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GEOSPATIAL DATA MAPPING & DISSEMINATION FOR RESPONSES TO COVID-19 OUTBREAK

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Abstract - *Novel Coronavirus (COVID-19) has become a unique issue topping global agenda by the beginning of 2020. On March 11th 2020 WHO announced COVID-19 as a pandemic and led to entire nations lockdowns, widespread halts of international travel, mass layoffs and battered financial markets. Location information is critical to decision-making associated with such large outbreaks. Geo-referencing of these pandemic spatial data brings a new extent to fight against Coronavirus disease. Geographic Information systems provides better visualization, understanding rapidly changing environment for decision makers to plan and respond for the slow spread. This paper insight the use of GIS for the mapping of confirmed positive cases, Fatalities, Risky Cluster Containment areas, Red zones, COVID specialty Hospitals, Care centers, Quarantine centers, and ICMR approved testing facilities. The prepared maps are published on cloud based resources so that it can be easily accessible by different stakeholders for future responses and decision making. In the conclusion part, the article presents some recommendations and future perspectives for the use of geospatial data science in epidemiologic researches.*

Key Words: **COVID-19; Pandemic; Epidemic; Geospatial; GIS; Web GIS; GIS Cloud; Dashboard.**

1. INTRODUCTION

A novel Coronavirus [COVID-19] has become a unique global crisis by the beginning of 2020. According to WHO, Coronaviruses are a large family of viruses that may cause illness in animals & humans. Coronaviruses are known to cause mild cold to serious respiratory infections. On march 11th 2020 WHO announced coronavirus as a pandemic have led to entire nations lockdowns, widespread halts of international travel mass layoffs and battered financial markets.

The corona virus has infected more than 5.24 million people and killed more than 3,45,296 worldwide as on 25th may 2020, since late January when it was first reported. The outbreak spread from Chinese City Wuhan to more than 180 countries and territories affecting every continent except Antarctica.

Epidemiologists, and various health supporting agencies like WHO, UNICEF, CDC, Ministries of Health, and other subnational departments of health around the world have activated many plans in response to coronavirus and they started sharing data as required by the international Health Regulations. Maps can aid better visualization, understanding the pattern, response to planning for decision makers in a rapidly way to ultimately solve the complex crisis.

Geographic Information System [GIS] is a computer based system for collection, storage, Manipulation, visualization, Display, Analyze and share the data related to earth's Surface. GIS integrates many types of data such as demographics, Remote sensing imagery, Big data, sensor data, smart device & Internet of things [IoT] Data, social media data & location based data tables to make interactive desktop maps, web maps, web applications, models, Dashboards, analysis tools. GIS has unique capabilities & flexibility and it reveals deeper insights into the data to understand the spatial data pattern and relationships that helps users to make smarter decisions.

GIS based decision making tools have been used by Epidemiologists and other related agencies to study the pattern of past epidemics such as EBOLA, ZIKA, MALARIA, Dengue and even in Polio Eradication. GIS helps them to map disease occurrence against multiple parameters like demographics, geographies, environment and past occurrence to understand origin, spread pattern, intensity to implement preventive control & surveillance measures. Government, Health Departments, policy makers, NGO's and other administrators need GIS to understand the outbreaks real time pattern to identify the risky areas, high risk population and to plan & evaluate the current health care facilities and future requirements. In addition, there is a need for effective communication among other supporting agencies and citizens to ensure coordinated response. Sharing & publication of Web maps, interactive dashboards to communicate widely the current situation and to identify preventive measures.

For this purpose, this paper demonstrates the importance of Geospatial Information for responses to COVID-19, it covers various techniques like spatial Data mapping to locate confirmed cases, to show the intensity of COVID cases & Fatalities, visualization of containment areas & Risky zones, Quarantine centers, COVID Care centers, Hospitals & ICMR approved testing labs. Furthermore, this article introduces

the Web-GIS platform to widely disseminate the pandemic data sets so that that are being accessed across the globe.

In the conclusion part, the article presents challenges, recommendations and future perspectives for the use of geospatial data science in epidemiologic researches.

2. GEOSPATIAL DATA SCIENCE FOR RESPONSES TO COVID-19 OUTBREAK

If appropriate and timely measures are not taken this crisis can exponentially go up with unforeseen magnitude. Government, Health Care consultants, decision makers, institutions should have collaborated to generate real- time information and public awareness.

The entire spread of this pandemic is spatial in nature and location plays a crucial role in taking effective decisions. Location intelligence helps in exploring connection between people, their physical and social This can help authorities to monitor and communicate the impact of the outbreak.

Main role of GIS is for mapping, tracking, monitoring, interpretation, evaluation, sharing, collaboration, decision making, social awareness and communication purposes during any pandemic outbreak.

- Map the confirmed & active COVID cases across the globe.
- Map the location of positive cases at a particular area.
- Map the available COVID care facilities like hospitals, care centers, quarantine facilities, and Government approved Testing labs.
- Map Demographic data such as elderly and those with chronic health conditions in order to identify the vulnerable population.
- Use location intelligence to monitor the spread of COVID -19 through space and time to implement surveillance and preventive measures.
- Map the hotspots, cluster containment areas and other risky zones & buffer zones.
- Maps people according to their travel history, and monitor them with Geotag and Geofencing technology to Quarantine tracking.
- Time enabled map to understand the spread over time and plan interventions accordingly.
- Map the medical resources supply and analysis the proximity while scarcity happens.
- Map Hospital facilities like number of beds, number of critical care doctors, ventilators, ICU beds, PPE and testing kits.
- Map the institutions, business centers, industries to understand their proximity with risky zones.
- Map the employees home location for effective business continuity.
- Share dashboards and interactive web maps to communicate the current situation different stake holders to identify preventive measures.

Gujarat is one of the worst affected cities in western part of India. The COVID -19 in the state is far higher than any other state when compared with total cases detected. Of the total deaths 81.30% (722) have been reported from Ahmedabad, which accounts for the highest number of cases at 10,590, in the state as on 25th may 2020. The mortality rate in Ahmedabad is 6.88% higher than national 2.85% rate. The Gujarat government set up a panel for proper research to find out the reasons of high mortality. Most deceased in Gujarat had comorbidity due to lifestyle disease like diabetics & obesity. Gujarat has the largest number of diabetics in the country. Obesity is also very high compared with other states.

2.1 Mapping of COVID -19 Confirmed Cases.

Government agencies and Health Officials can map Number of confirmed positive cases, number of fatalities and recoveries to identify which district or area is much affected.

These statistics come from the data published by Govt. of Gujarat on 25th May 2020, COVID -19 Dashboard. Some of the numbers are updated daily and others may be uploaded more regularly.

Data Source:- [https://gujcovid19.gujarat.gov.in/]; https://ahmedabadcity.gov.in/; https://www.mygov.in/aarogya-setu-app/.
Software Used: - QGIS 3.12 Bacuresti [Open source]
Tools Used: -MS Excel Data Tables, Latitude longitude Finder, QGIS Cloud.
Study Area: - Gujarat, Ahmedabad.

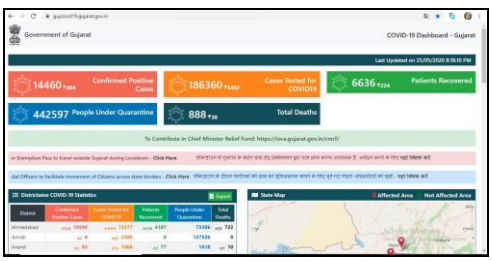


Fig -1: Gujarat State COVID -19 Dashboard

Table -1: Gujarat state COVID -19 Dashboard Data (as on 25th may 2020).

NO	DISTRICT NAME	POSITIVE CASES	TOTAL CASES TESTED	QUARANTINE	TOTAL DEATHS
1	AHMEDABAD	10590	73577	73306	722
2	AMRELI	6	2580	137526	0
3	ANAND	93	1968	1618	10
4	ARAVALLI	99	2002	2486	3
5	BANAS KANTHA	99	2535	10644	4
6	BHARUCH	37	1996	5669	3
7	BHAVNAGAR	117	4961	48615	8
8	BOTAD	57	1837	17476	1
9	CHHOTA UDEPUR	22	1721	14963	0
10	DAHOD	36	2960	6950	0
11	DEVBHOOMI DWARKA	12	1599	1848	0
12	GANDHINAGAR	225	5160	2450	13
13	GIR SOMNATH	44	1502	12731	0
14	JAMNAGAR	47	4711	6539	2
15	JUNAGADH	26	5680	13328	0
16	KACHCHH	64	2578	16866	1
17	KHEDA	63	2422	674	3
18	MAHISAGAR	88	1882	5564	1
19	MEHSANA	102	1186	2763	4
20	MORBI	3	1819	1135	0
21	NARMADA	18	1408	2104	0
22	NAVSARI	16	2460	5393	0
23	PANCH MAHALS	77	2714	3355	6
24	PATAN	72	1586	12638	4
25	PORBANDAR	7	1543	3120	0
26	RAJKOT	93	4430	10875	2
27	SABAR KANTHA	89	2313	2470	3
28	SURAT	1351	28926	9039	62
29	SURENDRANAGAR	25	2318	1198	0
30	TAPI	6	1457	63	0
31	THE DANGS	2	547	489	0
32	VADODARA	854	8588	3378	35
33	VALSAD	20	3394	5324	1

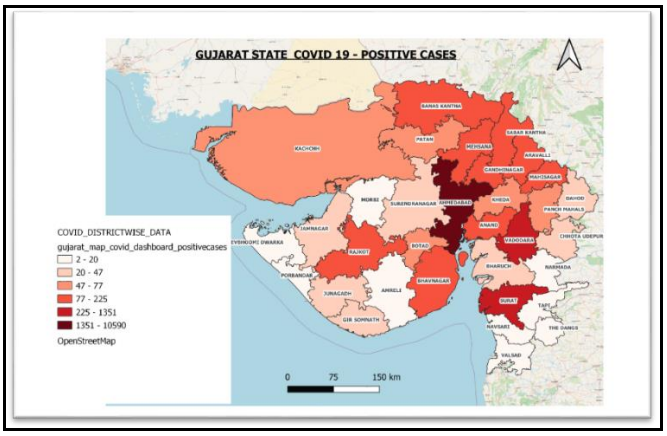


Fig -2 Map showing Gujarat State's District-wise COVID -19 Confirmed cases.

2. Mapping of COVID -19 Fatalities

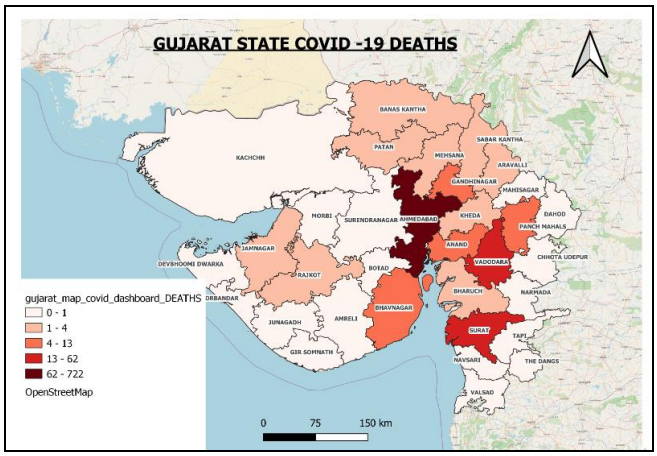


Fig -3: Map showing Gujarat State's District – wise COVID -19 Fatalities.

By selecting any district, we can able to get full description like Name of the District, Area, cases tested, Total confirmed cases, number of recoveries and number of deaths.

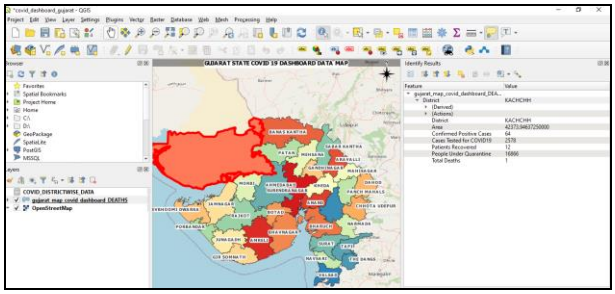


Fig -4: QGIS Mapping – Identification of COVID -19 information District wise.

2.3 Mapping Location of confirmed cases.

COVID-19 confirmed and active cases can be mapped to identify the source of infection. From this map any one can understand where the cases are more affected according this agency can do buffer & proximity analysis to declare hotspots, containment zones and other risky areas.

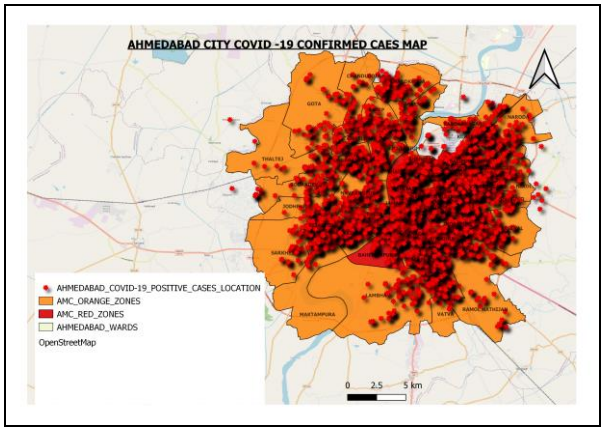


Fig -5: Map showing Ahmedabad City Locations of COVID -19 Confirmed cases.

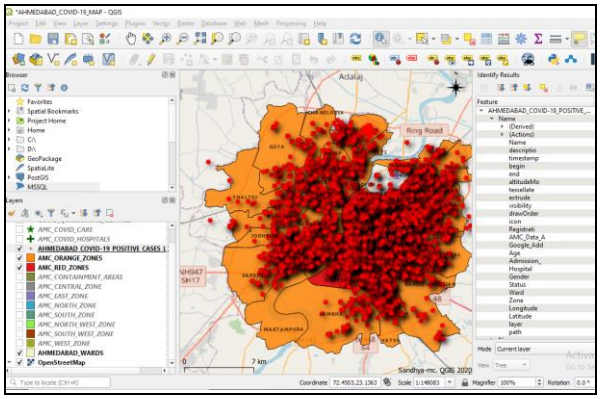


Fig -6: QGIS identification tool showing information of COVID -19 Confirmed cases.

2.4 Mapping of Risky Zones

The Government adopted a top-to-bottom approach for Geospatial mapping for monitoring and isolation of districts, cities that worst hit by corona virus outbreak. To fight against COVID -19 ministry of Health and family welfare declares zone wise classification of districts as hotspots (Red Zones) and Non – hotspots (Green ones) bases upon the reported cases. Districts with no reported cases are categorized as Green. This identification of Hotspots will have done on weekly basis.

The below mapping is for Ahmedabad City, Ahmedabad is one of the worst coronavirus affected city. Ahmedabad city comprising of 7 Zones North East, West, south, North west, and South West zones, with total 48 wards. Here mapping of all containment zones, Red zones and Orange zones are done. These statistics come from the data published by Ahmedabad Municipal corporation COVID -19 Dashboard. Some of the numbers are updated daily and others may be uploaded more regularly.

https://ahmedabadcity.gov.in/portal/web?requestType=ApplicationRH&actionVal=loadCoronaRelatedDtls&queryType=Select&screenId=114

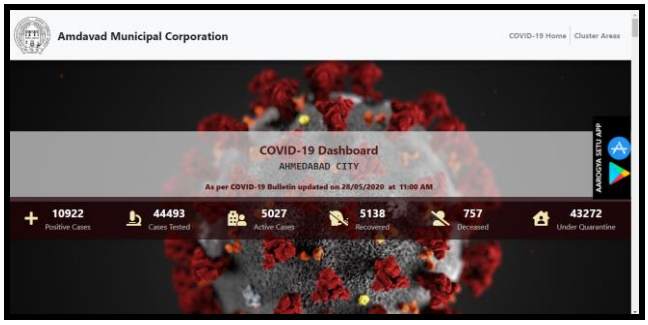


Fig -7: Ahmedabad Municipal corporation COVID -19 Dashboard [28.05.2020]

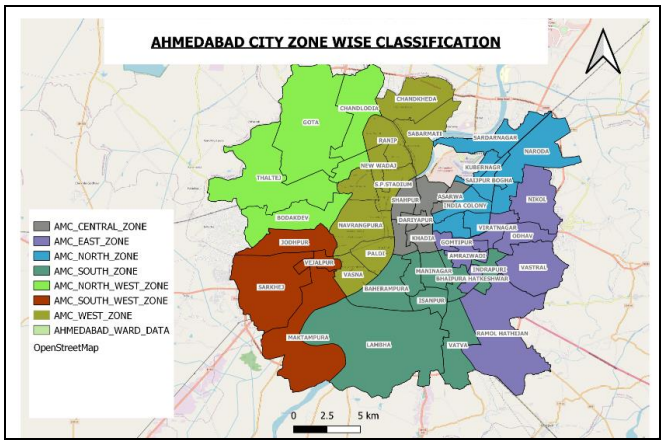
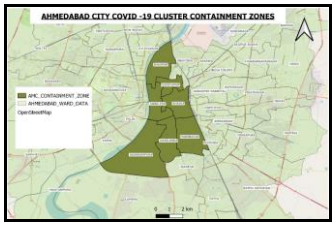
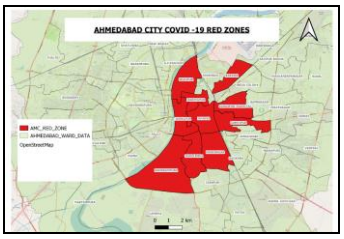


Fig -8: Map showing Ahmedabad City zone wise classification.



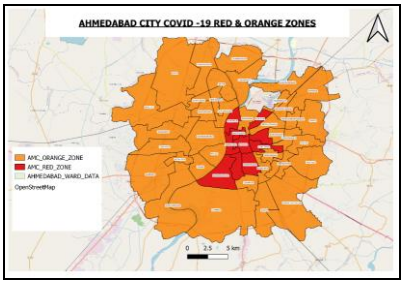
	WARD NUMBE	ZONE	Name
1	17	CENTRAL	SHAHPUR
2	21	CENTRAL	DARIYAPUR
3	28	CENTRAL	KHADIA
4	29	CENTRAL	JAMALPUR
5	35	SOUTH	BAHERAMPURA
6	36	SOUTH	DANILIMDA
7	37	SOUTH	MANINAGAR

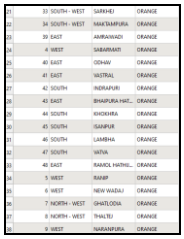
Fig -9: Map showing Ahmedabad City COVID -19 Cluster Containment Areas.



	WARD NUMBE	ZONE	Name	COLOURZONE
1	15	CENTRAL	ASARWA	RED
2	17	CENTRAL	SHAHPUR	RED
3	21	CENTRAL	DARIYAPUR	RED
4	27	NORTH	SARASPUR-RA...	RED
5	28	CENTRAL	KHADIA	RED
6	29	CENTRAL	JAMALPUR	RED
7	35	SOUTH	BAHERAMPURA	RED
8	36	SOUTH	DANILIMDA	RED
9	37	SOUTH	MANINAGAR	RED
10	38	EAST	GOMTIPUR	RED

Fig -10: Map showing Ahmedabad City COVID -19 Red Zones.





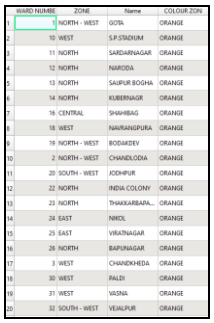


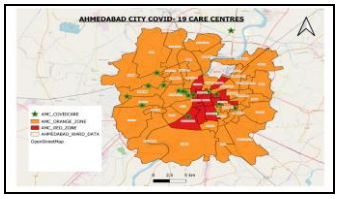
Fig -11: Map showing Ahmedabad City COVID -19 Orange Zones.

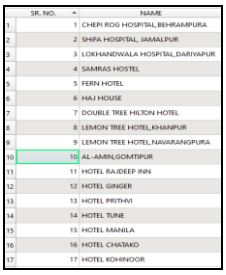
2.5 Mapping of Health Care facilities

GIS can be used to monitor medical resources & facilities and plan interventions accordingly. Mapping can be done for available COVID special hospitals, Care centers, quarantine facilities, ICMR approved testing labs, care centers, urban health centers, and to analysis the gap and future requirements to overcome the spread, and govt. can respond to a large scale outbreak.

Use location intelligence to plan, site implement and communicate about ICMR approved private and Govt. Testing labs for COVID -19.

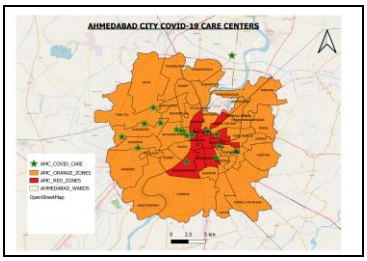
While mapping such facilities we can incorporate a detailed data table with detailed specification of each hospital, number of beds, doctors (general practitioners, infectious disease and critical care specialists, respiratory therapists, nurses, and other critical supplies (IV fluid, Oxygen, PPE, Ventilators, Dialysis unit,). Analyze mapped data to understand whether the supplies are proximate to need. And use global supply chain to understand the logistics flow.

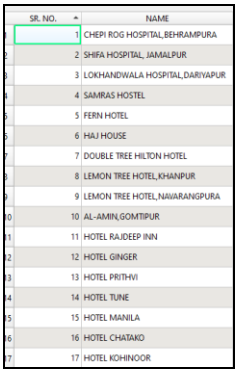




	SR. NO.	NAME
1	1	CHEPI ROG HOSPITAL,BEHRAMPURA
2	2	SHIFA HOSPITAL, JAMALPUR
3	3	LOKHANDWALA HOSPITAL,DARIYAPUR
4	4	SAMRAS HOSTEL
5	5	FERN HOTEL
6	6	HAJ HOUSE
7	7	DOUBLE TREE HILTON HOTEL
8	8	LEMON TREE HOTEL,KHANPUR
9	9	LEMON TREE HOTEL,NAVARANGPURA
10	10	AL-AMIN,GOMTIPUR
11	11	HOTEL RAJDEEP INN
12	12	HOTEL GINGER
13	13	HOTEL PRITHVI
14	14	HOTEL TUNE
15	15	HOTEL MANILA
16	16	HOTEL CHATAKO
17	17	HOTEL KOHINOOR

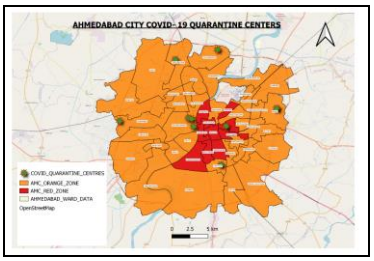
Fig -12: Map showing Ahmedabad City COVID_19 Special Hospitals.

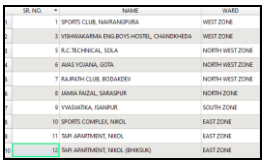




	SR. NO.	NAME
1	1	CHEPI ROG HOSPITAL,BEHRAMPURA
2	2	SHIFA HOSPITAL, JAMALPUR
3	3	LOKHANDWALA HOSPITAL,DARIYAPUR
4	4	SAMRAS HOSTEL
5	5	FERN HOTEL
6	6	HAJ HOUSE
7	7	DOUBLE TREE HILTON HOTEL
8	8	LEMON TREE HOTEL,KHANPUR
9	9	LEMON TREE HOTEL,NAVARANGPURA
10	10	AL-AMIN,GOMTIPUR
11	11	HOTEL RAJDEEP INN
12	12	HOTEL GINGER
13	13	HOTEL PRITHVI
14	14	HOTEL TUNE
15	15	HOTEL MANILA
16	16	HOTEL CHATAKO
17	17	HOTEL KOHINOOR

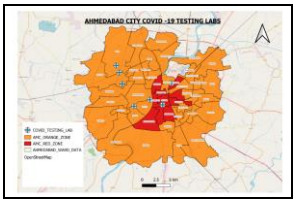
Fig -13: Map showing Ahmedabad City COVID -19 Care Centers.





	SR. NO.	NAME	WARD
1	1	SPORTS CLUB, NAVRANGPURA	WEST ZONE
3	3	VISHWAKARMA ENG.BOYS HOSTEL, CHANDKHEDA	WEST ZONE
5	5	R.C. TECHNICAL, SOLA	NORTH WEST ZONE
6	6	AWAS YOJANA, GOTA	NORTH WEST ZONE
7	7	RAJPATH CLUB, BODAKDEV	NORTH WEST ZONE
8	8	JAMIA RAZAL, SARASPUR	NORTH ZONE
9	9	VYAYAMSHALA, ISANPUR	SOUTH ZONE
10	10	SPORTS COMPLEX, NIKOL	EAST ZONE
11	11	TAPI APARTMENT, NIKOL	EAST ZONE
12	12	TAPI APARTMENT, NIKOL (BHIKSUK)	EAST ZONE

Fig -14: Map showing Ahmedabad City COVID -19 Quarantine Centers.



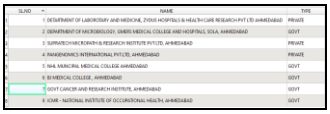


Fig -15: Map showing Ahmedabad City COVID -19 Testing Labs.

2.6 Sharing & Publishing Maps

Interactive Web Maps [WEB-GIS], Dashboard apps and story maps can be used to rapidly communicate the current situation.

As we all know, Coronavirus is quickly spreading globally, and organizations and communities need to consume a lot of geospatial data changing from one minute to the other, to

understand the patterns of the pandemic, and to plan how to organize staff and contain the virus. Open Geospatial data management enables to monitor the spread of virus throughout the world. This helps to determine the corridors where the virus travels and to delineate buffer zones depend up on the risk. By mapping & identifying the Risky zones preventive measures can be implemented in those areas.

COVID-19 maps prepared for Gujarat state & Ahmedabad city are shared publically through GIS Cloud based Technology. GIS Cloud technology can be of great value to anyone working with spatial data related to Coronavirus, gathering information or making strategic decisions.

The below Web maps showing District & ward wise COVID-19 related information. Click on any location on the map a pop-up will display information about the cases being reported there. The boxes on the right side display summary information about Total confirmed cases, total tests conducted, number of recoveries, number of people under Quarantine & total Deaths.

https://qgiscloud.com/sayamsandhya/COVID_GUJARAT_DASHBOARD/

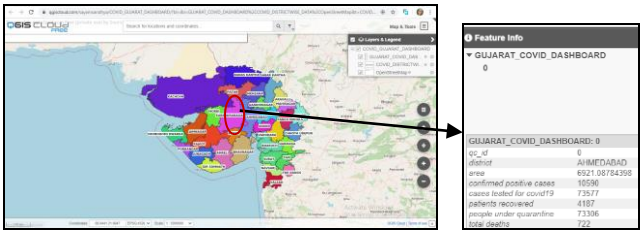


Fig -16: Gujarat State Dashboard Data WEBGIS Interface

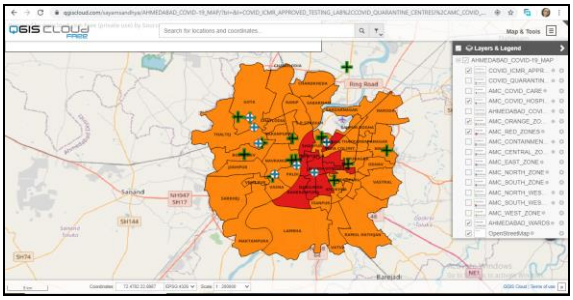


Fig -17: Ahmedabad City COVID -19 Dashboard Data WEBGIS Interface

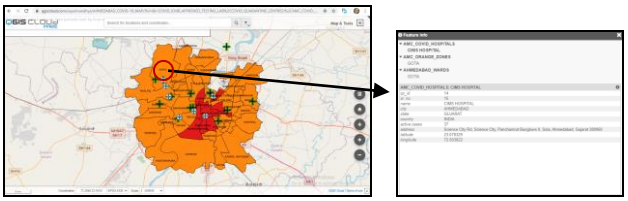


Fig -18: Gujarat State COVID -19 WEBGIS Interface

3. RECOMMENDATIONS

The most important thing that needed for GIS mapping & analysis is relevant Data. Researchers, Government, Health Departments & other agencies can utilize this data only when it is reliable, authoritative t is authoritative, reliable, and updated.

The COVID -19 Outbreak has been more Data Transparent than any other major outbreak in History and there are variety of information available in the form of Data tables, graphs, statistics, charts, dashboards and maps. These data sets can be georeferenced and theses spatial data can monitor such public Health crisis. This will be possible only when data patterns about the pandemic cases have practical relevant value.

One should take extreme care about the privacy of data for example while mapping the locations of confirmed cases it can reveal the identity openly. The authorities are more stressed that the data used for a particular project will not be used outside for any other purposes and should be destroyed when the risk of pandemic ends.

All countries should record all COVID -19 cases at state, District, city, village Level as precise as possible and store them in DBMS [Data Base Management System]. These datasets should be opened to Researchers, Academicians, NGO's, Government Administrations, consultants & IT sector stakeholders to study, understand respond and implement preventive measures. If the administration does not prefer to open it freely to the public, they need to set up secure intranet web among selected stakeholders.

The countries need to setup web based Applications to fulfil medical fields requirements. In that application medical staff can insert their supply needs will be useful for immediate needful action. The authorities can also set priority and arrange the needs accordingly.

The Government can utilize Geotag and Geofencing Technology and implement secure mobile applications for tracking the movement of people who are in Home Quarantine & Isolation.

The Next Census of India will be carried out in march 2021. During data collection time along with normal demographic data, authorities can record population density, age wise classification of citizens and critical illness category so that these type of data can be used to identify the vulnerable population who are at high risk during such disease outbreak.

4. CONCLUSIONS

Today COVID -19 is trending & emerging topic for the researchers. Geospatial mapping & analysis have played a crucial role in better understanding and responding to this current crisis.

In assessing the contribution of GIS to the containment and response of the COVID -19 pandemic it is obvious that many challenges remain to be studied & analysed. By the aggregation of Big Data Analytics and Real-time Data integration many multi-dimensional possibilities can be achieved to understand the situation better and take informed decisions in a timely manner.

It is also essential that the IT sectors should come together to leverage smart intelligent platforms and provide digital consultation & guidance to the Government, Organizations & Health Care agencies.

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