APPLICATIONS OF GIS TECHNIQUES FOR ANALYZING SPREAD OF COVID- 19 DISEASE IN INDIA

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Abstract:

The outbreak of the 2019 novel coronavirus disease (COVID-19) has caused more than 50,00,000 people infected with the virus and more than 333,000 of deaths as of 24th May, 2020 (World Health Organization (WHO) as of 24th May, 2020) across the world . At present, the number of infections and casualtiesis increasing rapidly throughout the world. COVID-19 seriously hovers human health, social functioning, and international relations. In the fight against COVID-19, Geographic Information Systems (GIS) has played a prominent role in many ways, including the rapid combination of various data, visualization of pandemic information, spatial tracking of infections, prediction of regional transmission, spatial segmentation of the pandemic risk and prevention, management of the supply and demand of material resources, and social-emotional guidance, which provided concrete spatial information support for decision-making, measures formulation, and effectiveness assessment of COVID-19 prevention and control. GIS technology has developed and matured relatively faster and has a complete technological way for data preparation, platform construction, model construction, and map production. However, for the struggle against the widespread pandemic, the main challenge is finding strategies to adjust technical methods and improve the speed and accuracy of information provided for social management. In this article methods like Spatial Interpolation, Quantities etc are used to show spatial distribution of covid-19 cases in the states and union territories of India.

Keywords: GIS, COVID-19, Geospatial, IDW, Interpolation

Introduction

In today’s world data no longer come mainly from the government but are collected from more diverse enterprises. As a result, the use of GIS faces difficulties in data acquisition and the integration of heterogeneous data, which requires governments, businesses, and academic institutions to jointly promote the formulation of relevant policies. The development of GIS should be strengthened to form a data-driven system for rapid knowledge acquisition. The outbreak of 2019 novel coronavirus disease (COVID-19) is a public health emergency of international concern that had caused more than 50,00,000 infections and over 333,000 deaths in more than 200 countries till May 24th, 2020 (WHO, 2020), seriously affecting economic and social development. In India total confirmed cases crossed 1 lakh mark and reached around 130,000 of which 54,441 are discharged, with 3867 deaths had been reported by the Ministry of Health and Family Welfare Government of India. The aim of the research is to analyze the spatial distribution of COVID-19 and its trends with the help of GIS software.

Coronavirus disease (COVID-19) is an infectious disease caused by a newly discovered coronavirus.Most people who fall sick with COVID-19 will experience mild to moderate symptoms and recover without special treatment.On February 28, UN Secretary-General Guterres called on governments to take action to do everything possible tocontrol the COVID-19 pandemic (New.cn, 2020).The United Nations Sustainable Development Goals (SDGs) aim toaddress social, economic, and environmental issues from 2015 to 2030and move towards sustainable development (United Nations Development Programme, 2015). The United Nations SDGs contain 17 goalsand 169 targets. SDG 3 aims to ensure healthy lives and promote wellbeing for all at all ages including the specific in SDG 3.3, which aimsto end pandemics of AIDS, tuberculosis, malaria and neglected tropicaldiseases and to combat hepatitis, water-borne diseases and other communicable diseases by 2030 (United Nations Development Programme,2015). The COVID-19 pandemic directly threatens the achievement ofthe above goals for health, and also affects the realization of goals foreconomic and social development. In the context of global environmental changes, the transmission characteristics of the COVID-19 pandemichave not yet been sufficiently recognized (CDC, 2020). Additionally, theacceleration of global urbanization, increased concentration of population, more frequent and complex interactions, and shortage of medicalprotection in developing countries all increase the difficulties of the prevention and control of COVID-19.

China's Response to COVID-19

At the beginning of thispandemic, the medical and research communities responded quickly. Theyrapidly isolated the new coronavirus,conducted gene sequencing to decide the intermediate host, activelyshared data with the international community, and sent three successiveexpert teams to Wuhan city. On January 23, 2020, the Chinese governmenttook decisive measures to lock down the city of Wuhan and to closethe external routes to all cities in Hubei Province (State council, 2020).Each province has successively launched a first-level public health response, which has effectively curbed the spread of the pandemic. Chinahas undertaken enormous personal and socioeconomic losses and haswon valuable time for the Chinese and for global prevention and control of the pandemic. On February 3, only 10 days after construction, Huoshenshan Hospital, which is a 1000-bed hospital in Wuhan, Hubei, wasput into use (China Daily, 2020a). On February 8, Leishenshan Hospital, which has 1600 beds, was completed and put into use (China Daily,2020b). In the interim, medical staff from all over the country rushed toHubei to fight the pandemic. On February 12, the local government tookthe measure of receiving and curing all patients that should be treated,following which the pandemic in Hubei Province reached a turning pointand began to decline. During this period, we utilized GIS and spatial bigdata technology, which have a high degree of scientific and technological display (Zhou et al., 2016), to provide important scientific and technical support to allow the government to judge the pandemic situationand formulate prevention and control measures (Health Commission ofHubei Province, 2020).

Pandemic and GIS

Geographic Information Systems (GIS) and spatial mapping are emerging global health tools, but the degree to which they have been implemented in India for COVID-19 research is not clear. To inform researchers and program developers, this mapping review presents the scope and depth of the GIS and Spatial Analysis Studies conducted by COVID-19 in India. In particular, GIS and spatial analysis can be essential tools for knowledge, prevention, and treatment of diseases. For example, GIS technology can be used as a visualization help to map the geographical distribution of the disease, the potential risk factors and the resources available for treatment and prevention. In relation to the spatial analysis of certain information, it is possible to evaluate the risks of disease, trends in outbreaks over time and space, and hotspots of infection (Lyseen et al., 2014; Kandwal et al., 2009). Similar to each other, such methods may relate to the design, planning, and distribution of international health resources for treatment and prevention facilities and may help mitigate the impact of interference. The aim of this research is to analyze the spatial distribution of COVID-19 and its trend to predict the spread of diseases with the help of GIS software.

This study reviewed peer-reviewed research papers prepared on COVID-19 in India and concerning GIS or spatial assessment. COVID-1 related issues, except for the incidence of COVID-19, COVID-19 specific cardiovascular disease, COVID-19 health conditions, and COVID-19 preventive facilities. Research papers expressly based in India or in other parts of the world have been included. Spatial analysis approaches and the use of GIS were ambiguously defined for the uses of this analysis in order to obtain a diversity of emerging activities, i.e. they included research papers using any specialized GIS software or explicitly implementing any spatial analysis techniques (Kawo and Shankar, 2018; Shankar and Kawo, 2019; Balamurugan et al., 2020). The data used in this study is the number of COVID-19 disease patients in state-wise in India from February to 11th April obtained from the health department of India. In the present research work, distribution pattern of disease transmission is illustrated with GIS tools.

Study Area

India is located in South Asia, bordered to the north by the highest mountain chain in the world, bordering the central and southern Bay of Bengal and the Arabian Sea, between Burma and Pakistan. Geographic coordinates are from 8°4' N to 37° 6' N latitude and 68° 7' E to 97° 25' E longitude, with a total area of 3287590 km2. The capital of India is New Delhi, and the major cities in the nation are Mumbai, Delhi, and Kolkata. India is the 7th largest country in the world. India's population is one billion, making it the second-most densely populated nation after China (Figure 1 and Table 1). It is more than three times the population of the US, but only about a third of its area. The most populous state in India is Uttar Pradesh and the least populous state in India is Sikkim, shown in Table- 1. India is the biggest democratic country in the world. The country is mainly an agricultural nation, although it has a huge iron and steel industry and supplies all kinds of manufactured goods.

Spatial Distribution of Covid-19

In this work, interpolation using Inverse Distance Weighted (IDW) makes clear the conclusion that objects similar to each other are more similar than those further apart. IDW uses the calculated values (cases) of the prediction site to estimate the value for each undetermined site. The values determined nearest to the location of the forecast have a greater impact on the expected value than those further away. IDW assumes that each measured point imposes a time-decreasing local effect. Using values from nearby weighted locations, the IDW approach calculates the average value for unsampled locations. The weights were commensurate with the proximity of the points sampled to the non-sampled location and the IDW power coefficient could be specified.

Table-1 State-wise Total Population in India

Sr. No	Name	Tot.Pop.	Sr. No	Name	Tot.Pop.
1	Andaman & Nicobar Islands	380,581	19	Madhya Pradesh	72,597,565
2	Andhra Pradesh	49,386,799	20	Maharashtra	112,372,972
3	Arunachal Pradesh	1,382,611	21	Manipur	2,721,756
4	Assam	31,169,272	22	Meghalaya	2,964,007
5	Bihar	103,804,637	23	Mizoram	1,091,014
6	Chandigarh	1,055,450	24	Nagaland	1,980,602
7	Chhattisgarh	25,540,196	25	Nct Of Delhi	16,787,941
8	Dadra & Nagar Haveli	585,764	26	Odisha	41,947,358
9	Daman And Diu	585764	27	Puducherry	1,247,953
10	Goa	1,457,723	28	Punjab	27,704,236
11	Gujarat	60,383,628	29	Rajasthan	68,621,012
12	Haryana	25,353,081	30	Sikkim	607,688
13	Himachal Pradesh	6,864,602	31	Tamil Nadu	72,138,958
14	Jammu & Kashmir	12,548,926	32	Telangana	35,286,757
15	Jharkhand	32,966,238	33	Tripura	3,671,032
16	Karnataka	61,130,704	34	Uttar Pradesh	199,812,341
17	Kerala	33,387,677	35	Uttarakhand	10,116,752
18	Lakshadweep	64,473	36	West Bengal	91,347,736

Source: Census, Government of India (2011)

Prediction of COVID-19Spread Pattern

Interpolation using IDW has been obtained with the aim of predicting the spread of disease in India. This map shows the number of patients and the extended disease zone across the country. As per IDW, the pattern of COVID-19 diseases in the seven classes is 0 to 500, 501 to 1000, 1001 to 2000, 2001 to 5000, 5001 to 10000, 10001 to 15000 and > 15000 shown in Figure 1. These classes are at risk of exposing the spatial spread of the disease in relation to different states, based on population and environmental factors that may control the distribution of the patient. The highest number of patients returning on board, including families, friends, and relatives in close contact with incubation carriers, is reported daily as an observational analysis.

India could be the next global hotspot for infectious diseases of the COVID-19 virus. For this research COVID-19 prediction IDW map suggests that extreme cases will be conforming next two months >1000 cases in the following states are Maharashtra and Tamil Nadu. Maharashtra is the largest urbanization in the country, (Table-2) close to the Mumbai financial center and the stock market. The largest spread of infectious disease with COVID-19 cases has been increased daily. Where the observed increase in patients is concentrated primarily in these states, there is a need for more prevalence, with some major distributions ranging from 451 to 1000 being Delhi, Gujarat, Telangana, Uttar Pradesh (city) and Rajasthan (city). The moderate range of spread ratio is observed in the following states: Karnataka, Kerala, Andhra Pradesh, Madhya Pradesh, with a range of 251 to 450 might to be affected more cases in future. The lowest range 0 to 250 is observed in Odisha, Manipur, Haryana and Jammu & Kashmir, Bihar, Chhattisgarh, Chandigarh and Mizoram for patients in the center ofthe city. The death and cured prediction distribution of the COVID-19 map in India as shown in Figure 3 and 4, respectively. In cases of death, the area around Maharashtra is more extremely dangerous and the area around Madhya Pradesh and Gujarat is moderately risky and the rest of the states are less than 20. In cases of healing, the area around Maharashtra, Kerala, and South Tamil Nadu is more healing and the areas around Telangana, Karnataka, Uttar Pradesh, Ladakh, and Gujarat are moderately cured and the cases are less cured in the center of Tamil Nadu and the rest of the states. Some diseases move quickly between people. However, the exposure behavior of each disease differs from another depending on regional or space factors,environmental conditions, etc. No specific drugs for the prevention or treatment of coronavirus disease (COVID-19).

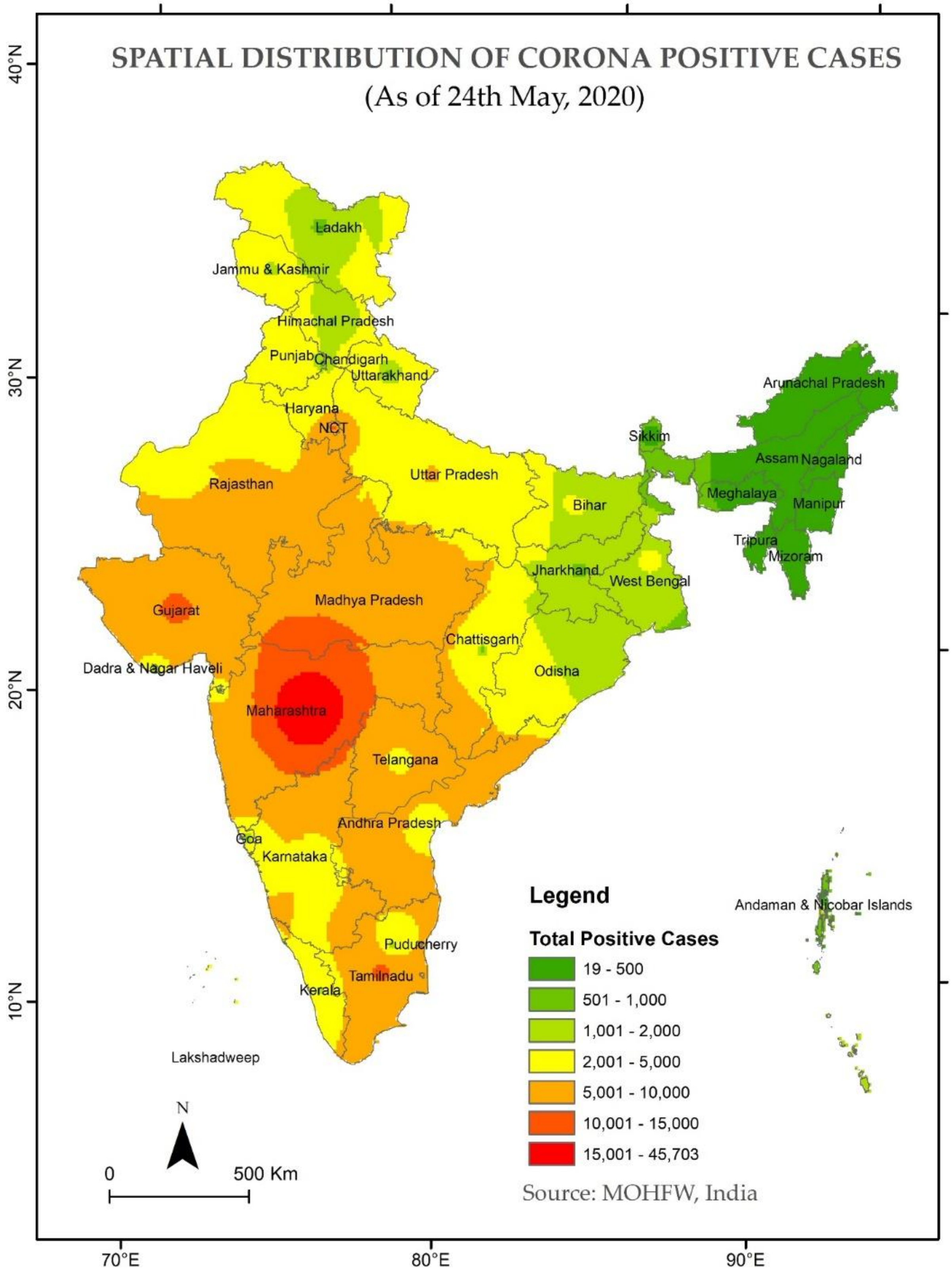
SPATIAL DISTRIBUTION OF CORONA POSITIVE CASES
(As of 24th May, 2020)
40°N
30°N
20°N
10°N
70°E
80°E
90°E
Ladakh
Jammu & Kashmir
Himachal Pradesh
Punjab
Chandigarh
Uttarakhand
Haryana
NCT
Rajasthan
Uttar Pradesh
Arunachal Pradesh
Sikkim
Assam
Nagaland
Meghalaya
Manipur
Bihar
Tripura
Mizoram
Jharkhand
West Bengal
Gujarat
Madhya Pradesh
Chattisgarh
Dadra & Nagar Haveli
Odisha
Maharashtra
Telangana
Andhra Pradesh
Goa
Karnataka
Puducherry
Tamilnadu
Kerala
Lakshadweep
Andaman & Nicobar Islands
Legend
Total Positive Cases
19 - 500
501 - 1,000
1,001 - 2,000
2,001 - 5,000
5,001 - 10,000
10,001 - 15,000
15,001 - 45,703
N
0
500 Km
Source: MOHFW, India

Figure-1

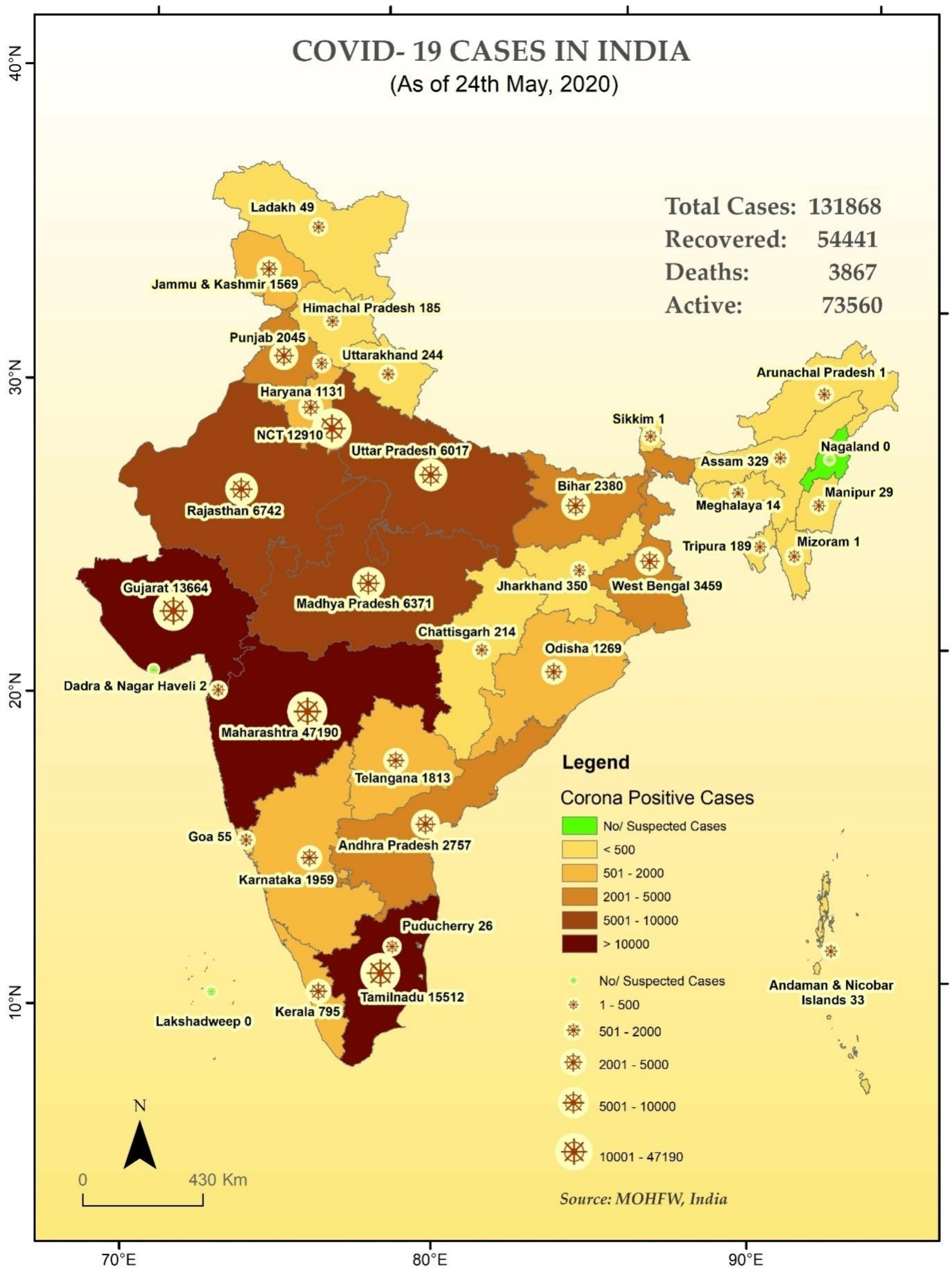
COVID- 19 CASES IN INDIA
(As of 24th May, 2020)
Total Cases: 131868
Recovered: 54441
Deaths: 3867
Active: 73560
Ladakh 49
Jammu & Kashmir 1569
Himachal Pradesh 185
Punjab 2045
Uttarakhand 244
Haryana 1131
NCT 12910
Uttar Pradesh 6017
Rajasthan 6742
Arunachal Pradesh 1
Sikkim 1
Assam 329
Nagaland 0
Bihar 2380
Meghalaya 14
Manipur 29
Tripura 189
Mizoram 1
Jharkhand 350
West Bengal 3459
Gujarat 13664
Madhya Pradesh 6371
Chattisgarh 214
Odisha 1269
Dadra & Nagar Haveli 2
Maharashtra 47190
Telangana 1813
Goa 55
Andhra Pradesh 2757
Karnataka 1959
Puducherry 26
Tamilnadu 15512
Kerala 795
Lakshadweep 0
Andaman & Nicobar Islands 33
Legend
Corona Positive Cases
No/ Suspected Cases
< 500
501 - 2000
2001 - 5000
5001 - 10000
> 10000
No/ Suspected Cases
1 - 500
501 - 2000
2001 - 5000
5001 - 10000
10001 - 47190
Source: MOHFW, India
N
0
430 Km
40°N
30°N
20°N
10°N
70°E
80°E
90°E

Figure- 2

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Table 2. State-wise breakdown of total confirmed cases of COVID-19 in India

Sr No	STATE	CAPITAL	Total Cases	Recovered	Deaths	Active Cases
1	Andaman & Nicobar Islands	Port Blair	33	33	0	0
2	Andhra Pradesh	Hyderabad	2757	1809	56	892
3	Arunachal Pradesh	Itanagar	1	1	0	0
4	Assam	Dispur	329	55	4	270
5	Bihar	Patna	2380	653	11	1716
6	Chandigarh	Chandigarh	225	179	3	43
7	Chattisgarh	Raipur	214	64	0	150
8	Dadra & Nagar Haveli	Silvassa	2	0	0	2
10	Goa	Panaji	55	16	0	39
11	Gujarat	Gandhinagar	13664	6169	829	6666
12	Haryana	Chandigarh	1131	750	16	365
13	Himachal Pradesh	Simla	185	61	3	121
14	Jammu & Kashmir	Srinagar	1569	774	21	774
15	Jharkhand	Ranchi	350	141	4	205
16	Karnataka	Banglore	1959	608	42	1309
17	Kerala	Thiruanthapuram	795	515	4	276
18	Ladakh	Srinagar	49	43	0	6
19	Lakshadweep	Kavaratti	0	0	0	0
20	Madhya Pradesh	Bhopal	6371	3267	281	2823
21	Maharashtra	Mumbai	47190	13404	1577	32209
22	Manipur	Imphal	29	4	0	25
23	Meghalaya	Shilong	14	12	1	1
24	Mizoram	Izwal	1	1	0	0
25	Nagaland	Kohma	0	0	0	0
26	NCT	New Delhi	12910	6267	231	6412
27	Odisha	Bhubaneswar	1269	497	7	793
28	Puducherry	Puducherry	26	10	0	16
29	Punjab	Chandigarh	2045	1870	39	136
30	Rajasthan	Jaipur	6742	3786	160	2796
31	Sikkim	Gangtok	1	0	0	1
32	Tamilnadu	Chennai	15512	7491	109	7912
33	Telangana	Hyderabad	1813	1065	49	699
34	Tripura	Agartala	189	153	0	36
35	Uttar Pradesh	Lucknow	6017	3406	155	2456
36	Uttarakhand	Dehradun	244	56	2	186
37	West Bengal	Kolkatta	3459	1281	269	1909

Source: Ministry of Health and Family Welfare, Government of India (24th May, 2020)

This analysis may be provide valuable information to support government monitoring and predicting spread of virus across small and large areas. The WHO announced that the outbreak of Novel Coronavirus Disease (COVID-19) was a pandemic and reiterated its call for immediate action by governments to step up their response to diagnose, identify and mitigate spread to save lives. In this context, the Government of India will take all necessary precautions to ensure that we are well prepared to face the challenge and threat posed by the growing pandemic of COVID-19 Corona Virus.

Conclusions

In present study an attemptwasmade to showcasethe spatial distribution of Covid-19 disease in India. Geo-spatial techniques provided anoutlook for simplifying and measuring the outbreak status of COVID-19 diseases in particular areas and provided a basis for future surveys of environmental factors responsible for the imminent threat of disease. Analysis of spatial distribution patterns may provide valuable information to support government monitoring and the predicting spread of the virus across small and large areas. As a result, a GIS-based spatial distribution using the IDW method was performed in this article to identify disease risk assessments and distribution pattern in India. The IDW analysis of the spatial interpolation layers and the apparent weight of the conditioning factors were also prepared. Validation results discovered the strength and effectiveness of the proposed method for detecting and predicting the potential for disease risk assessment in India. The results of this study may be appropriate for the associated agencies to carry out a comprehensive assessment of the spread of the virus and environmental control in the study area. In addition, the method not only prohibits the predictive mapping of satisfactory zones for different parts of the country, but also permits the demonstration of the level of uncertainty in the forecast that could be directly applicable to other countries with associated distance and density characteristics.

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