Assessing and Communicating Spatio-Temporal Pattern of COVID-19 with the help of Geospatial Technology and Geo-media Research for preparing COVID warriors for better response

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PREFACE

Empowering Youth as COVID-19 Warriors through Geographical Information Systems

In the face of unprecedented global challenges, a new generation of warriors has emerged—unyielding in their commitment to combating the far-reaching impacts of the COVID-19 pandemic. These warriors are not defined by their age or experience, but rather by their unwavering determination to make a difference in the world. It is to these remarkable young individuals that this report is dedicated.

The COVID-19 pandemic has demanded swift and strategic action from governments, healthcare professionals, and communities worldwide. In this battle against an invisible enemy, information and technology have become invaluable weapons, allowing us to navigate an ever-evolving landscape of risks, vulnerabilities, and opportunities.

Geographical Information Systems (GIS) have emerged as a powerful tool in our arsenal, providing us with the means to collect, analyze, and visualize spatial data. By harnessing the potential of GIS, we can unravel complex patterns, identify hotspots, and make informed decisions to guide our response efforts. It is within this context that we recognize the immense potential of empowering our youth to become COVID-19 warriors through GIS.

This report serves as a comprehensive guide, offering a roadmap for educators, mentors, and youth leaders who seek to equip young individuals with the knowledge and skills necessary to effectively utilize GIS in the battle against the pandemic. It is designed to bridge the gap between theory and practice, empowering young minds to become active participants in the fight against COVID-19.

Through the pages of this report, we have explored the fundamental principles of GIS and their application in the context of the pandemic. We have delved into data collection techniques, spatial analysis, and visualization tools, enabling young learners to harness the full potential of GIS in their efforts to understand, monitor, and mitigate the impact of COVID-19.

Moreover, this report goes beyond technical proficiency, recognizing the importance of fostering a multidisciplinary approach to the pandemic response. We have explored the intersections between GIS and fields such as public health, social sciences, and planning. By integrating diverse perspectives, we made efforts to encourage young warriors to develop holistic solutions that address not only the immediate challenges posed by the virus but also the long-term implications on society.

It is our belief that the youth have the power to drive transformative change. By equipping them with the tools and knowledge contained within these pages, we tried to empower them to shape a more resilient and inclusive future. We invited educators and mentors to adapt and implement the ideas presented here, fostering an environment of innovation and collaboration that nurtures the talents of young COVID-19 warriors.

This report is the culmination of collective efforts, a testament to the indomitable spirit of collaboration and the belief that together, we can overcome even the most formidable of

challenges. It is a call to action—a call to empower our youth to become leaders, innovators, and agents of change in the face of adversity.

To the youth who hold the potential to reshape the world, this report is dedicated to you. Embrace the knowledge within these pages, ignite your passion, and unleash the power of GIS in your journey as COVID-19 warriors.

Together, let us forge a path towards a healthier, safer, and more resilient tomorrow.

The battle begins now.

ACKNOWLEDGEMENT

This research project entitled - Assessing and Communicating Spatio-Temporal Pattern of COVID-19 with the Help of Geospatial Technology and Geo-media Research for Preparing COVID warriors for better response is sponsored by the National Council for Science and Technology Communication, DST. We would like to express our gratitude towards NCSTC, DST for giving us this opportunity to conduct this research work.

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Chapter 1

Introduction

About COVID-19

The novel CORONA Virus illness was discovered in Wuhan, China, in 2019. COVID-19 has infected around 69.04 million people worldwide to date. (Worldometer,2023) The World Health Organisation declared the conditions created by the virus as a pandemic due to the rapid spread of infection challenging humans. COVID-19 has a 2 to 14-day effect on humans. It spreads from one person to another through droplets when a person sneezes, coughs, or even speaks. Contaminated surfaces from the droplets also increase the chances of the spread of the virus. Initially, many studies observed that the COVID-19 infections are more common in cities than in villages. This was because the higher concentration of population in cities is responsible for more hotspots in the cities than in villages. However, later it spread over the countryside.

Symptoms

COVID-19is a highly infectious disease. The clinical symptoms of the disease include fever, dry cough, myalgia, fatigue and many more. The disease leads to severe functional disabilities causing acute respiratory distress syndrome.

COVID-19 - Inspection on Global Spread

Coronavirus, known as SARS-CoV-2, was discovered as the source of an outbreak of viral pneumonia (COVID-19) in Wuhan after the first positive case of COVID-19 was reported in **Wuhan on December 31, 2019**. In a very short span of time, on **January 30, 2020**, the first positive case of COVID-19 in **India** was reported in **Thrissur, Kerala**, with the patient having travelled from Wuhan. Gradually the number propelled to 250,000 by the beginning of June. The disease spread across the country in three months (Spatio-Temporal Spread of Covid-19 September 11, 2020, COVID-19 Pandemic: Case Studies & Opinions, Volume 01(04): 58–67, 2020.) A man from Sao Paulo who had travelled to Italy tested positive for the illness, proving that the virus had been transmitted from Italy toBrazil.The case was reportedon February 25, 2020. By March 21, 2020, the virus had spread to every federative unit in Brazil. The country recorded its one-millionth case and nearly 49,000 reported deaths on June 19, 2020. On March 5, the National Institute for Communicable Diseases confirmed that a suspected case of COVID-19 had tested positive. The patient, a 38-year-old man, had travelled to Italy with his wife and returned to South Africa on March 1 as part of a group of ten people. As of January 30, 2020, there were 9,976 confirmed cases of the virus in at least 21 countries, including the first confirmed case in the United States on January 20, 2020. In London, SARS-CoV-2 RNA was discovered in cases A and B by parallel PCR testing of nasopharyngeal swabs and reported on January 30, 2020. In Germany, there have been 26,452,148 confirmed cases and 139,313 deaths as a result of the COVID-19 pandemic. The first case in Germany was confirmed near Munich, Bavaria, on

January 27, 2020. The first case in Bordeaux, France, was recorded on January 24, 2020, making it the first city in the region to have a confirmed case of COVID-19.In an international context, eight nations accounted for 60 percent of all COVID-19 cases worldwide. India, the United States, the United Kingdom, South Africa, France, Germany, Italy, and Brazil are among the countries that witnessed a spike in the number of covid cases. According to a report published by the WHO, the virus affected people in 225 countries. Thus, the regional dimension of COVID-19 vast and therefore, the implications and responses also vary over regions.

India and COVID 19

The first positive case of COVID-19 in India was reported in Thrissur, Kerala on January 30, 2020. The patient had travelled from Wuhan. Within three months, the number of cases had propelled to over 250,000, spreading across the country. To contain the epidemic, the Government of India implemented four phases of country-wide lockdowns, beginning on March 24, 2020. Gujarat reported its first two cases of COVID-19 around the same time - a 32-year-old man from Rajkot who had returned from Saudi Arabia and a 21-year-old woman from Surat who had returned from the UK and tested positive. On March 22, 2020, Gujarat reported its first COVID-19 death,as a 69-year-old man succumbed to the disease in Surat.

Key Developments

Several key developments marked the trend of COVID-19 cases globally since the beginning of the pandemic.

- Initial Outbreaks: In late 2019, the initial cases of COVID-19 were reported in Wuhan, China. The virus spread rapidly within the city and soon spread to other parts of China and beyond. Within a few months, the virus had become a global pandemic, affecting millions of people and causing widespread economic disruption.
- The First Wave: In the first few months of the pandemic, many countries experienced initial waves of COVID-19 cases. These waves were characterized by rapid growth in the number of cases and hospitalizations, as well as a high proportion of severe cases and deaths. In many countries, these initial waves overwhelmed the healthcare system, leading to widespread shortages of personal protective equipment, hospital beds, and ventilators.
- Response Measures: In response to the initial waves of cases, governments worldwide implemented various response measures to slow the spread of the virus. These measures included lockdowns, social distancing, and travel restrictions. The measures had varying levels of success in controlling the spread of the virus, with some countries experiencing a rapid decline in the number of cases and others experiencing more sustained transmission.
- The Second Wave: In many countries, the initial wave of COVID-19 cases was followed by a second wave, which was more widespread and severe than the initial one. The second wave was partially fuelled by the relaxation of response measures and the emergence of new, and more contagious variants of the virus. In many countries, the second wave led to a resurgence in the

number of cases, hospitalizations, and deaths and put additional strain on the healthcare system.

- Vaccination Efforts: In response to the second wave of cases, many countries ramped up their vaccination efforts, administering vaccine to large numbers of people in an effort to reach herd immunity and bring an end to the pandemic. These efforts have been largely successful in controlling the spread of the virus and reducing the number of cases, hospitalizations, and deaths.
- Variants: As the virus continues to spread, new variants have emerged, some of which are more contagious and potentially more dangerous than the original strain of the virus. The emergence of new variants has raised concerns about the effectiveness of existing vaccines and has highlighted the importance of ongoing surveillance and genetic analysis of the virus.
- Current Status: The current trend of COVID-19 cases shows a decline in the number of positive cases, hospitalisations, and deaths. This decline has been driven partly by the success of vaccination efforts, the continued implementation of response measures, and the emergence of more effective treatments for COVID-19. However, the virus continues to spread in many parts of the world, and new variants pose an ongoing threat to public health.

Overall, the trend of COVID-19 cases globally has been marked by significant ups and downs, with outbreaks and surges in the number of cases followed by declines and plateaus. The pandemic has been a complex web and various factors, including response measures, vaccination efforts, and the emergence of new variants, have shaped the trajectory of the virus. The ongoing challenge of controlling the spread of COVID-19 and bringing an end to the pandemic highlights how it is pertinent to improve our understanding of the virus and develop effective strategies to control its spread.

Scope of Study

The study focussed on training the youth for making them prepared for the pandemic. The study used secondary data analysis to assess the spatio-temporal pattern of the disease. The study explores the pandemic situation in developed and developing countries. The developed countries include the United States, the United Kingdom, France, and Germany while the developing countries include India, Brazil, South Africa, and China. In-depth patterns of COVID-19 in developed and developing countries were found in this study using the geospatial approach. The study builds a link between active cases and death data. This research revealed how the world has dealt with infectious sickness. COVID-19 waves were recorded in this investigation, and it was discovered that the CORONA virus was at its peak for a specific period. A few countries experienced more than three waves. Because of some particular factors, COVID-19's destructive character must be investigated, and this research is critical for understanding the virus's pattern and behaviour. Similarly, district wise analysis of COVID-19 spread was studied to understand the state scenario.

Our Stand

Gujarat was analysed to understand the positive cases' spatial and temporal degree of transmission from March to August 2021. The geospatial and statistical analysis was carried out to understand the

transmission trajectory and disease intensity in Gujarat.This was used as a guide for the interpretation of the COVID-19 spreadand pattern of the transmission of the disease both in space and time.

Research has proven, the early stages of the new infectious diseases can be examined using spatial-temporal analysis. The guidelines of each country differ here, as do their respective approaches and plans to prevent the spread of COVID-19 infection.

After understanding the trends, the study developed the modules which helped as guide to train the COVID-19 warriors. This initiative helped us to prepare CORONA Warriors who can spread awareness and become vigilant during the time of emergency.

A committee of five expert members, including a medical officer, continues to guide and assess the project's progress. The committee also endeavours to monitor the project's performance in terms of time, speed, coverage of work quality, etc. The project work was reviewed every six months, and the progress report along with the documentation of other materials, was disseminated to assess the impact of the project work.

Reflections

One notable example is the COVID-19 Dashboard and Mapping Platform developed by the Ministry of Health and Wellness in Botswana, which was largely created and maintained by a team of young people. The platform utilized geospatial technology to map the spread of the disease, monitor hotspots, and track health resources in real-time.[1]

In India, the Bhuvan COVID-19 Portal was developed by the Indian Space Research Organisation (ISRO) to provide real-time tracking of COVID-19 cases and resources using geospatial technology. The platform was used to monitor the spread of the disease and to plan and allocate health resources based on the location of outbreaks.[2]

In the United States, the Esri COVID-19 Response Dashboard was developed by Esri, a company specializing in geographic information systems (GIS). The dashboard utilizes GIS technology to provide real-time tracking of COVID-19 cases, hospital resources, and other important data. Additionally, Esri launched a program called the COVID-19 GIS Hub, which provides resources and training for individuals and organizations interested in using GIS technology to respond to the pandemic.[3]

These examples demonstrate the potential of geospatial technology and the value of training youth to utilize it in COVID-19 response efforts.

Project Objectives

The major objectives of the project are as below:

[1]https://www.ub.bw/news/ub-develops-covid-19-monitoring-tools-ministry-health-and-wellness
[2]https://bhuvan-app3.nrsc.gov.in/corona/corona_dashboard/dashboard/dashboard.php?type=citizen
[3]https://www.esri.com/en-us/covid-19/overview

1. To understand the trend and characteristics of COVID-19 at the Global, National and State level
2. To understand the determinants of COVID-19 in Gujarat by documenting the appropriate procedure and methodology
3. To prepare a module on how to make maps on the Spatial Pattern and Temporal Changes in the Spatial pattern of COVID-19 in Gujarat with the help of GIS
4. To prepare a module on how to assess the status and quality of health infrastructure in Gujarat with the help of GIS
5. To train young COVID warriors to acquire knowledge and skill to understand and prepare themselves with the help of Geo media

The methodology for a geospatial project on COVID-19 in India was rigorous and well-planned to ensure accurate and reliable results. Given the scale of the pandemic and the need for timely and effective decision-making, a multi-faceted approach that combines geospatial data analysis, statistical modelling, and on-the-ground observations is essential. This approach helped identify trends and patterns in the spread of the disease, assess the impact of mitigation measures, and identify areas where interventions are needed most urgently. Additionally, the use of high-quality data sources, such as satellite imagery and mobile phone data, provided critical insights into population mobility, infrastructure, and access to healthcare services. Overall, a robust methodology for a geospatial project on COVID-19 prioritized accuracy, transparency, and responsiveness to evolving circumstances on the ground.

To achieve the above objectives the project was divided into four parts. The methodology adopted was to document the plan to execute the CoVID-19 Workplan for Study Area & Future Aspects. The vital part of the project was ToT (Training of Trainers), where responsible and capable youth were trained to make use of Geospatial Advances and resolutions.

Part 1: Database Collection

The database reflected the epidemic's recent, past, and future trends. The data helped to perform spatial analytics and show the actual situation of any region in a country. To advocate the real situation the data collection was done in two layers-

- Secondary Data Collections- From Government organisations and NGOs
- Local Data Collections- Individuals and Group data with the help of Particiapnts

Part 2: GIS Mapping & Training

A key component of the project was the geospatial approach, which used administrative boundaries of the area, human interface, spatial data analytics techniques, numerous practical maps, and training of trainer components to present real data in a way that is understandable to the common man. The below components played a vital role in spreading awareness among youth in the district of Dahod-

- Databoard
- Attributes
- Spatial Modelling
- Map Layouts

- Geospatial Hands-On Workshops

Part 3: Data Frame &Portal

The project aimed to create a user-friendly database. Feedback was collected from the local people and ToT youth to create a web portal that can be useful in the future using a dashboard, User credentials, Free access & Data flow with Spatially prepared maps.

Dataframe

The data collected from various organizations & field experiences served as additional points on the portal and acted as a mirror to the ground reality. This data helped to train people to spread awareness among local youth at the villages & tehsil level. The data frame was prepared after all the observations from Phase 1 collection to make a better scenario of working over data analytics.

Web portal

The web portal was integrated keeping in mind the minimal bandwidth and user-friendly approach. This helped every human resource in the study area make data entry and give feedback on the real scenario making the model robust for Training & Analytics. One can find the real-time data on the http://dahodcovid19.co.in/ website.

Part 4: ToT (Training of Trainers)

Training is very important in strengthening people, especially at the local ground level. Training of frontline staff can't go beyond one level as it can't reach the local people due to various challenges. Under this project, the major target was to train responsible youth to make more people aware of these epidemics, and solutions & developing a will to fight. The following aspects were taken into consideration and studied in-depth:

- Field Data Collection (Questionnaire survey)
- Data Verification & Processing
- Geospatial Training
- Web portal Training & Implications
- Overall approach towards Success

The training module focussed on giving the trainees the practical and theoretical aspects of the COVID warriors. The topics of the ToT programme are listed below:

- Introduction to the GIS and COVID-19 mapping
- COVID-19 Disease and Prevention
- Real-time Surveillance of COVID-19 in the study block with the help of a mobile app
- Introduction to the Data Collection process of COVID-19 through the GPS application
- Getting Familiar with QGIS Interface in terms of Health Application & Digitalisation and Visualisation of Health Data with a Special Focus on COVID 19
- Geospatial Activity
- GPS Hands-on exercise for COVID-19 – Point Data Collection
- Mapping Spatial Pattern of COVID-19 in study block

- Role of GIS in COVID mapping
- COVID cognizance Game Activity
- GPS Point Collection for the location of COVID patient

Our training cohorts covered the topics which are mentioned above. The trainees were provided orientation on how to collect the data door-to-door and plot them on the GPS via Geospatial activity.

Chapter 2

Trends and Characteristics of COVID-19 at Global, National, and State Levels

This chapter overviews the trends and characteristics of COVID-19 using the Spatio temporal study. The different approaches, materials and methods used in the study are discussed in depth. It is in two parts-a global analysis and a detailed analysis of Gujarat state.

Understanding the Global Trend Using Spatio-temporal study

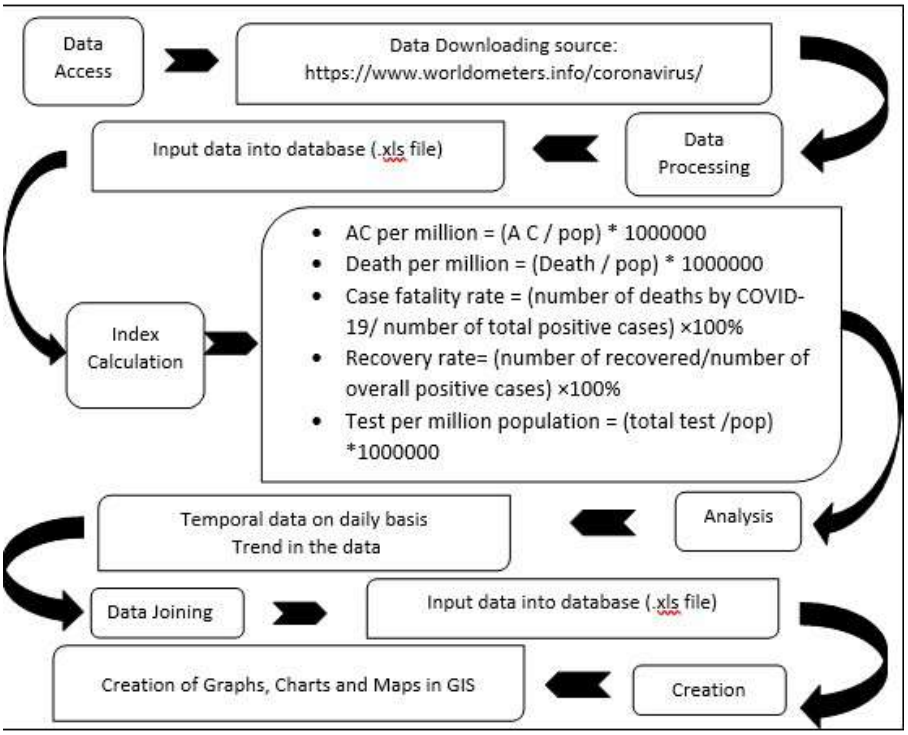
Materials and methods

Data extraction: We extracted population data (total population of the affected countries from 2020 to 21/5/2022) from the world population review database (https://www. worldometers.info/population). The data included -

- number of new cases
- number of total cases
- total number of deaths
- total number of recoveries
- total number of tested population from the WHO database and worldometer coronavirus databases (https://www.worldometers. info/coronavirus).

WHO and worldometer update the data on a day-to-day basis.

The below flowchart shows the process of data analysis -



In all the cases, graphs and maps were produced showing spatial distribution using QGIS software.

Trends and Characteristics

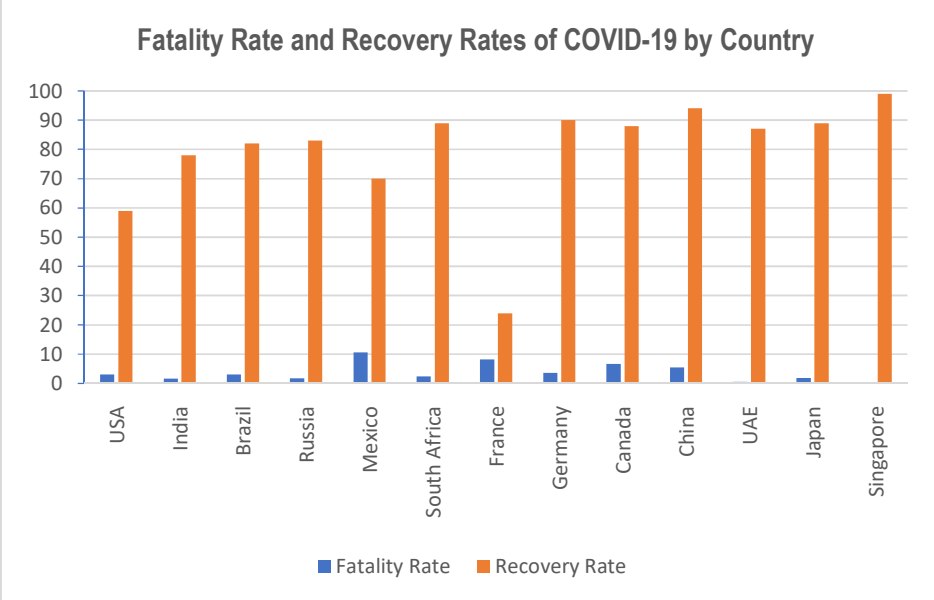


Figure 1 Case fatality rate and recovery rate of COVID-19 patients in different regions of the globe

The above Fig. 1 shows the rate of recovery (orange) and fatality (blue) of COVID-19 in different countriesacross the world. As we see across all the countries, the recovery rate was high almost above 90%. Though in some countries– Maxixo, Brazilm China and Brazil, the fatality rate was high in comparison to other regions.

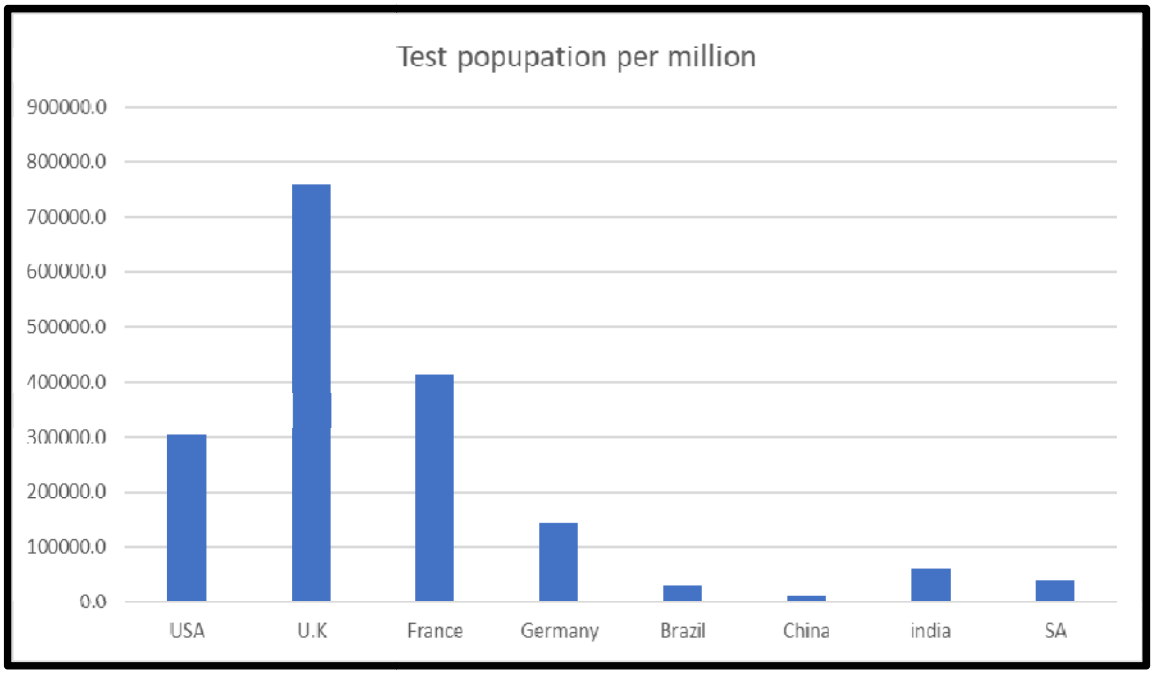


Figure 2 Tested Population per million in different countries

Fig. 2 depicts the COVID 19 tests conducted per million population in different countries till April 2022. As shown in the illustration above, UK tops all the countries followed by France.

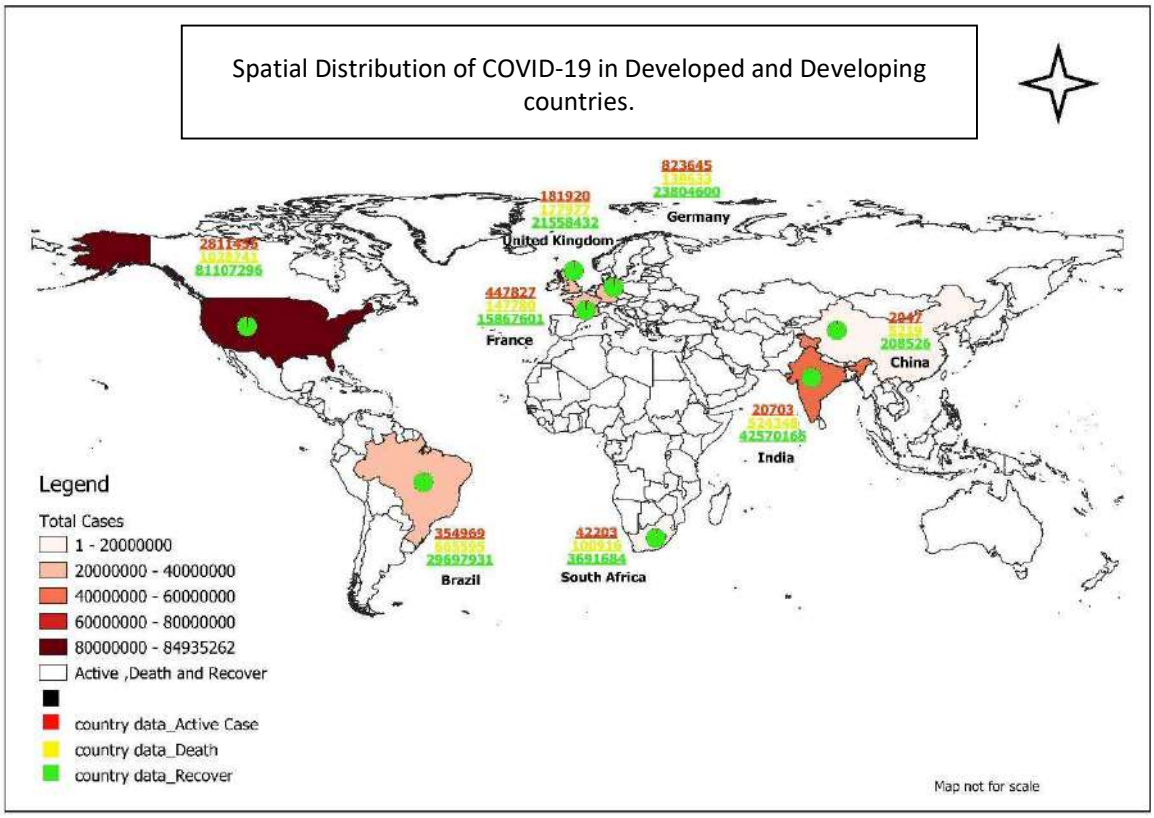


Figure 3 Spatial Distribution of COVID 19 cases in Developed and Developing Countries

In both developed and developing countries, the spatial distribution of active, recovered, and death cases of COVID-19 are shown in Fig.3. The colour gradient of the base map depicted several cases that were yet to be reported (as of May 21, 2022). The map's pie chart indicated the number of active cases (red), recovered cases (green), and deaths (yellow) in various countries.

Epidemiological Characteristics and Test Rate of COVID-19 in Developed and Developing Countries

COVID-19 caused the highest CFR (2.6%) in South Africa, compared to other countries worldwide. The CFR in Germany and France, on the other hand, was the lowest (0.5%). On the other hand, the recovery rate from COVID-19 was highest (98.7%) in India and lowest in France (54.1 %) as represented in Fig. 1. The United Kingdom had the most tests performed per million people. China performed the fewest COVID-19 tests per million people compared to the other countries. Over 1,00,000 tests per million population were conducted in affluent countries such as the United Kingdom (762189.3), France (414205.1), the United States of America (305217.7), and Germany (145137.5). India (60217.5), South Africa (41219.10), Brazil (29608.5), and China (11116.3) were among the developing countries that performed less than 100,000 tests per million people (Fig.2)

In developed and developing countries, the number of COVID-19 cases to date is 23.99 Cr. And the total number of deaths is 2,75,9225. In developed countries, 16.08 Cr cases and 14.6 Lakhs Deaths are there whereas in developing countries 7.91 Cr cases and 12.98 Lakh deaths are there.

In this study, the cases in the developed country, the United States, totalled 8.36 Cr. and 10 Lakhs deaths, whereas the cases in the developing country, India, totalled 4.31 Cr. The United States has the most cases and deaths in the developed world, while India has the most cases in the developing world, and Brazil has the most deaths, with 6.66 lakhs.

This study measured COVID-19 active cases per million population for each country. France had the highest number of active per million cases, while China has the lowest amount. These eight countries are the United Kingdom, the United States of America, Germany, France, India, South Africa, Brazil, and China. The number of active cases per million in China is 10.52, which is quite low in contrast to these countries, and the largest number of cases is 1067.78 in France. China has the lowest per million death rate of 0.89, while France has the highest per million death rate of 30.55.

Distribution and epidemiological characteristics of COVID-19 cases in Developed and Developing countries

In Developed and underdeveloped countries, a total of 23.99 cr. people were infected. As of May 2022, a total of 23.99 cr. people were infected in Developed and developing countries, including the United Kingdom, the United States, Germany, France, India, South Africa, Brazil, and China. The United States of America has the most cases (8.36 cr), followed by India (4.31 cr.), Brazil (3.09 cr.), France (2.86 cr.), Germany (2.62 cr.), the United Kingdom (2.24 cr.), South Africa (39.4 lakhs), and China (12 lakhs), and the United States of America has the most deaths (10 lakhs), followed by Brazil (6.66 lakhs), India (5.25 lakh). COVID-19 instances are distributed in a linear Distribution between developed and developing countries in Appendix 1.

South Africa (2.6 %) has the highest CFR among developed and developing countries, followed by China (2.3 %), Brazil (2.2 %), India (1.2%), the United States (1.2%), the United Kingdom (0.8 %), France (0.5 %), and Germany (0.5 %) (0.5 %). In India, the recovery rate was 98.7%, while in France, it was 54.1 % (Fig. 1). France, South Africa, Germany, and China had limited planning to battle the pandemic COVID-19, whereas India, Brazil, the United Kingdom, and the United States of America had a well-planned response. All of the countries took steps to raise public awareness.

Spatial Distribution of COVID-19 cases in Developed and Developing Countries

From this study, we identify results for how many COVID waves have come so far in which country, and how long has it been. The tables show the highest number of active per million population in a single day and the most deaths in a single day. The detailed tables are appended in Appendix 2

This research studies the geographic distribution of COVID-19 active, recovered, and death cases. The colour gradient of the base map (Fig. 3) depicts several cases that have yet to be reported (as of May 21, 2022). The map's pie chart indicates the number of active cases (red), recovered cases (green), and deaths (yellow) in various countries illustrated in Fig. 3. The highest COVID-19 case were identified between 80000000 to 85000000 in the United States, and in South Africa between 1 to 20000000. Developed countries have the most cases of COVID-19 compared to developing countries in this spatial distribution. The most considerable number of COVID-19 cases recovered is in India and the lowest in France. The pie chart of the map also shows the highest number of active cases and deaths in the United States and China's lowest number of active cases and deaths.

Spatio-Temporal pattern of COVID-19 for regions of Gujarat

This session has made an effort to examine the Spatio-Temporal pattern of COVID-19 in Gujarat state. It has utilized various formulas to calculate the case index and has assessed variation in regional dimension within the state. The brief methodology is as follows:

1. Sourcing COVID-19 data from the Gujarat government website (gujcovid19.gujarat.gov.in)
2. *Daily Data* is already available on the portal. The calculation of active cases per lakh is as follows: Active case per lakh = A C / pop. * 100000, *where A C = Active Cases and pop. = Population*
3. The data is available on a daily basis. Hence, for temporal analysis, different temporal resolution is selected, and the number of cases in the required period is observed and studied to understand the variations in the number of COVID-19 cases.
4. The temporal pattern studied is as follows
   Daily basis – which can be monthly, bi-monthly or 6- monthly studies, etc.
   Monthly basis GIS Map was created in Gujarat.
5. Analysing the trend of COVID-19 cases.
6. Creation of different charts, and graphs for the selected intervals.
7. Compiling of the data to shape files to create maps.

Here, the data is represented in 5 zones:

1. North Gujarat Region
2. South Gujarat Region
3. Central Gujarat Region
4. Saurashtra Region
5. Kutch Region

North Region

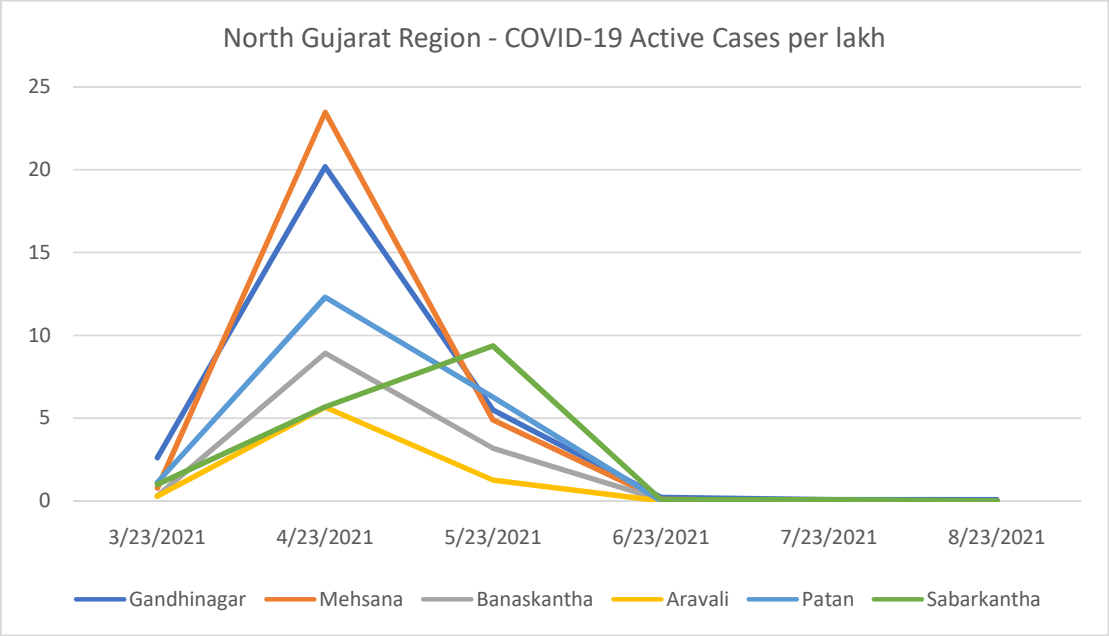


Figure 4 North Gujarat Region COVID 19 Active cases

In the North Gujarat region, the number of COVID-19 cases was less than 2.60 lakhs in March, with the highest number of cases recorded in the Gandhinagar region at 2.59 AC per lakh. Subsequently, there was a rapid surge in cases, with the highest peak occurring in April. On April 23, 2021, the district-wise comparison showed that the highest number of cases was recorded in the Mehsana district at 23.47 AC per lakh, followed by 20.18 ac per lakh in the Gandhinagar district, while the other districts had less than 12.20 AC per lakh active cases.

In the following months, while many areas experienced a decrease in COVID-19 cases, Sabarkantha district saw an increase to 9.36 ac per lakh, while other districts remained below 6.26 AC per lakh. By June, the number of cases in the region had decreased to 1 AC per lakh, and this trend was sustained.

South Region

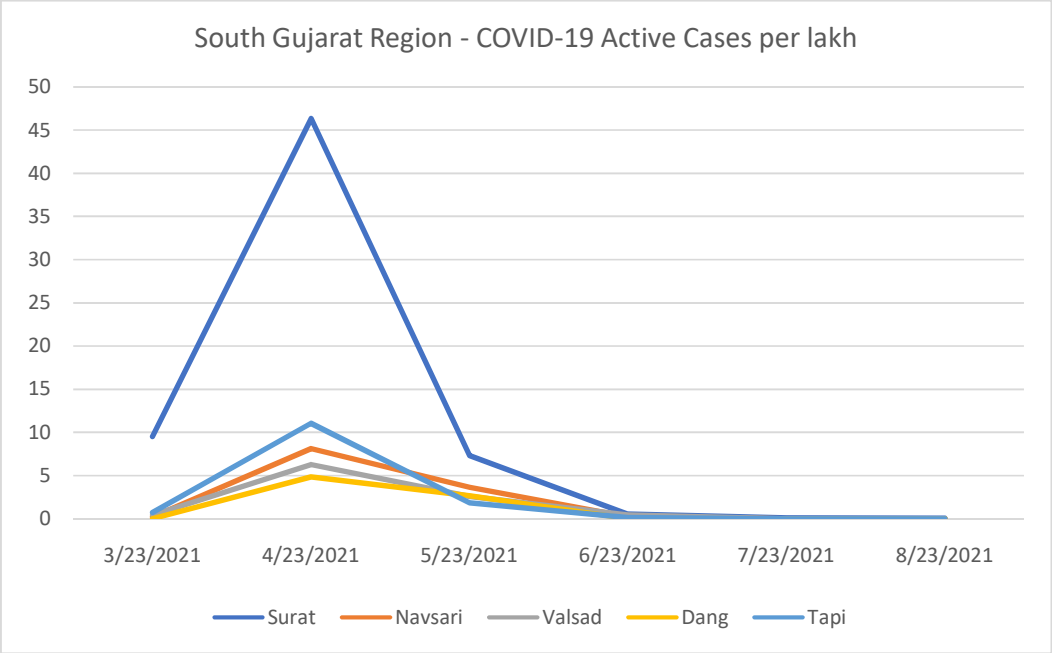


Figure 5 South Gujarat Region COVID 19 Active cases

In the South Gujarat region, except Surat district where the number of active COVID-19 cases was 9.46 AC per lakh, the cases in March were less than 1 AC per lakh. Surat is one of the major cities of Southern Gujarat. Thereafter, there was an increase in cases with the peak occurring in April, during which Surat recorded the highest number of cases at 46.33 ac per lakh, while other districts had less than 11.04 ac per lakh.

Following April, there was a decline in the number of COVID-19 cases. On May 23, 2021, the highest number of cases was recorded in the Surat district at 7.32 AC per lakh, while the other districts in the South Gujarat region had less than 3.61 ac per lakh.

In June, the number of cases in all districts was less than 0.51 AC per lakh and continued to decrease.

Central Region

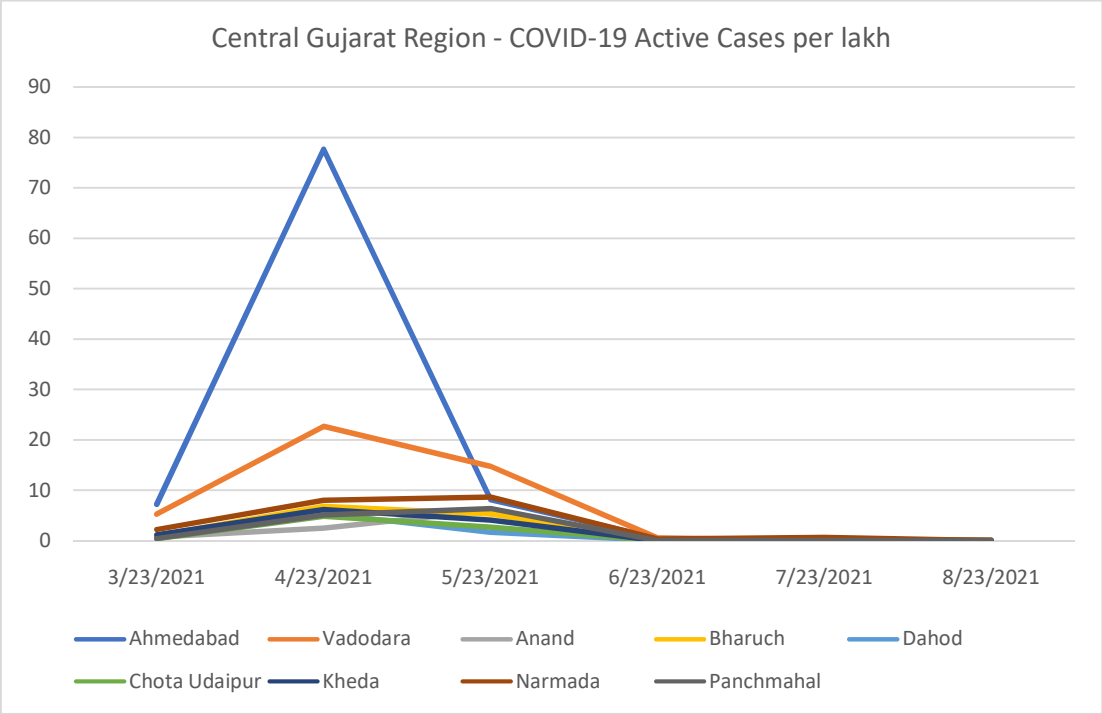


Figure 6 Central Gujarat Region COVID 19 Active cases

In the Central Gujarat Region, COVID-19 cases were high in the month of March in comparison to other regions of Gujarat. In Ahmedabad district, the COVID-19 cases were 7.22 AC per lakh, whereas in other districts it was less than 5.23 AC per lakh during that time.

In the month of April, there was a tremendous rise in COVID-19 cases in these districts, and it was recorded high in the Ahmedabad district, which was 77.64 AC per lakh which was the highest among all the regions of Gujarat.

In other districts of the central region, the number of COVID-19 AC cases was less than 7.97 AC per lakh.

After April, there was a decrease in the COVID-19 case in this region.

Saurashtra Region

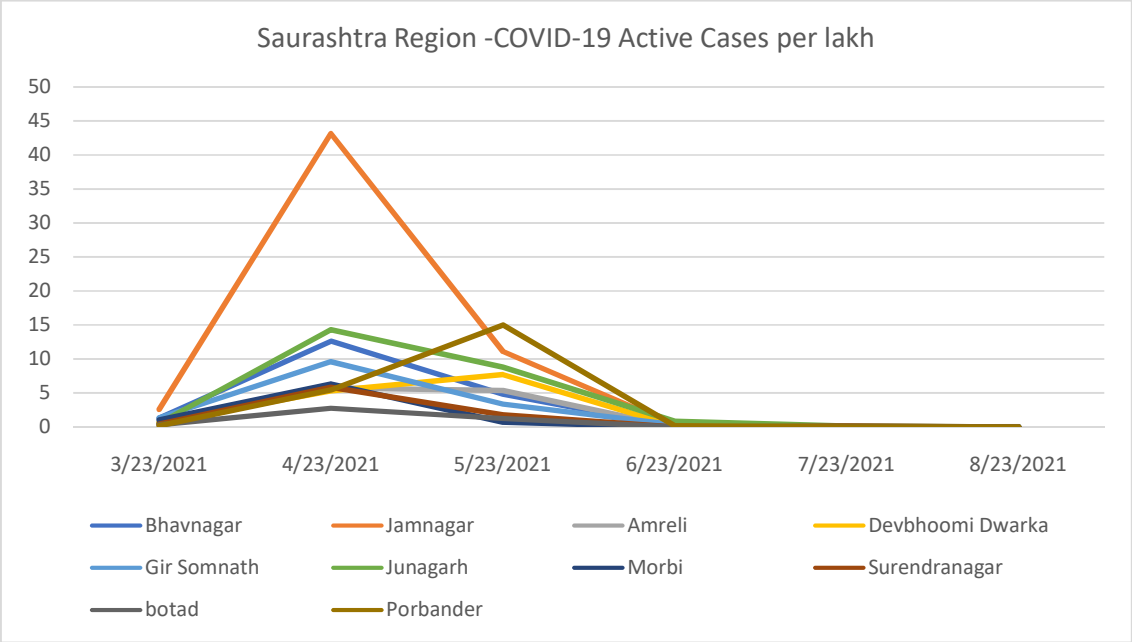


Figure 7 Saurashtra Region COVID 19 Active cases

In the Saurashtra Region, COVID-19 cases were the highest in the Jamnagar district. On the starting date it accounted to 2 AC per lakh. And also, other districts recorded the cases as 1 AC per lakh. Subsequently, in all the districts of Saurashtra, there was a rise in active cases. On 23rd April 2021, the highest cases were in the Jamnagar district with 43 AC per lakh cases and the lowest recorded in Botad district with 2 AC per lakh. During this period there was no peak observed in Devbhoomi Dwarka and Porbandar. And in the rest of the district, 14-15 AC per lakh were recorded.

After this scenario, there was a decline in the active cases of COVID-19, excluding Devbhoomi Dwarka and Porbandar. On 23rd May 2021 highest peak was observed in Porbandar with 15 AC per lakh and after that Jamnagar, Junagarh, and Devbhoomi Dwarka with 11.08, 8.78 and 7.70 AC per lakh.

After May, there was a decline in the active cases of COVID-19in the Saurashtra Region.

Kutch Region

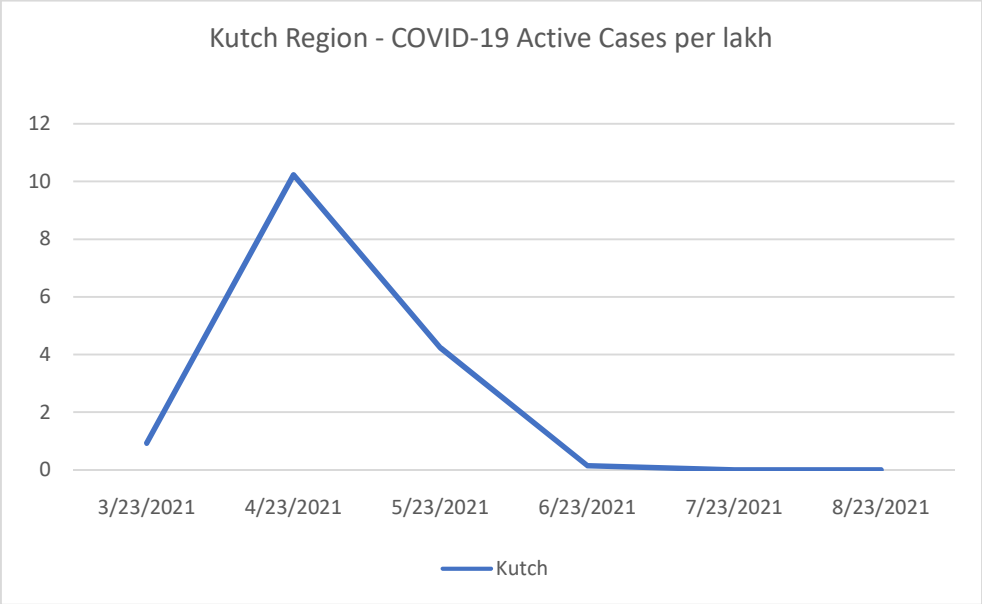


Figure 8 Kutch Region COVID 19 Active cases

The Kutch region, located in the northwestern part of Gujarat and the state's largest district, recorded the lowest number of active COVID-19 cases at 0.92 per lakh in March compared to other regions in Gujarat and Saurashtra. However, the number of cases began to rise in April and reached a peak of 10.22 AC per lakh.

In May, the number of active cases decreased to 4.23 per lakh, and in June, July, and August, the number of cases remained low.

After analysing and creating a map, it was observed that April 2021 had the highest number of COVID-19 cases in most places. Peaks were observed in most cities when the data was analysed for the months from March to August and plotted on a graph. The results were similar among all regions except for the Saurashtra region, where only one city named Porbandar showed a peak in May. The rest of the cities reflected a similar trend, except for major cities like Ahmedabad, Vadodara, and Surat, which had higher values in the number of COVID-19 cases. However, from May to July, the number of cases decreased, and by the end of August, the cases were significantly lower in most places.

Chapter 3:

Documenting the Procedure and Methodology to Understand the Determinants of COVID-19 in Gujarat

India

The Republic of India's official name is derived from the Sanskrit name 'Sindhu', which refers to the Indus River. It is located between 8°4'N (the mainland) and 37°6'N latitude and 68°7'E and 97°25'E longitude. The Indian subcontinent is located North of the Equator. With a total area of 3,287,263 square km, it is the seventh-largest country in the world (1,269,219 sq. mi).

India has 15,106 kmof land boundaries and 7,516 kmof coastline. Only 5 of the 29 states do not have an international boundary or a coastline. It shares its border with China, Pakistan, Bhutan, Myanmar, Afghanistan, Nepal, and Bangladesh.

Gujarat State

Gujarat is located inthe western coastal region of India, bordered on the west by the Arabian Sea, on the northeast by Rajasthan, on the east by Madhya Pradesh, and on the southeast by Maharashtra. On the north-western edge, the state shares an international boundary with Pakistan. It is located between latitudes 20^0 1' and 24^0 7' N and longitudes 68^0 4' and 74^0 4'E. The state features the world's longest coastline, measuring roughly 1600 km, attracting seafarers throughout history, drawn by the lucrative trading opportunities. Gujarat was a part of the former Mumbai state during British control. However, the Gujarati population opted to form their union in 1960, creating two new states, Gujarat and Maharashtra.

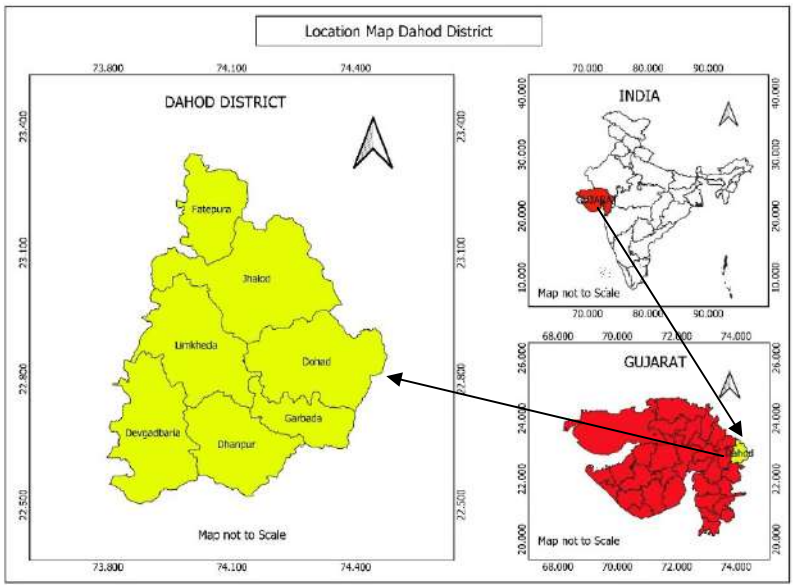
According to the 2011 census, Gujarat had a total of 26 districts. Since August 15, 2013, seven new districts have been formed. The total number of districts in Gujarat now stands at 33.

Even though Gujarat is becoming a significant agricultural and industrial state, the benefits of the green revolution have not reached rural and tribal people. Many disadvantaged districts face the issues of rain-fed, drought-prone, flood-prone, and hilly terrain and mountains. As a result, to achieve balanced regional development, an integrated approach to sustainability is highly recommended. Tribal people live in ten districts across the state, from Banaskantha in the north to Dangs in the south. It is representative of a wide range of soil and climatic conditions. The planning commission has designated six tribal districts in Gujarat as disadvantaged based on the backwardness index[4]. Two of these districts, Banaskantha and Sabarkantha, are in North Gujarat and are managed by SDAU; Panchmahals and Dahod in Central Gujarat are managed by AAU, and

[4]A composite index indicating levels of deprivation or backwardness is derived using such parameters that the Mandal Commission has developed for identifying backward classes but with certain modifications to reflect contemporary conditions.

Narmada and Dangs in South Gujarat are managed by NAU. The primary income sources for this district's people are agriculture and related activities.

Dahod District



Dahod district is located on the east coast of Gujarat, primarily composed of indigenous people living in a diverse environment. Dahod is a small city with a municipality that serves as the district's headquarters. This district covers 3,642 square km, ranking 18th among the state's districts in terms of geographical coverage. It is located between the latitudes of $22^0$30' and $23^0$19' and the longitudes of $73^0$47' and $74^0$29'. The district is 91.74 kmfrom north to south and 71.90 kmfrom east to west.

Fatepura, Jhalod, Limkheda, Dahod, Garbada, DevgadhBaria, and Dhanpur are the seven talukas (Tehsils) that make up the district of Dahod. Because of the tribal majority, these talukas have been designated as tribal talukas. The former Jhalodtaluka was separated into two talukas, Jhalod and Sanjeli, on September 9, 2013, bringing the total number of talukas in the district to eight. However, because Sanjelitaluka was found recently, the study did not address bifurcation. Nonetheless, the current SanjeliTaluka's details have been included in the JhalodTaluka's details.

Caste and Culture

CASTE

Dahod district was formed by separating tribal areas from Panchamahal district in 1997. The district's population is mostly rural, and most of the district's residents are Tribal, mostly Bhills[5]. Dahod District also has the second largest population of the Dawoodi Bohra[6] sect of Muslims in India. Tribal people make up 74.3% of the district's total population, while Schedule Caste (SC) accountsfor 1.9%. The Bhils are India's "most scattered tribal tribe," according to Victoria R. Williams. They make up India's most populous group.

[5]Bhills are considered as one of the oldest tribe in India. Once they were the ruler in parts of Rajasthan, Gujarat, Malwa, Madhya Pradesh and Bihar.

[6]The DawoodiBohras are members of the Muslim community's Shia sect

OCCUPATION

Dahod Scheduled Tribes (ST) have a long history of conflict. Agriculture and forest are the primary sources of income in this region. There isn't a single activity that guarantees them enough money to live comfortably. The tribalpopulation's limited land holdings and low productivity are the primary causes of their diverse vocations. In this region, agriculture is primarily rain-fed and mono-cropped, but double cropping (Kharif and Rabi) is common among tribal farmers. Due to the availability of suitable irrigation facilities in some areas, triple cropping is also practiced. As a result, wheat and vegetable contributions have increased, ensuring food security for five to seven months of the year. Agriculture is a major source of income for indigenous people in the Dahod area. This industry employs over 95 percent of indigenous people. Land holdings vary little in the Dahod, and the majority of tribals own no more than 6 Guntha of land, from which they can make an income of Rs. 1500/- per Guntha. This salary is insufficient to meet their basic needs. During the off-season, some of the tribals migrate to neighbouring locations in search of work. They encounter obstacles and hurdles in securing a sustainable livelihood and a gracious living as a result of environmental degradation and non-tribal involvement

Apart from land, employment in the public and commercial sectors has become a new source of income. Very few tribes have technological education, and only a handful have decent occupations.

Traditions and Practices

The districtofDahod houses a majorly tribal population. Wood is an important aspect of tribal communities' social lives, and they rely fully or partially on forests for their sustenance. They rely on forestsfor medicine, food, firewood, fodder, and certain other non-timber forest products, among other things. Plants have an indirect and cumulative effect on the local economy, food security, and health of tribal communities. Every species has its name and identifying techniques given by locals. Plant-based medicine is an old, worldwide practice that is the foundation of health care for many rural communities and residents in third-world nations. As the relevance and demand for traditional herbal treatments grow, recognizing and evaluating such traditional knowledge and practices is becoming increasingly important. Dahod district consists of nearly 182 species of plants belonging to 127 genera and 57 families. Some of these species hold characteristics that help cure many diseases. Women use angiospermic plants in the Dahod district to cure a variety of gynaecological diseases. The tribal females of the Machhar, Sangoda, Baria, Ninama, Vasaiya, Vasava, Parmar, and Chauhan communities utilise a total of 23 kinds of angiospermic plants of 13 genera from 17 families to cure gynaecological disorders and other related problems. Tribal people of the district use other plant-based remedies to cure lucceouria, ovary disease, urine infection, lactation, maturation- problem, sexual-potential problem, and infertility. Tribal people have been attentive toboth forest usage and forest conservation. In the Dahod district area, the Bhil community has long been the sole keeper and conservator of forest patches. Yet, Bhils have never received credit for their conservation efforts in anthropological studies. Nearly every village with a large Bhil population has its holy grove. They have no written scriptures or religious literature, but they believe in Deities who reside in the Sacred Groves and watch over them at all times and in all actions. Their Deities dwell in trees, and the

community will not allow anybody to damage them. Some groves depict the ancient splendour that the woodlands must have once had.

Methodology and System Approach

Survey/pre-exercise:

Dahod was chosen the Study Area. The overall literacy rate of the district is the lowest in the state; major income sources are daily wages and agricultural activities. The region has the highest number of tribal population who are generally less aware of new technologies and other ways to mitigate modern problems. Hence, we decided to train the area youth and make them aware of this project's current scenario and objectives. To include youth in the fight against COVID-19,we acquired alist of interested students from various colleges of each talukas. After training the selected students, the students will train the students from school to school. This created a chain of Warriors who will spread awareness in the tribal area. To make the process engaging, various games and activitieswere implemented as we were dealing with the students. A web portal for DahodCOVID-19 updates is in the process, which will enable people to get regular updates on COVID-19 cases.

Community Mobilization /Social Engineering

Information has grown into one of the essential pillars of modern civilization. Knowledge and information have become the most important factors in a society's economic well-being and, as a result, a role in its stability and long-term growth. In such times, where “A lie can travel halfway around the world before the truth can get its boots on.” Effective community mobilization by using adequate techniques, can be a miraculous boon to spread awareness and bring effective change in the behaviour towards the problem. Community mobilization is essential, as it leads a vulnerable community section towards awareness. In the tribal area, they have their standards, values, beliefs, and civilizations on which to base their existence.They must comprehend the importance and relevance of community mobilization in today's world, with breakthroughs occurring and the advent of modernization and globalization. This is regarded as the most important notion in improving one's overall living situation. In tribal areas, participatory skits, public meetings led by the head of the community, door to door awareness can be helpful aspects. Effective social engineering can be a great tool inthis aspect, as the main purpose of social engineering is to bring awareness via manipulation and facts. In the act of social engineering, the active participation of youth brings fruitful outcomes, as the youth of modern times are familiar with social media, smartphones, and other modern technologies. Community mobilization will encourage them to gain more education, develop skills, and improvised communication skills, this all may lead them to a more a better way of life.

Technology Identification

Modulization (Annexure 1)

In this study, 7 different types of modules are developed. The topics are as follows:

1. To create geospatial technology with COVID Aspect
2. Getting Familiar with the QGIS interface
3. To import the Indian census data of districts into a shapefile by using the joining method
4. QGIS Digitization and visualization.
5. Thematic data mapping and layout mapping
6. How to Field data collection using GPS android App (GPS hands-On)
7. How to make Google form

These modules focus on how Geographic Information Technology can be used in COVID-19.

Training Component

Two training programmes were undertaken-

1. Online training programme
2. Offline training programme

The target of the online and offline training was the youth of college, school students, and district people. Thereafter, the role of the doctor, expert, and speaker became important. The training'spedagogy included hands-on application practice, question-answer sessions, data acquisition, field visits, feedback, etc.

Science & Technology Component

Technology Package Development

This study's main components are Geographic Information System (GIS), Interactive Maps, Website, and Geocoding for ground data collection.

New Innovation

GIS application **provides the capability to identify high-risk areas that require emergency care**. Pinning down the vulnerable locations, nearest vaccination centres, and check-up centres on the map using geocoding. Health and disease management is critical to the socio-economic development of any society. So, this approach offers substantial benefits to healthcare sectors across the world. We also do buffer zone, contact tracing, and high-risk training for the infected.

Observation

Most of the participants in the training had hardly any experience working on any computer-based programs/software. We should note that the participants were keen to learn about the new technology. On the second day of training, all the trainees actively participated in field data collection. Participants went to interact with the local community. These interactions helped us know the myths and hesitations among the local community, which helped us figure out the local community's mindset and state of awareness.

People's Participation From Planning To Implementation Stage

We have given a total of **10**pieces of training; in which **3** pieces of traininghave been given via online mode and **7** pieces of traininggiven in offline mode. Total participants in the training were, these, **378** participants took part in online training and **200** participants attended offline training. Day 1 focussed on the theoretical aspects, where various topics related to the trainingwere covered. The major topics are as follows:

- Basics of Remote Sensing and GIS
- COVID-19 and its Awareness
- The COVID-19 mapping using Open-Source Software,the Global Positioning System and
- Global Navigation Satellite System.
- The visual demonstration of the whole process of COVID-19**,** and the point data collection with the help of Google Form.

On day 2, field data werecollected by the participant for different locations with the help of Geocoded COVID-19 Survey Google Form and the collection of Geo-tagged photographsfrom the GPS Map Camera Lite Mobile App.

Students collected geo-tagged photographswhich were compiled into an Excel sheet in which all the geo-locations were registered. The Excelfile was then mapped and the geo-reference polygon was also mapped with the help of the field area measurement app. The basic and essential map elements were added and a map was prepared. Students prepared the COVID-19 mapping of their respective Talukas.

INDICATORS APPLIED FOR THE MONITORING

Feedback was collected from participants at the end of the training. The feedback form focussed on the perception of the participantsfor the two-day training and their willingness to be part of the advanced training. The detailed feedback form is appended in Appendix 3. The questionnaire will serve as a monitoring tool for further training. As we focus on creating COVID-19 for each such communitythe participants play a vital role in this process. This will work as a chain process as they continue educating others and spreading awareness in their community.

Collecting feedback from participants was an essential step to measure the effectiveness of the training program. The feedback form used in this training program served as a useful tool for monitoring and evaluating the training outcomes. The detailed feedback is appended in Appendix 3. The questionnaire allowed participants to provide their perceptions of the training and express their willingness to participate in future training sessions. This feedback will help the team to improve future training programs' content, structure, and delivery.

The focus of the training program on creating COVID-19 awareness in communities highlights the importance of the participants' role in this process. After acquiring the necessary skills and knowledge, the participants can educate and spread awareness among their communities. This process will create a ripple effect where each participant can contribute to creating a better-informed community.

Moreover, the feedback form will also help in identifying the strengths and weaknesses of the participants, which can be used to tailor the advanced training program. The form will also be useful in tracking participants' progress, identifying areas of improvement, and ensuring that they meet the program's learning objectives.

In summary, collecting feedback from participants is an integral part of any training program. The feedback form used in this training program will help monitor and evaluate the training outcomes, identify areas of improvement, and tailor future training programs. The role of the participants in creating COVID-19 awareness in their communities cannot be overstated, and their willingness to participate in advanced training programs will contribute to the success of the program.

Chapter 4

Preparing the Modules Based on the Training.

The Geospatial approach was a crucial part of the project, which shows actual data using administrative boundaries of the area and human interface with the help of Spatial Data analytics techniques, various handy maps,and Training of Trainer components. The approach needs an expert to understand its results. In order to achieve the target of creating COVID Warriors,ten two-days training programmes (3online and 7 offline) for 198 youths from seven different Talukas of Dahod were held in the duration spanning from October 2021 to January 2023. The primary data tools which were used in the training were as follows:

- Databoard
- Attributes
- SpatialModelling
- Map Layouts
- Geospatial Hands-OnWorkshops

The two-day workshop delivered by various experts in the field proved helpful in creating the modules that focussed on the following areas:

- How to make maps on Spatial Patterns and Temporal Changes in the Spatial pattern of COVID-19 in Gujarat with the help of GIS
- How to assess the status and quality of health infrastructure in Gujarat with the help of GIS

The themes of the modules

The training program consisted of six sessions; each focused on different aspects of Remote Sensing and GIS, their relevance to COVID-19, and the usage of various tools and software for data collection, analysis, and visualization. Here is an elaboration on each of the sessions:

Relevance of the training

Remote Sensing and GIS (Geographic Information Systems) play a significant role in the context of COVID-19. In this module, participants were introduced to Remote Sensing and GIS basics and their relevance to the current pandemic. They were trained to use GIS applications in various fields, such as Health, Agriculture, Urban Planning, and Disease Prevention. The participants were taught the basic elements of map-making and their roles as skilled human resources. The focus was kept on COVID-19, and various databases on COVID-19 were shown to participants to have an idea about ongoing studies at national and international levels.

During the session, participants were provided with an overview of Remote Sensing and GIS principles and applications. They were taught the basics of map-making, such as how to create maps and visualize data. The experts highlighted the importance of GIS in the health sector and how it can be used for tracking and analysing the spread of COVID-19. They also demonstrated how GIS can be used in various fields, such as Agriculture and Urban Planning, to make informed decisions.

In the second part of the session, participants were given a detailed understanding of Raster and Vector data. They were taught how to use Vector data tools for making COVID-19 maps at various administrative levels. The participants were encouraged to use their learnings from the session to train college and school children. The experts emphasized the importance of developing skilled human resources for the effective use of GIS in various fields. Overall, the module provided participants with a comprehensive understanding of the basics of Remote Sensing and GIS and their relevance to COVID-19. They were able to gain insights into the practical applications of GIS and its role in decision-making.

COVID-19 – Disease and Prevention

In addition to the information provided about the biological nature of the coronavirus and its transmission, the facilitator also explained the importance of testing for COVID-19. Stress was laid on the 'Testing' as it is a crucial tool to identify individuals who are infected and isolate them to prevent further transmission. Knowledge was given regarding the types of tests available, such as PCR and rapid antigen tests, different stages of COVID-19, and how the disease progresses. The facilitator pointed out the importance of seeking medical attention if symptoms worsen, such as difficulty breathing, persistent chest pain or pressure, confusion, or pale lips or face.

The module also discusses the impact of COVID-19 on certain populations, such as older adults, people with underlying medical conditions, and pregnant women. These populations are at a higher risk of developing severe illness from COVID-19 and may require special precautions.

The module throws light on the importance of mental health during the pandemic. The pandemic has been stressful for many peopleand provides resources and tips for managing stress and anxiety.

It encourages participants to get vaccinated and to continue practicingsafety measures even after vaccination. While the vaccine is highly effective, it is important to follow guidelines to prevent the spread of COVID-19, especially since new variants are emerging.

Real-time Surveillance of the COVID-19

The mobile application, 'Advanced Covid-19 Syndromic Surveillance System' (ACSyS), is designed to track the spread of COVID-19 and monitor the health status of infected individuals. The application was developed by Mr. Abhiyant Tiwari and his team, with the aim of providing an effective tool for a pandemic response, particularly in low-resource settings where there may be limited access to healthcare resources.

One of the key features of the ACSyS application is its real-time monitoring capabilities. The application collects data from individuals who have been infected with COVID-19, as well as from healthcare workers and other sources, to provide a real-time view of the spread of the virus. This data can be used to identify outbreaks, track the spread of the virus, and help healthcare providers make informed decisions about allocating resources and responding to the pandemic.

In addition to real-time monitoring, the ACSyS application also uses advanced algorithms to analyse the data collected by the system. These algorithms are designed to identify patterns and trends in the data, which can help healthcare providers make more accurate predictions about the future

spread of the virus. The application also uses machine learning techniques to improve its predictive capabilities over time, based on new data and feedback from healthcare providers.

Overall, the ACSyS application represents an innovative approach to pandemic response, leveraging technology to collect and analyse data in real-time, and providing healthcare providers with the information they need to make informed decisions about how to respond to the pandemic. By providing an effective tool for monitoring the spread of COVID-19, the ACSyS application has the potential to save lives and mitigate the impact of the pandemic, particularly in low-resource settings where healthcare resources may be limited.

Geo-Spatial Activity

The Geospatial Activity conducted by the Gujarat University Team experts focused on using a Google form and its applications. This activity aimed to introduce the participants to the benefits of using technology in geospatial data collection and analysis. The team explained the use of the Google form in collecting geospatial data and how it can be used to gather information on specific locations or areas.

During the activity, the experts also provided an overview of the Global Positioning System (GPS) and the Global Navigation Satellite System (GNSS). They explained how these systems work and how they can be used to determine the location and navigate accurately. The experts also discussed the differences between GPS and GNSS and its usage in different parts of the world.

The satellites used in the GNSS were also explained to the participants. The team provided information on the different satellites used by various countries and the differences between their orbits and accuracy. This comparison helped the participants understand how different GNSS systems function and the role they play in providing accurate location data.

The importance and usage of these technologies in day-to-day life were also highlighted during the activity. The experts explained how GPS and GNSS are used in various applications such as navigation, agriculture, transportation, and disaster management. The participants were also shown how these technologies are being used in mobile devices and how they are changing the way we interact with the world around us.

The experts also discussed the future of these technologies and their potential for further development. They explained how advancements in satellite technology, such as the launch of new satellites and the development of more accurate location tracking systems, are likely to improve the accuracy and reliability of GPS and GNSS.

Overall, the Geospatial Activity conducted by the Gujarat University Team provided the participants with an introduction to the use of technology in geospatial data collection and analysis. The team's discussion of GPS and GNSS helped the participants understand how these systems work and their applications in different fields. The activity also highlighted the importance of these technologies in day-to-day life and their potential for further development in the future.

QGIS Interface in Terms of Health Applications

The module focused on educating participants on the use of the QGIS Interface for Health Applications. The session began with a discussion on how to download and use the QGIS software. Participants were provided with step-by-step instructions on installing the software on their computers and navigating through the QGIS interface.

The session then moved on to digitising and visualising health data with a special focus on COVID-19. Participants were instructed to collect ground data from their respective colleges, which was then used for the purpose of map preparation. The experts explained the map preparation process, including the steps involved in importing data into QGIS and digitizing the data.

The application of QGIS software in visualizing health data was then demonstrated to the participants with the help of available health data from the government website. The experts provided a practical demonstration of how to create thematic maps and how to lay out health data in a visually appealing manner.

Thematic mapping, which involves displaying data with different colors and patterns to represent different values, was explained to the participants. The experts demonstrated how to create thematic maps in QGIS using health data related to COVID-19. They also explained how to interpret thematic maps and how they can be used to identify trends and patterns in health data.

Finally, the layout of health data was explained to the participants. They were taught how to create a visually appealing layout for health data using QGIS, which involved arranging the map elements to effectively communicate the data to the viewer.

Overall, the session provided participants with a comprehensive introduction to the use of QGIS software for health applications. They learned how to download and use the software, digitize and visualize health data, and create thematic maps and layouts. The practical demonstrations the experts provided helped participants better understand the software and its applications.

Knowhow of data collection

The module focused on educating participants about Geo-tagging health data with reference to COVID-19. The experts provided a detailed explanation of how geo-tagged images on the field are being collected. Participants were introduced to the hardware settings of mobile devices and were taught how to enable their phones to take geo-tagged images.

The session began with an overview of the importance of geo-tagging in collecting health data related to COVID-19. The experts then explained how geo-tagged images are collected on the field using mobile devices. They provided step-by-step instructions on how to configure mobile devices to capture geo-tagged images and how to use them for data collection.

The hardware settings of mobile devices were well explained to the participants. They were taught how to enable GPS and other location-based services on their mobile devices to capture accurate location data. Participants were also taught how to adjust the camera settings on their phones to capture high-quality images.

After the hardware settings were explained, participants were given practical training on how to apply all the settings on their mobile phones to enable them to collect field data. They were given the opportunity to experiment with their phones and capture images with geotags.

On the same day, participants were also taught point data collection with the help of Google Forms. The experts provided an overview of how to create and use Google Forms to collect health data related to COVID-19. Participants were given step-by-step instructions on how to create a Google form and how to customize it for their specific data collection needs.

In conclusion, the module provided participants with a comprehensive introduction to geo-tagging health data with reference to COVID-19. They were taught how to configure their mobile devices to capture geo-tagged images, use Google Forms for point data collection, and customize the forms to meet their specific data collection needs. The practical training provided by the experts helped participants gain a better understanding of the techniques and tools used for geo-tagging health data.

Mapping Spatial Pattern of COVID-19 and the Role of GIS

This module was conducted over two sessions and focused on field data collection for different locations using a COVID-19 Survey Google form and Geotagged photographs from GPS Map Camera Lite Mobile App.

During the first session, participants were given an overview of the data collection process and were taught how to use the COVID-19 Survey Google form for data collection. They were also introduced to GPS Map Camera Lite Mobile App and were given practical training on how to capture geotagged photographs using the app.

In the second session, participants were instructed to collect geotagged photographs and compile them into an Excel sheet. They were then taught how to map the locations using the Excel file and geo-reference polygons with the help of a field area measurement app. The experts provided step-by-step instructions on how to add basic and essential map elements to prepare a map.

The participants were shown how to map the locations of COVID-19 cases in Dahod using thematic mapping techniques. They were given an overview of the significance of Corona mapping and how it can be used to analyze and monitor the spread of the virus. The experts demonstrated the process of mapping the locations of COVID-19 cases on the prepared map.

The module provided participants with hands-on experience in field data collection, geotagging photographs, and mapping. They were able to apply the techniques and tools taught in the sessions to prepare maps and visualize data related to COVID-19. The module helped participants better understand the practical applications of mapping and data visualization in the context of health emergencies.

To conclude all ten trainings were scheduled andplanned revolving around the above broad topic and based on the same seven modules were prepared which can be referred to in Appendix 3.

Chapter 5

Training of the COVID Warriors

Knowledge provides strength to the minds of people. To impart knowledge, we believe training sessions play a crucial role. Training of frontline staff can't go beyond one level as it can't reach the local people due to various challenges. Under this project, one major target was to train responsible youth to make more people aware of how to respond to situations of a pandemic; work outsolutions, and a will to fight against this virus. This exercise helped us in the following aspects:

This project trained youth in two aspects: technological advancement and using this technological advancement for mapping disease spread patterns and health infrastructure. The specific outcome -

- Increase in the number of COVID Warriors who can contribute productively to future potential health risk
- Increase in technological understanding and further utilization to deal with health issues.
- Encouraging youth by giving them technological exposure for further study.
- Generating the right information and knowledge regarding COVID-disease and health infrastructure
- Educating society onthe prevention ofvector disease.

Training Schedule across the seven Talukas

The two-dayoffline trainingswerescheduled in the seven talukas of Dahod as follows:

Taluka	**Date**
Limkheda	27-28 January 2022
Garbada	10-11 February 2022
Dhanpur	28-29 July 2022
Devgadhbariya	25-26 August 2022
Fatepura	27-28 September 2022
Dahod	14-15 October 2022
Sanjeli	17-18 October 2022

Table 1: Taluka-wise Training date

Trainers Profile

For the two-day training, 11 experts imparted their knowledge to the students in the various taluka and helped them understand the GIS software and its end-to-end utilisations. The doctor remained present in all the training programmes. The programmewas designed focussing the theoretical and practical parts of the software. The brief introduction of all the resource persons is as follows:

- **Dr. Shital Shukla:** Head of the Department of Earth Sciences at Gujarat University. She is successfully running the Geoinformatics course at the department, guiding many Ph.D. students in Geography and Geoinformatics. Dr. Shukla has been part of all the training sessions and imparting her enriching knowledge to the trainees.
- **Mr. Abhiyant Tiwari:** Assistant Professor at Gujarat Institute of Disaster Management. He is the lead climate resilience and health consultant at NRDC India. He is a member of the National Disaster Management Authority of India's technical experts' group that develops national heatwave adaptation plans guidelines. He is also a member of the technical expert group on Heat-Related Illnesses constituted by the National Centre for Disease Control, Govt. of India.
- **Dr. Pankaj Panchal:** Working in Samir Hathila Hospital, he is a visiting Doctorat Om Hospital Dahod and Zydus Hospital Dahod. He has played an active role in the surveillance of COVID-19 Cases and diligently counselled the Covid affected.
- **Prof. Chandrikaben Raval:** Retired Prof of the Department of Sociology at Gujarat University.
- **Dr. Parijat Goswami:** Professor and Head of the Department of Microbiology at Zydus Medical College, Dahod.
- **Dr. Rajesh Damor:** Assistant Professor at the Department of Earth Science. He did his Ph.D. From Saurastra University, Rajkot
- **Dr. Sangita Patel**: Head of the Department of Sociologyat Gujarat University.
- **Mr. Abhinav Srivastava:** He did his M.Tech. (Geomatics) and currently working as a Research Assistant at the Department of Earth Sciences, Gujarat University, Ahmedabad
- **Mr. Jayraj Panchal:** He did his Master's in Geoinformatics from Gujarat University and currently working as a Research Assistant at the Department of Earth Sciences, Gujarat University, Ahmedabad
- **Mr. Savyasachi Goswami:** He did his Master's in Geography from Gujarat University and is currently working as a Research Assistant at the Department of Earth Science, Gujarat University, Ahmedabad
- **Dr. Komal Shah**: Assistant Professor at Department of Journalism and Mass Communication.

Trainee Profile and feedback

Number of Trainees

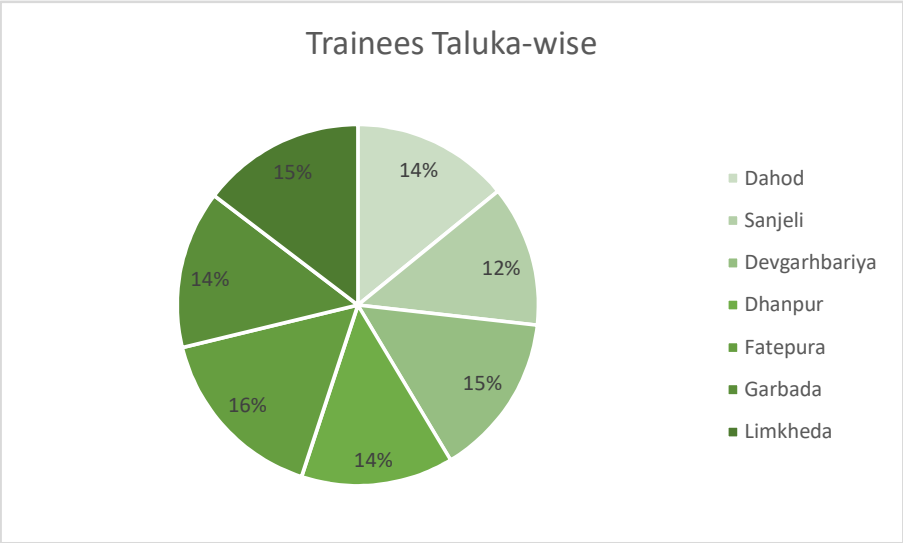


Figure 1: Number of Trainees in the different Talukas

A total of 198 trainees attended the two-day workshop on Assessing and Communicating Spatio-Temporal patternsof COVID-19 with the help of Geospatial Technology and Geo-media research for preparing COVID warriors for better Response catalysed and supported by National Council for Science and Technology Communication, DST, Govt. of India, New Delhi. The highest number of trainees was seen from the Fatepura block (32), whereas Sanjeli saw the least trainees. Around 54% of the trainees filled out the feedback forms. Thus, the data evaluated in this report correspond to only 108 respondents.

Gender Distribution of the trainees

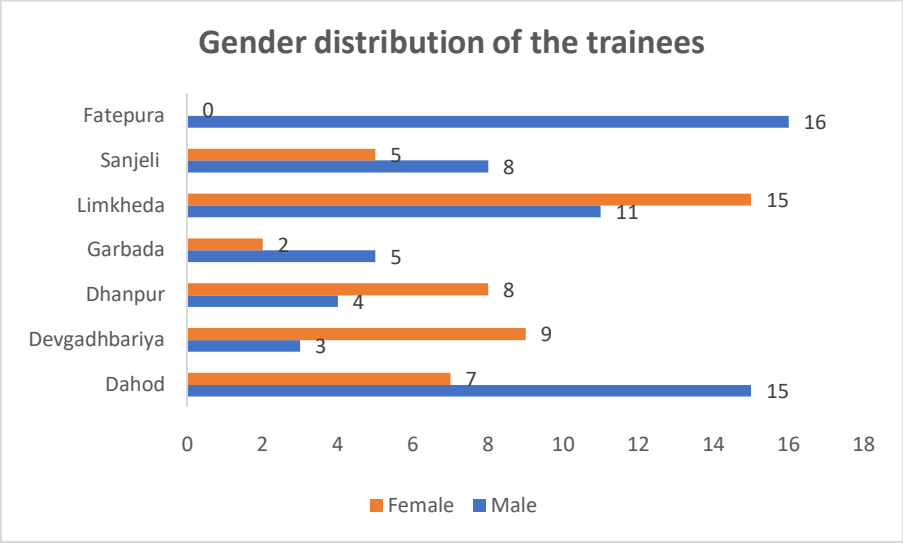


Figure 2 Gender Distribution of the Trainees

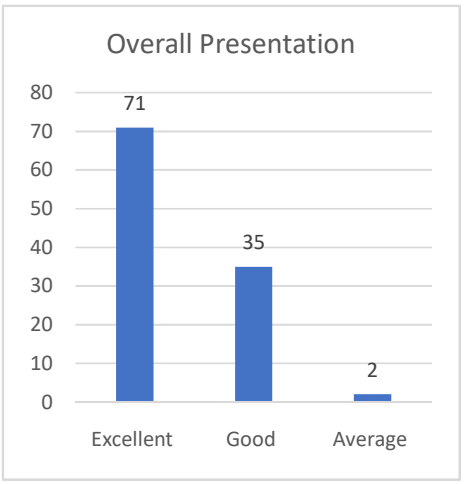
Of the total respondents, 57% (62) are male, and the rest are female. The number of female trainees outnumbers the number of male trainees in the three talukas- Devgadhbariya, Dhanpur, and Limkheda. Fatepura taluka training did not have any female trainees ad it was boys institute.

Educational Background

As known, GIS, or geographic information systems, are computer-based tools used to store, visualize, analyze, and interpret geographic data. Hence, it is expected that more students from Engineering backgrounds are interested and be part of the workshop. On the contrary, Dahod, Devgadhbariya, and Garbada taluka training had students from the Arts background. In the rest of the talukas, the students from the Science/Engineering background took part in the training.

Perception ofthe Facilitators and the Presentations

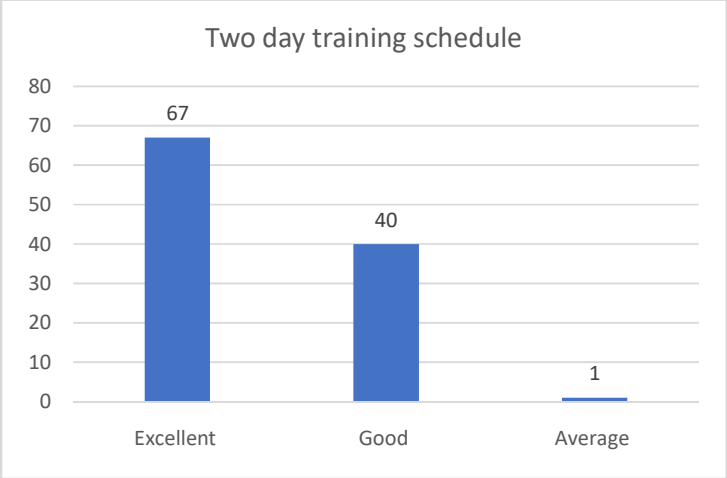
Dr. Shukla and Mr. Panchal have been part of all the training across all seven talukas. The participants have rated all the facilitators between 'Excellent to Good'. All the trainees belonged to the tribal background, and learning the technology and being a part was such activity has been a very rewarding journey. And in this journey, the trainers have played the role of an immense source of knowledge. All the training venues had the projection facility except Devgadhbariya. The trainers there adopted the traditional method and conducted the training using charts and programs, which was challenging in these times of technology.



The majority of the respondents rated the presentations made by the facilitators between Excellent to Good. The presentations had an in-depth understanding of each of the topics presented in the sessions.

Schedule of the Workshop

62% of the respondents believed that the training schedule was Excellent, whereas 37% found it to be Good, which indicates that there can be a chance of making minor improvements. For different talukas, different techniques were used. However, some basic techniques remained similar training schedule. The sessions ranged from giving them an understanding of the COVID-19 virus and its different aspects and later giving them theoretical and practical knowledge about the working of GIS software. The participants on day 2 were given a demonstration of the software. The trainees were given on field experience where they were instructed to go door-to-door for data collection and map the spatial pattern of COVID 19 in their respective taluka. The combination of the classroom and on-ground activity gripped the students for the workshop. The detailed outcome (Maps etc.) of the training is documented separately.



Game Play

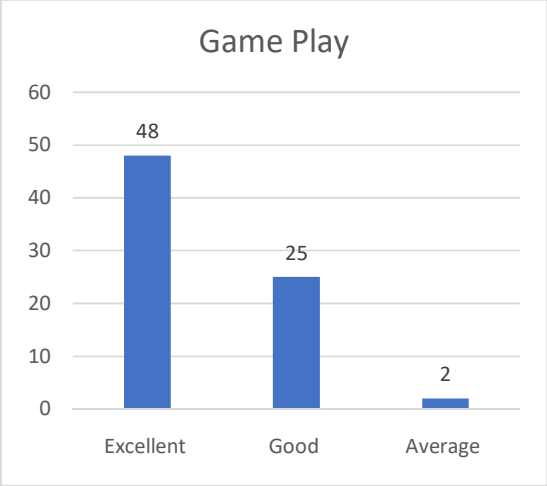


Figure Feedback on Game Play

On the second day of the two-day training workshop, the participants were also introduced to a board game-"COVID Cognizance". The goal was to make them aware of DOs and DON'Ts during the pandemic and the outcomes of their actions. The training at Limkheda and Garbada was scheduled in January and February, respectively. The rest of the training happened post-June. The activityof gameplay was planned after the initial two pieces of training. Thus, for feedback on gameplay, there are only 75 respondents, out of which 64% of participants had an excellent experience of the gameplay.

It was a board game with the instructions mentioned on the cells. It had to be played with two dice, and participants were divided into groups where they acted like pawns. One of the playersthrows the dice and moves their pawn according to the summation on both dice. Wherever the pawn lands, the instructions written on the call had to be followed. The player will have perks/fines according to the instructions related to the cell. Each player was given an amount of INR 10000 as a token, wherein, according to the instructions, they had to exchange the money with each other. In the end, the player with the highest amount remaining with him/herself was declared a game-winner.

Way forward

Towards the end of the workshop, all the trainees were determined to be a part of advanced training if held in the future. They pledged to be the COVID-19 Warrior for their community. they were very intrigued about how technology can create wonder and help them become a contributor helping the community during such times of emergency.

Stories from the Field

Prof. Chandrika Raval, Dept. of Sociology

I am grateful to the Department of Earth Science and especially Dr. Shukla to invite me and allow me to interact and share my experience with the students from the tribal area. I enjoyed the process thoroughly, the workshop was refreshing and motivating for the students and me. The biggest challenge we faced was the training was organised in the interior area of the Debgadhbairya Taluka, which had a minimal infrastructure in terms of technology. We had to adopt the traditional method of training the students with the help of Posters and Pictures as there was no facility for PowerPoint Presentations. Though we faced difficulty with the teaching tools, the students' interest and curiosity surprised us. They were inquisitive about the workshop and enthusiastic about the new learnings.

The trainers had complete understanding of the objectives of the training, hence all discussions focussed on maximum offering for students in terms of skills and technology. This has been a two-learning process for the trainers and trainees. It bought us immense joy to seethe positivity of the students and their readiness as COVID Warriors.

Anita Parmar, Trainee, Degadhbariya

I came across the registration for the COVID Warriorand GIS training at my college. I registered for the workshop with the sole objective of learning something new and getting to know a new technology in times of the need. The workshop was as per my expectations and fulfilled all my expectations. In the workshop, I gained knowledge about Geographic Information Software; I learned various techniques, like mapping of COVID 19 cases, etc. I enjoyed the activity where we had to click a photo and map it with the help of the satellite.

The experience of the field activity helped me understand the data collection basics. We, as a tribal community, do not have access to modern tools and techniques. During COVID, the virus and the rumours about the epidemic spread fast in our community. The activity of the door-to-door data collection helped me spread awareness about the virus and bust some myths in our community.

When I informed my family about my interest in joining this two-day workshop, they were initially slightly reluctant as to mybeing a female and how it will help me in the present and future. Later seeing me excelling, they were happy.

Unfortunately, after the workshop, I have not used the software, but I aspire to use it in the future in the times like this. It will help me map in case of any epidemics concerning animals too. If given a chance, I am willing to work as a COVID Warrior

Ravi Prakash, Trainee, Dahod

From a very young age, I used to notice people coming into our village to measure the land and field size using different technologies. It intrigued me, so I immediately enrolled in the workshop when I got this opportunity to use the Geographic Information System. My experience throughout was exciting. I learned what I had expected out of the workshop. My major three takeaways are- any size of the plot/area can be measured without the tools using the digital GIS system, how to understand the intensity of the spread of any epidemic in any area, and how to use and plot the data on the map using the satellite technology.

I am an Engineering student; the workshop helped me during my first paper on GIS, where they asked questions regarding the usage and features of the GIS software. After the workshop, I continued using the software, experimented with the data, created maps using latitude & longitudes, and exercised data entry in MS Excel.

My family was supportive; they felt proud as I contributed to spreading awareness when people had many misconceptions about the pandemic. I also enjoyed the door-to-door data collection activity, doing the data entry, and creating the maps for further usage. I want to contribute more and be a part of any further training in the future.

-Ravi Prakash, Trainee, Dahod

Chapter 6:

Conclusion Recommendations and Challenges

In conclusion, the two-day training program on "Assessing and communicating Spatio-Temporal pattern of COVID-19 with the help of Geospatial Technology and Geo-media Research for preparing COVID warriors for better response" was successful in introducing the participants to the application of geospatial technology in dealing with COVID-19. The training sessions were designed to provide an in-depth understanding of various geospatial tools, their relevance to COVID-19, and their practical usage in data collection, analysis, and visualization.

The participants were enthusiastic and actively participated in all the sessions, showing a willingness to learn and apply their knowledge in real-life scenarios. The feedback collected from the participants indicated that they found the training to be informative, interactive, and relevant to their field of work. Moreover, the participants were willing to be part of advanced training in this field.

Recommendations

1. Increase investment in Geospatial Technology and Geo-media research to better understand and manage COVID-19 and other pandemics.
2. Train more healthcare professionals and first responders in the use of Geospatial Technology and Geo-media research for better preparedness and response.
3. Develop and implement real-time surveillance systems for monitoring the spread of COVID-19 and other pandemics using Geospatial Technology.
4. Use Geospatial Technology to identify high-risk areas and vulnerable populations, and to target interventions and resources accordingly.
5. Share geospatial data and research findings across institutions and organizations to facilitate collaboration and coordination in pandemic response.
6. Use Geospatial Technology to map and visualize the availability and distribution of essential resources such as PPE, ventilators, and medical personnel.
7. Develop and implement protocols for the collection, management, and sharing of geospatial data in pandemic response.
8. Use Geospatial Technology to monitor and evaluate the effectiveness of pandemic response interventions and adjust them as necessary.
9. Use Geo-media research to better understand public attitudes, perceptions, and behaviours related to pandemic response and to develop targeted communication and education campaigns.
10. Invest in the development of open-source geospatial tools and resources to increase accessibility and facilitate widespread adoption of Geospatial Technology for pandemic response.
11. Train more youths in this direction to spread awareness and strengthenthem to uplift their community in case of any pandemic situations.

Challenges

1. Lack of availability of timely and accurate data on COVID-19 cases and related information.
2. Limited resources and funding for carrying out comprehensive research and data collection.
3. Technical challenges in the use of geospatial technologies and software by some of the participants.

4. Limited awareness and understanding of the importance and relevance of geospatial technology and GIS in disease prevention and control.
5. Difficulty in collecting ground-level data due to restrictions imposed during the pandemic.
6. Limited availability of trained human resources in the field of geospatial technology and GIS.
7. Limited access to high-speed internet and technology infrastructure in some areas, leading to difficulties in accessing and sharing data.
8. Lack of cooperation and coordination between different government departments and agencies responsible for managing the COVID-19 response.
9. Difficulty in communicating complex technical information and data to non-technical stakeholders and the general public.