776	33	48	1292
Dadra & Nagar Haveli	220	26.4	54	2391
Delhi	260	25.2	66	617
Goa	543	27	69	3005
Gujarat	719	27.3	55	842.5
Haryana	850	24.4	67	617
Himachal Pradesh	3641	14.2	77	1251
Jammu & Kashmir	3691	24.2	49	1011
Jharkhand	836	23.7	40	1174
Karnataka	963	32	57	1771
Kerala	1346	32	64	3055
Ladakh	4996	5.2	43	103
Lakshadweep	9	27.9	78	1515
Madhya Pradesh	721	25.3	62	1177.5
Maharashtra	1076	26.8	64	1455.5
Manipur	1517	21.1	64	1881
Meghalaya	1058	30	71	2818
Mizoram	1649	20.6	70	1881
Nagaland	3140	17.8	64	1881
Odisha	913	27.4	68	1489
Pondicherry	21	28.3	76	998
Punjab	612	21	76	649
Rajasthan	1036	25.1	42	464
Sikkim	4433	18	49	2739
Tamil Nadu	1442	27.6	74	998
Telangana	733	26.7	43	1102
Tripura	495	25.5	70	1881
Uttar Pradesh	541	25.7	65	981
Uttarakhand	4003	21.8	68	1069
West Bengal	1875	10.9	66	1735

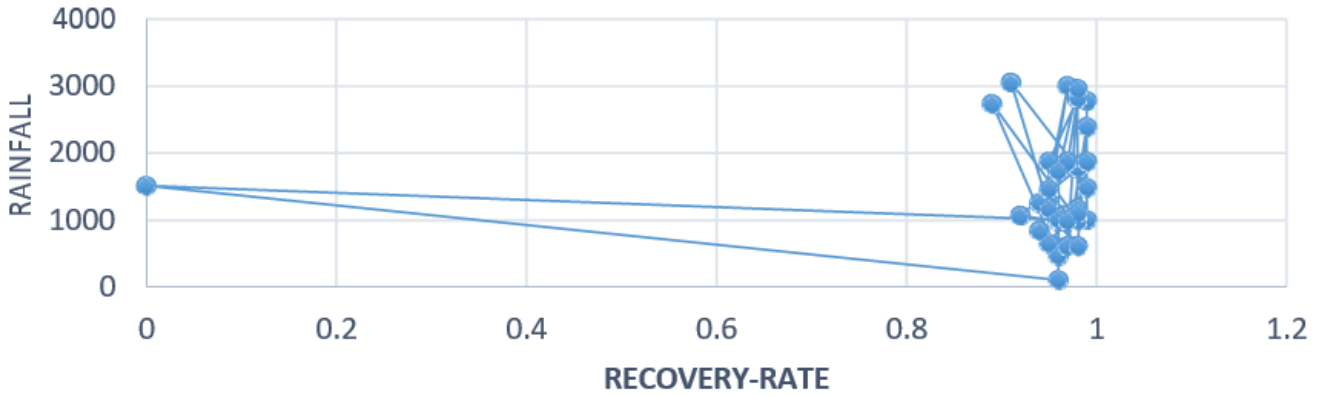**Figure 1. Recovery rate vs altitude**
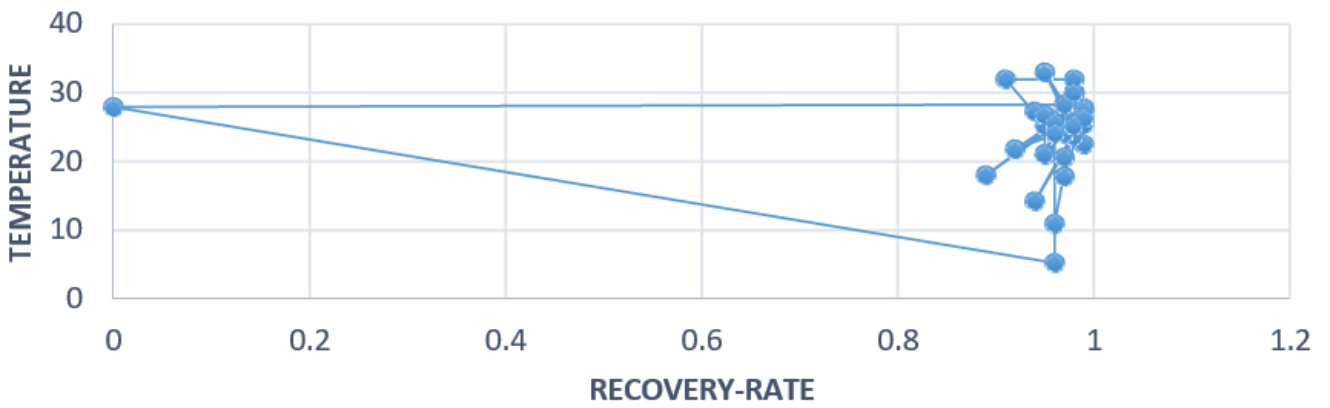

Figure 2. Recovery rate vs rainfall

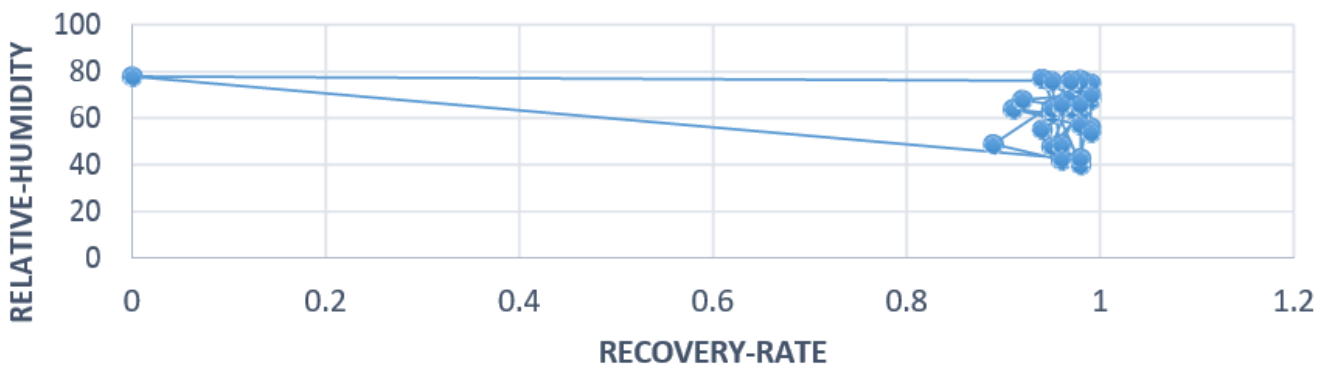**Figure 3. Recovery rate vs temperature**

Figure 4. Recovery rate vs relative humidity

Results and Discussions

In the study, an attempt is made to identify the impact of topological factors on the recovery rates of covid-19. Major countries of the world and states along with union territories in India are considered for analysis. The topological parameters surveyed in this case study are altitude (m), mean temperature(°C), rainfall (mm) and humidity (%) respectively. A MATLAB code is generated for correlation analysis performed for all the datasets. The outcome of this analysis is presented in a tabular form. As per the values of results, these topological parameters are then sorted to recognize the factors having a significant impact on recovery and others not affecting it critically as seen in Table 2 which represents the data values of all the topological parameters with respect to their corresponding states and union territories.

Figures (1-4) depicts all the comparison graphs between the recovery rates of India dataset with respect to all the topological parameters (altitude, rainfall, temperature and relative humidity). Consequently, Figure 1 represents the comparison graph between the recovery rate and altitude. The value of altitude ranges from 9 m to 4996 m with its lowest point Lakshadweep at 9 meters to the highest point Ladakh at 4996 meters. The comparison graph between the recovery rate and rainfall has been shown in Figure 2. The value of rainfall ranges from 103mm to 3055mm with the least amount of rainfall received in Ladakh and the heaviest amount of rainfall is received in Kerala.

Figure 3 represents the comparison graph between the recovery rate and temperature. The temperature ranges from 5.2°C to 33°C with the lowest temperature recorded in Ladakh 5.2°C and the highest temperature recorded in Chhattisgarh is 33°C. Similarly, Figure 4 represents the comparison graph between the recovery rate and relative-humidity. The relative humidity ranges from 40 to 78 with the lowest humidity 40 recorded in Jharkhand and the highest 78 recorded in Lakshadweep.

Figures (5-7) depicts all the comparison graphs between the recovery rates of world dataset with respect to all the topological parameters (temperature, altitude, rainfall, and relative humidity). Consequently, Fig. 5 represents the comparison graph between the recovery rate and temperature. The temperature ranges from -5.35°C to 28.29°C with the lowest temperature recorded in Canada

-5.35°C and the highest temperature recorded in Burkina Faso is 28.29°C. It has also been observed that the 36 countries have temperature ranging from -5.35–10, 25 countries have temperature ranging from 10-20,

93 countries have temperature ranging from 20-28.29°C respectively. The comparison graph between the recovery rate and altitude has been shown in Figure 6. The value of altitude ranges from 0m to 5243m with its lowest point at Anguilla and Hong Kong at 0 meters to highest point Rwanda at 5243 meters. It has also been observed that 124 countries have altitude ranging from 0-1000, 31 countries have altitude ranging from 1000-2000, 9 countries have altitude ranging from 2000-5243 meters respectively out of total 164 countries.

Figure 7 represents the comparison graph between the recovery rate and relative-humidity. The relative humidity ranges from 8 to 97.5 with the lowest humidity 8 recorded in Niger and the highest 97.5 recorded in India. From the 154 observations 17 countries showed relative humidity ranging between 8-50, 97 countries showed relative humidity ranging between 50-80, 40 countries showed relative humidity ranging between 80-97.5 respectively.
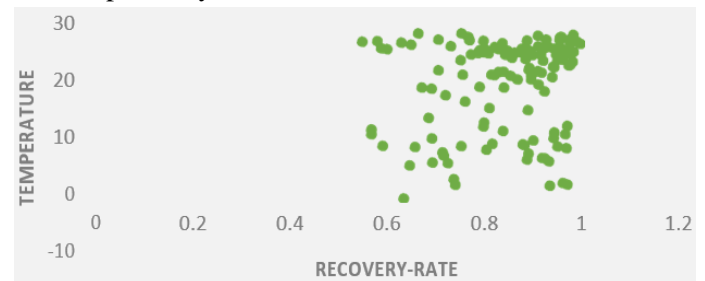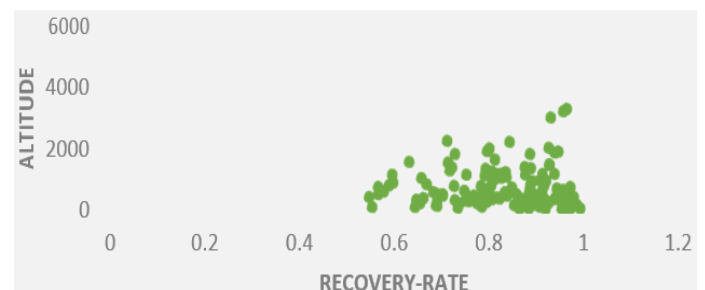

Figure 5. Recovery rate vs temperature

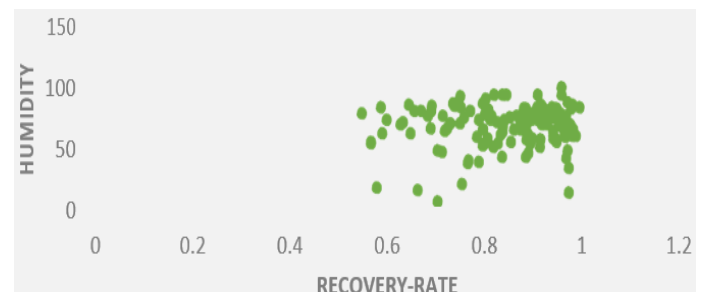**Figure 6. Recovery rate vs altitude**

Figure 7. Recovery rate vs humidity

Conclusion

After the analysis of different parameters on the recovery rate for different states and union territories of India as well as on most of the countries of the world

the following observations can be derived. Table 3 represents the various topological parameters, the number of observations taken for these parameters and their respective correlation coefficients with respect to recovery rates and it can be concluded that the topological parameter that has the most effect on the Covid-19 recovery rate is altitude. These parameters are positively correlated with the recovery rates. The rest of the topological parameters i.e., rainfall, temperature and humidity has negative correlation values and thus are negatively correlated with the recovery rates. Therefore, from the findings the ordering of these topological parameters on the basis of correlation analysis for India can be done as:

Altitude > Rainfall > Temperature > Humidity

Table 3. Ordering of topological parameters for India

S. No.	Parameters	Number of observations	Correlation coefficient with Recovery rate
1.	Altitude	36	0.113425
2.	Rainfall	36	-0.00441
3.	Temperature	36	-0.07207
4.	Humidity	36	-0.19965

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