GEOGRAPHICAL ANALYSIS

RESEARCH ARTICLE

Mapping the Invisible: A Comprehensive Study of COVID-19 Diffusion Over Space and Time

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Abstract

Geography subject bridges the natural sciences with the social sciences. A map is the most powerful component of geographical studies because a map can express huge spatial information concisely and help users to understand particular phenomena effectively. The COVID-19 outbreak has spatial as well as temporal dimensions and it can be well understood through maps. This study highlights the shifting epicenter of the pandemic and delineates key milestones in its rapid global spread, from the early stages in China, and Western Pacific countries to its peak in the United States via Europe. It started in the month of January and the subsequent months reached an alarming situation of infections and fatalities of the pandemic that covered from local to global scale. In a mere four months, the coronavirus rapidly transcended geographical boundaries, encompassing the entire globe. The study utilizes secondary data from the World Health Organization and employs GIS Open Source software to map the diffusion and intensity of the outbreak. The maps, produced using GIS software, serve as effective visual aids, offering critical insights into the spatial distribution of COVID-19 cases and deaths which underscores the holistic nature of geographical studies in understanding pandemics. This is an exploration of the spatio-temporal dynamics of the COVID-19 pandemic, through geospatial mapping under health geography to understand its multifaceted dimensions.

Keywords: COVID19; Spatiotemporal mapping of COVID-19; Diffusion; Pandemic; Health geography

1 Introduction

Wuhan City in China is the epicenter of the COVID-19 pandemic. The cases started reporting at the end of December 2020 and in four months its transmission spread to the entire world. Geographical factors and diseases have a correlation. The COVID-19 outbreak and the impact of lockdown have been studied by different scholars. The spatio-temporal distribution of patients and mortality are the study aspect of geography subject. The magnitude of diffusion of the outbreak over the period and space has been addressed through maps. Health geography helps to understand the intensity of diseases, the association of geographical components in the spread of diseases, its impact on demography especially morbidity and mortality rates, etc. In these

studies, maps play a great role. Geoinformatics helped to address spatial aspects more efficiently and effectively. GIS software has very good cartographic representation capability that helps to prepare different types of maps. The distributional maps of COVID-19 help to understand the global diffusion and spread of coronavirus. The present study is an attempt to map the COVID-19 outbreak and understand different dimensions.

2 Objectives

The objective of this study is to map the diffusion of the COVID-19 outbreak and understand its intensity.

3 Data and Methods

This study is based on the secondary data published by the World Health Organization. The mapping of COVID-19 cases is carried out using GIS Open Source software. The intensity is tabulated and mapped through cartographic techniques. From a geographic perception, the spatial distribution is understood through maps, and geographical inquiry into the COVID-19 outbreak is carried out.

4 Results and Discussion

The GA and Durham University carried out a study (2008-09) that reveals that geography helps to explore the distribution and spread of disease, its intensity, risk-taking behaviour, etc. A map is a powerful tool that describes huge information in a small space with a spatial distribution. The COVID-19 outbreak is having spatial as well as temporal dimensions. There are many questions regarding this outbreak like… *How did this outbreak originate and spread in due course of time? How many people were infected due to COVID-19? How many deaths took place due to coronavirus? Which were the areas where still coronavirus was still not reached?* etc questions are well addressed through maps. Hence, here an attempt is made to map some aspects of the COVID-19 outbreak.

The below map is published by the World Health Organization. It shows the diffusion of coronavirus among the countries. The transmission of the virus on 12th Feb 2020 is shown through a flow map. It represents that all South-Asian countries get infected from China. As of 12th Feb, it had not reached in the African continent but transmission reached European countries. France got transmitted from Singapore and from there virus spread to the United Kingdom, Germany, and Spain. There were 23 countries that were infected from China whereas 4 countries got transmission other than China. The international spread is well depicted by the flow map and anyone can read these maps and understand the pattern of the COVID-19 outbreak.

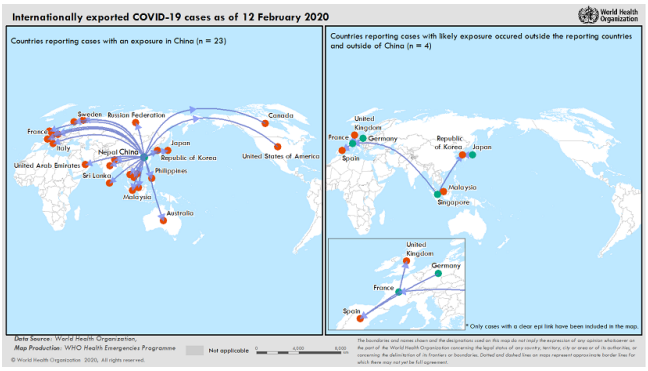

Fig. 1. Covid 19 report
Source: World Health Organization Covid-19 Report No-23

4.1 Spatio-Temporal Mapping of COVID-19 Outbreak

The phase-wise transmission of COVID-19 is mapped and represented in this section.

- Phase — 1

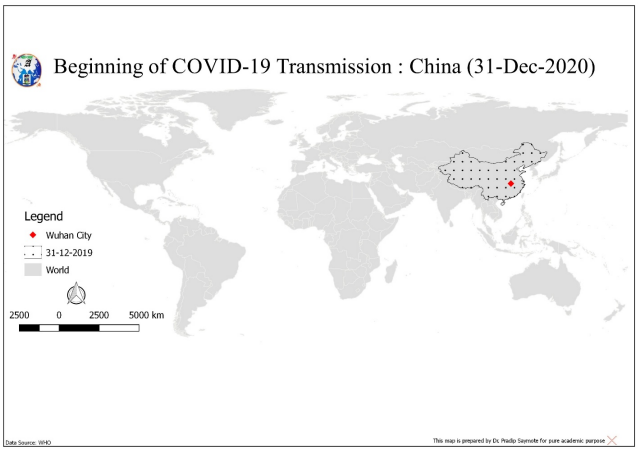

Fig. 2. Covid-19 transmission

The actual beginning of the coronavirus spread started on 31st December 2020 with few cases. In this first phase, China was the only country having COVID-19 cases. But gradually transmission starts taking place all around the world.

- Phase — 2

January 2020 is the first month when actual transmission of coronavirus started in a few countries which is considered as Phase — 2. In this month countries like the USA, Canada, Australia, India, Japan, Thailand, France, Germany, Italy, etc. got infected with some cases.

- Phase — 3

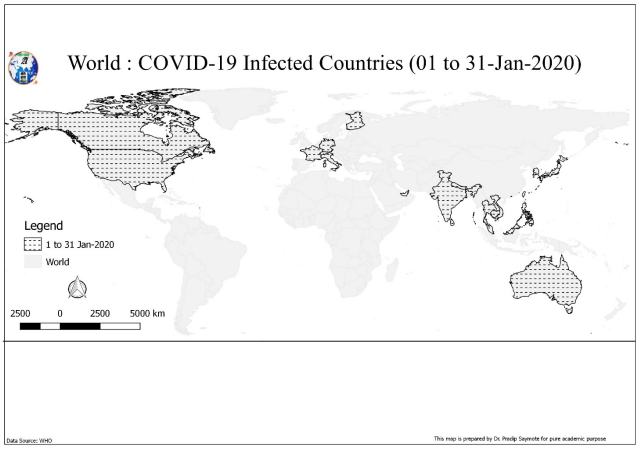

Fig. 3. Covid-19 infected countries

February – 2020 is the second month of the COVID-19 outbreak and is treated as phase — 3. In this month the patients of coronavirus are found in 35 countries. The countries like United Kingdom, Russia, Spain, Sweden, Egypt, Iran, Iraq, Afghanistan, Pakistan, Brazil, Nigeria, Mexico, New Zealand, etc. got infected with a few cases. Till this time maximum cases were reported from China but same time slowly hidden transmissions were taking place in the rest of the countries.

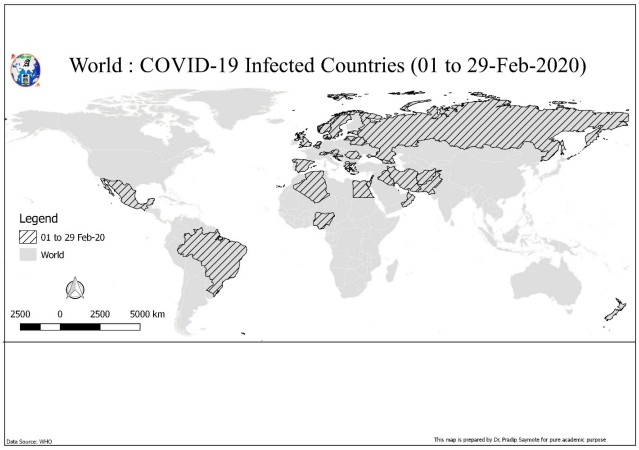

Fig. 4. Covid-19infected countries

- Phase — 4

This month is considered a peak period of transmission of the COVID-19 outbreak as most countries in the world have reported that they found the first cases of coronavirus in their region. The month of March 2020 is termed as phase — 4 where 150 countries got infected. The outbreak reached to African continent, South America, the Middle East, and even the small islands and territories that were safe but by this time isolated areas also got infected with COVID-19 cases.

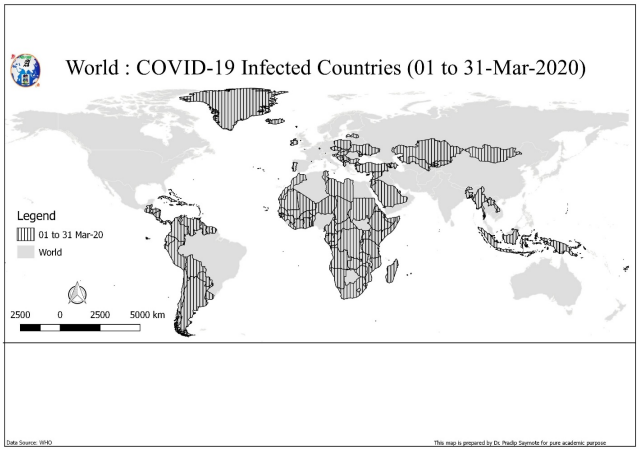

Fig. 5. Covid-19infected countries

- Phase — 5

The April 2020 month is treated as Phase — 5 of the COVID-19 transmission. In this month 11 countries got infected and reported the cases. However, the count of patients seems increased this month. By this time coronavirus reached all countries around the world. The countries like South Sudan, Sierra Leone, Burundi, Malawi, Falkland Islands, Yemen, etc. got the transmission in the first half of the month. The count of cases as well as the deaths due to COVID-19 continued with high intensity.

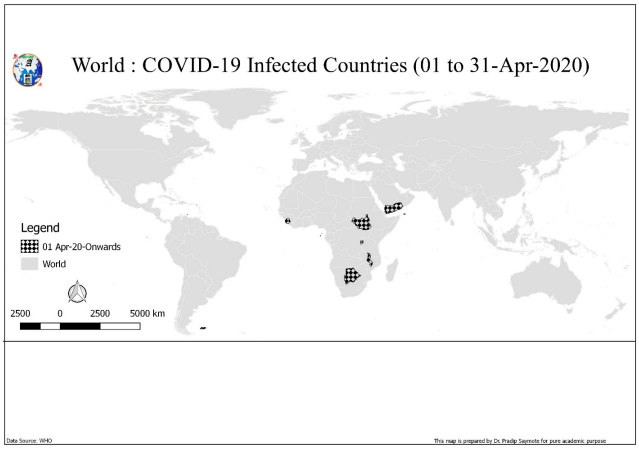

Fig. 6. Covid-19infected countries

- Phase — 6

The month May 2020 is the last phase of the transmission of coronavirus in new regions. By this time COVID-19 outbreak

has reached almost the entire world. There are hardly a few areas that are out of coronavirus attack. On 1st May Tajikistan and Comoros reported that they found coronavirus cases in their region. The increasing trend of patients and deaths is noticed in this month.

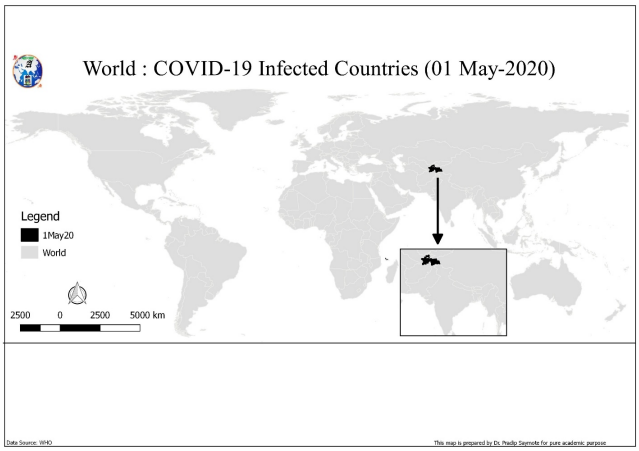

Fig. 7. Covid-19infected countries

4.2 Intensity and Spatial Distribution

In this section, the intensity mapping of the COVID-19 outbreak is carried out to understand the spatial distribution of patients as well as the deaths that occurred due to coronavirus. The intensity and geographical distribution of the outbreak are understood with two indicators i.e. total number of cases and total deaths for two time periods.

- 1st Feb 2020

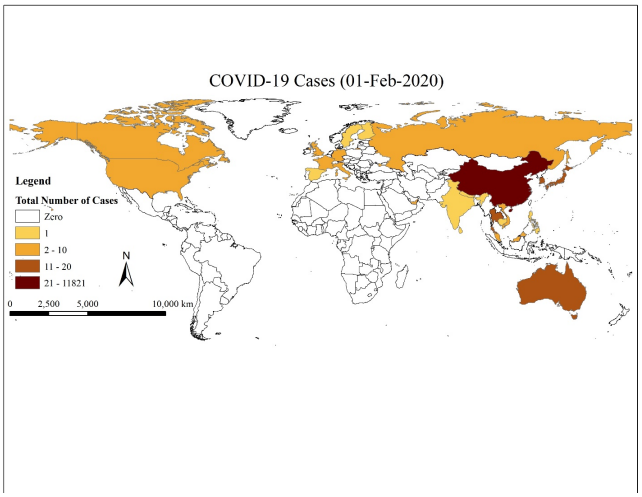

Fig. 8. Covid- 19 cases

1st Feb-20 is selected as the first period because it is a month time period from the beginning of the coronavirus spread from China. The spatial distribution of total COVID-19 cases is shown in Figure — 7. There are 11,953 cases reported from 24 countries. By this time the cases were ranging from zero (in many countries) to 11,821 cases reported in China. There are many countries where coronavirus has not yet reached the same time there are some regions that reported very few cases i.e. below 20.

There were 304 deaths took place in China due to the novel coronavirus which is represented in Figure 9.

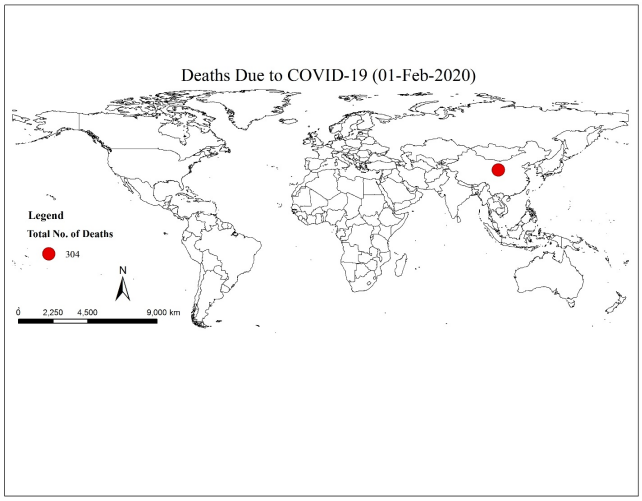

Fig. 9. Deaths due to Covid- 19

- 1st May 2020

The second point period selected to understand the intensity of the COVID-19 outbreak is 01st May 2020. This date is selected because this is the peak period of the outbreak.

Figure 10 represents the total number of cases of coronavirus as of 1st May 2020. By this time 213 regions were infected and victimized 3,174,481 people across the world. A maximum 1,035,353 cases are recorded in the USA, on the contrary, some regions have only 1 patient with COVID-19. North America, Europe, and North Asia are the areas which are having high cases whereas African countries have comparatively fewer cases of coronavirus.

As of 1st May due to the novel coronavirus, 224,157 deaths occurred in 127 regions (Figure 11). It seems that the total number of deaths has increased all around the world but the high rise is noted in the developed countries. The USA (55,337 deaths) is on top however the drastic impact is seen in the European continent i.e. Italy (27,967), U K (26,771), Spain (24,543), and France (24,342).

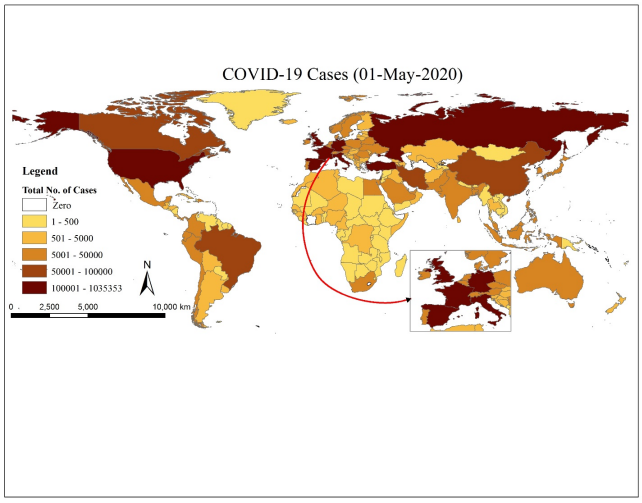

Fig. 10. Covid- 19 cases

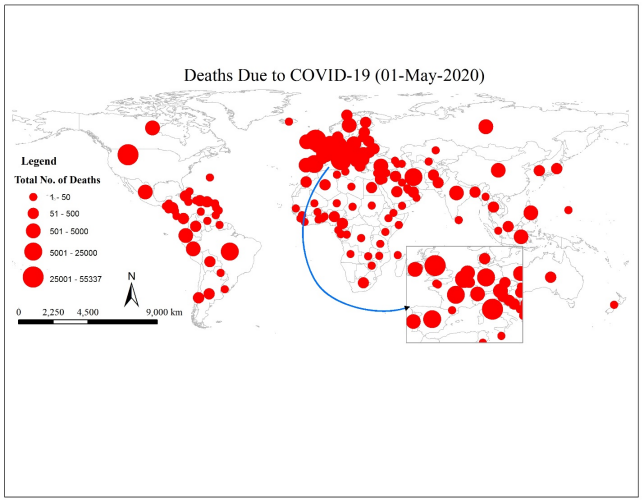

Fig. 11. Deaths due to Covid- 19

Impact of COVID-19 Outbreak

As per UN Framework, COVID-19 is not just a health crisis but it is much more than that (Socio-economic impact of COVID-19, 2020). Due to the COVID-19 outbreak, many countries followed lockdown. The movement of people was restricted, and all social and economic activities were stopped. Hence the impact of COVID-19 can be seen mainly on social, economic, and indirectly it affects all phases of human life. The working population and labour class have been affected the most. Hence the sector-wise detailed appraisal of impact is very much essential.

Conclusion

The geography of an area plays a major role in the spread of epidemic diseases. Health geography is a branch of Human geography that deals with the different health parameters. Geospatial mapping is an effective tool for understanding the spatial distribution of COVID-19 cases. The impact of COVID-19 can be seen in social, cultural, political, and economic aspects which are also integral parts of geographical studies.

In the early phase of the month of Jan-2020 coronavirus transmission took place in a few Western Pacific countries like Thailand, Japan, South Korea, and Taiwan. The epicenter of COVID-19 is changing after China and shifted to Europe in March thereafter in April month it is shifted to the USA.

On 1st Feb-2020 11,953 patients of COVID-19 reported in 24 countries out of that 11,821 cases were found in China and 304 people were died. On 1st March 2020 total of 87,137 people got infected from 60 countries out of that China has the highest i.e. 79,968 cases and 2,873 patients died. On 1st April-2020 the highest 163,199 patients were reported in the USA which is 12.84%. Spain had 94,417 patients (11.46%), France 51,477 (6.25%) and China 82,631 patients (10.03%).

On 1st May-20 the novel coronavirus reached 213 regions and infected 3,174,481 people. The highest 1,035,353 cases (32.61%) were recorded in the USA, followed by Spain with 213,435 patients (6.72%), and Italy with 205,463 (6.47%). A total 127 regions have reported 224,157 deaths. The USA reported the highest number of 55,337 deaths (24.69%), followed by Italy 27,967 (12.48%), United Kingdom 26,771 (11.94%), Spain 24,543 (10.95%) and France 24,342 (10.86%). The deaths due to COVID-19 seem increased all around the world.

The map is the best tool to represent spatial pheromones and the spatial distribution of COVID-19 is one of them. Geospatial technology especially GIS software is the best tool to bring distribution and representation through the maps. The maps prepared in this study help to understand the COVID-19 outbreak as well as the intensity of the coronavirus. The total number of cases as well as to number of deaths are represented through maps.

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