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GIS-Based Review for Monitoring the Spatial Distribution of Covid-19: A Case Study of Haryana

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Abstract: ***Worldwide COVID-19 cases were noticed from its first variant to new variant very fast which is becoming threatening to human health, social function, production and supply of goods, and international relations. In Haryana, cases are increasing rapidly. GIS techniques contribute to controlling the epidemic by mapping of visualizing epidemic data, spatial visualization of protected and risk zones, spatial tracking of spreading, and route networking to fulfill demanded supply. These types of big spatial data can support taking decisions, formulating measurements, and effectiveness to control and prevent COVID-19. In the study area, total cases, daily reported cases, active cases, recovered cases, and fatalities were mapped. Based on daily reported cases, a high to less affected zone map was prepared by using the IDW technique. Results showed that the NCR region was highly affected and the rest of the part was less affected. Mapping of spreading epidemics on spatial distribution and variability of corona can provide the most useful insights to the authorities for decision making.***
Keywords: COVID-19, GIS, Spatial Distribution, IDW, Haryana

I. INTRODUCTION

At the end of the year 2019, Wuhan in China emerged a virus named Novel Coronavirus-2019 or SARS-coV-2 has severe effects on respiratory syndrome [1]. On 12th Jan 2020, World Health Organization (WHO) named the coronavirus as Novel Corona Virus 2019. Covid-19 spreads all over the world very fast. In Europe, Italy is the first country hit by the virus with immense impact [2]. The World Health Organization (WHO) announced Covid-19 a pandemic after confirmation of near about 2 lakhs patients with eight thousand deaths across the world [3]. On 7th Jan 2020, the coronavirus was isolated from the positive patient by a Chinese researcher which also issued the genome sequence of the coronavirus [4]. Covid-19 is transmitted from human to human and increases continuously. The virus replication rate was 2.2 and ranges from 1.5 to 6.5 [5, 6]. On 21st August 2020, coronavirus confirms the case was 22,536,278, and 277,617 reported new cases in the last 24 hours at the global level. Total deaths were 789,197 and 6659 deaths were reported in the last 24 hours (7). On 30th January 2020, the first corona positive case was reported in India having traveled from China. Now, the virus is spreading to all parts of the country [8]. Coronavirus cases are continuously increasing day after day. On 22nd August 2020, the status of coronavirus as 2,979,562 confirmed cases, 55,950 deaths, and 2,223,202 were recovered. Active cases were reported as 696,641 and daily new cases were reported as 69,039 on 21st August 2020 [9]. The first case of coronavirus was reported in Haryana on 4th March 2020[10]. Gurugram and Faridabad district of Haryana state has the highest coronavirus cases as 9302 and 9172 while Charkhi Dadri has the lowest numbers of positive cases as 155. On 22nd August 2020, the total cases of coronavirus in Haryana were 52,129, in which 43,413 were recovered, 585 deaths, and 8131 were active cases [11]. Globally, various issues were faced which were originated by the coronavirus. The everyday situation is becoming more and more critical for administration and government at every level. The whole world is losing health and wealth.

Geographic Information System as a mapping approach is an advanced tool for health in providing prevention, treatment, and knowledge about the disease. The mapping approach visualizes the spatial distribution, resources, and risk factors for checking any disease. This provides information about risk zones, hotspots, and trends of disease in a particular area [12, 13,]. But in the case of Covid-19, the approach is not used clearly in India. Covid-19 has spatial spreading characteristics depending upon the human activity and controlling strategy [14]. Geographical information System provides fruitful information regarding this as the spatial correlation between variables and transmission identification [15, 16, 17, 18]. GIS has the potential to monitor the Covid-19 pandemic with mapping of routes, highlighting the most infected place, and categorizing the area at different levels [19]. Various organizations used spatial analytical methods and mapping applications of GIS to control diseases like Ebola, Zika, and SARS [20]. Lots of countries used GIS to control the outbreak of Covid-19 as accurate, unique, and fast-tracking the infected person and their direct contact traveling history beside another strategy [21].

However, not specific and accurate medicine is available for Covid-19 but the social distance from corona positive person and maintaining personal cleanliness. In India, lockdowns and specific guidelines are issued from time to time by the center and state governments. But, after this much effort, coronavirus cases are very difficult to control. New cases of coronavirus in India and Haryana state are increasing day after day. GIS-based spatial modeling for the coronavirus increasing rate is used in the United States. The result showed that the mapping of covid-19 provides better insights to policymakers [22]. A risk assessment study was conducted to curb COVID 19 through remote sensing and geographical information system in Jaipur, Rajasthan. Various risk elements such as population density, hotspots, water availability, and LULC were to reduce risk by the GIS method [23]. The result showed that a high-risk zone was found in the northeast and southeast parts of the study area. Conclude that risk reduction priority and decision policy should be given to the high-risk zone area [24]. The major objective of the study is to enlighten the scope of the Geographical Information systems for researchers and policymakers in India and also analyze the coronavirus spatial distribution in Haryana with ARC GIS software. In section 2, information about the study area is given. Section 3 discusses the methodology which is adopted to analyze the data. Section 4 includes results and discussion and the last conclusion of the study is given.

II. STUDY AREA

Haryana is situated in the northern part of India. The state lies at the extant of $27^0$39’ to $30^0$35’ N latitude and $74^0$28’ to $77^0$36’ E longitude. Haryana has a 1.4 % (44212 sq. km) area of the country. Haryana consists of 22 districts. It is bounded by Himachal Pradesh, Utter Pradesh, and Punjab in the western and southern part, eastern part, and northern part. Elevation in the state varies from 200 m to 1200 m above mean sea level. Haryana has an arid to semi-arid climate. Deciduous, dry, and shrub vegetation are found here. Haryana is an agriculture-dominated state [25]. Geomorphological units of the study area are alluvial plain (newer and older), flood plain, Aeolian Plain, structure hills, palaeo channel, dune complex, and dunes. Soil is fine loamy, loamy, and coarse loamy [26]. Fig. 1 displays the location of Haryana.

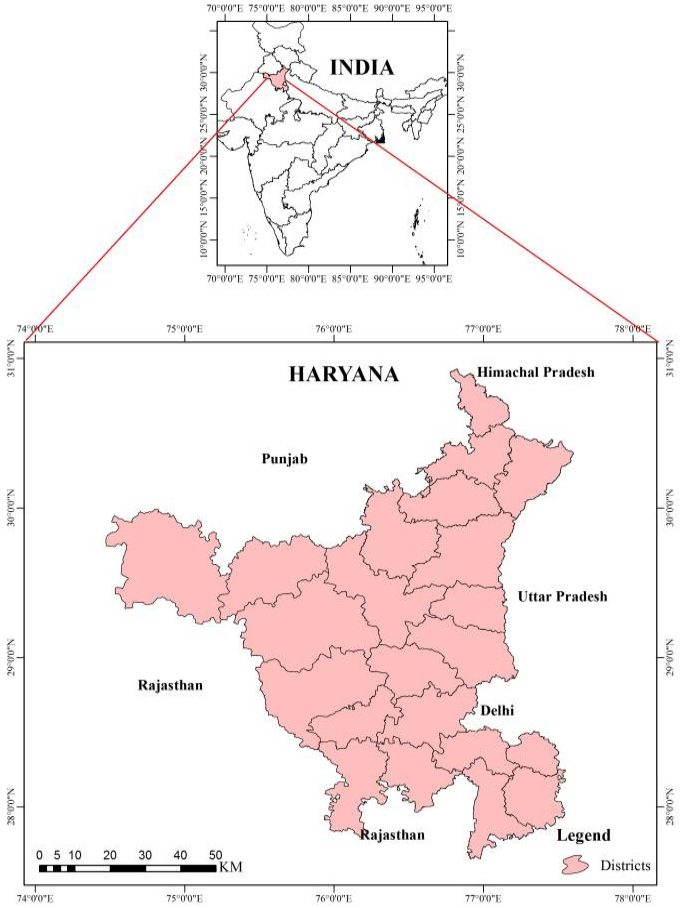

Fig.1 Locational map of Haryana

III. METHODOLOGY

For the analysis of the study, data was collected from the site of the National Health Mission of Haryana (nhmharyana.gov.in/page.aspx?id=208). On this site, data related to COVID-19 is available in a detailed form. Only data of newly reported cases, total positive cases, total active cases, deaths, and recovered cases were collected. All the collected data are arranged and processed in a manner. The boundary or shapefile of the study area was downloaded from diva-gis.org/data. ArcGIS 10.2 software is used for processing and mapping. Both COVID-19 and geographical data were integrated into the software to get possible results. Table no 3.1 provides detailed information about COVID-19 status in Haryana. IDW method was used to prepare maps of covid-19 data.

Table: 3.1: Detailed status of COVID-19 data

Sr. No	District Name	New_ Cases Reported Daily	Total Cases	Active Cases	Recovered	Deaths
1.	Bhiwani	16	1054	152	894	8
2.	Faridabad	88	11403	685	10559	159
3.	Fatehabad	11	604	132	468	4
4.	Gurgaon	111	10650	755	9764	131
5.	Hisar	44	1452	271	1169	12
6.	Jhajjar	6	1027	89	924	14
7.	Jind	5	423	97	319	7
8.	Kaithal	20	568	218	346	4
9.	Kurukshetra	33	1104	400	685	19
10.	Mahendragarh	13	1284	402	881	1
11.	Mewat	0	651	39	599	13
12.	Palwal	23	1345	96	1239	10
13.	Panchkula	114	1427	459	959	9
14.	Rewari	40	2742	355	2371	16
15.	Rohtak	72	2372	497	1849	26
16.	Sirsa	25	830	369	452	9
17.	Sonipat	50	3622	337	3245	40
18.	Yamunanagar	50	880	422	444	14
19.	Panipat	98	2486	741	1709	36
20.	Karnal	58	1873	557	1295	21
21.	Charkhi Dadri	17	266	100	165	1
22.	Ambala	92	2863	382	2457	24

Source: National Health Mission Haryana

IV. RESULT AND DISCUSSION

After data processing and integration, a district-wise map was prepared which is shown in Fig. 4.1. The map showed the current status of COVID-19 status in Haryana. According to table no 3.1, Faridabad (11403) district was a highly affected district followed by Gurgaon (10650) district. High newly reported cases were noticed in Panchkula district (114) followed by Gurgaon district. In the death case matter, Faridabad (159) district was in top and Gurgaon (131) was at second position. Active cases were highest in Panipat district (741) which is followed by Faridabad district (685). Fig. 4.1 shows diagrammatically corona status in Haryana state. In this figure, comparative analysis can be done at a glance. Total, active, newly reported total deaths and total recovered cases were comparatively analyzed by ArcGIS software. Sirsa, Fatehabad, Bhiwani, Hisar, Charkhi Dadri, Rewari, Mahendergarh, Jind, Kaithal, Kurukshetra, Yamunanagar districts have less impact than NCR region. Fig. no 4.2, 4.3, 4.4, 4.5, and 4.6 shows the total cases, recovered, daily reported, active cases, and death reports on covid-19 status in Haryana.

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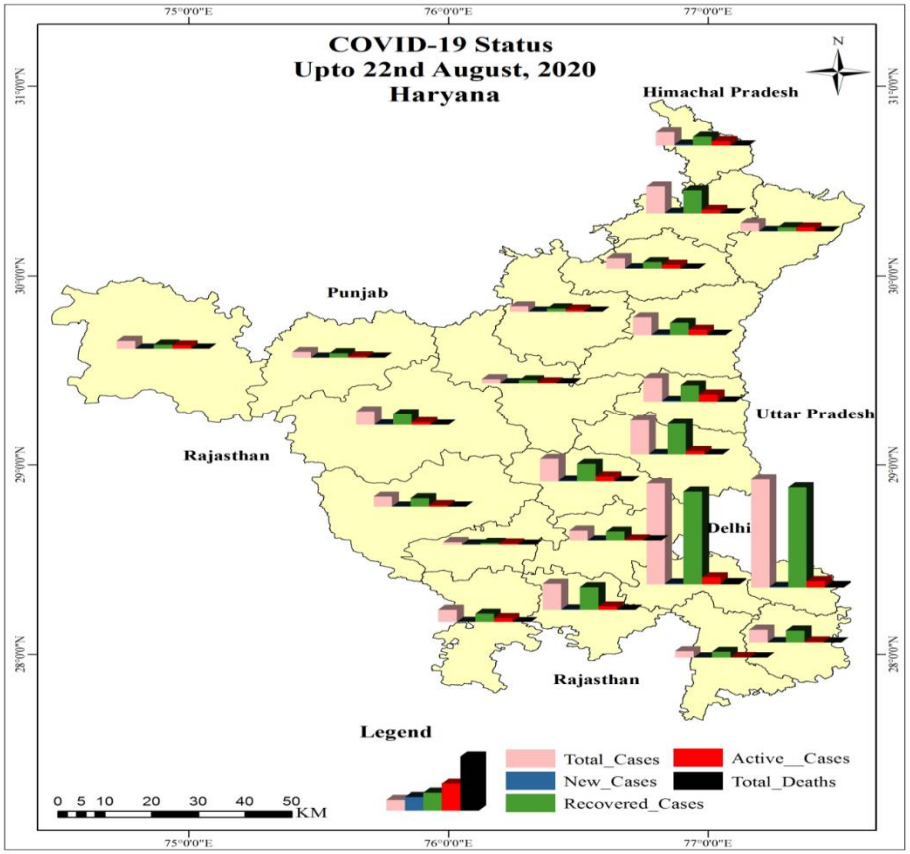

Fig.4.1 Comparative status of corona cases

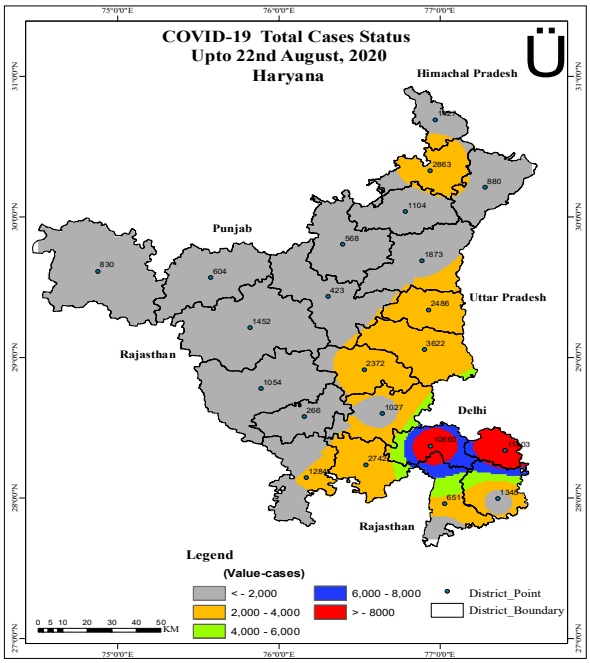

Fig.4.2: Total cases status

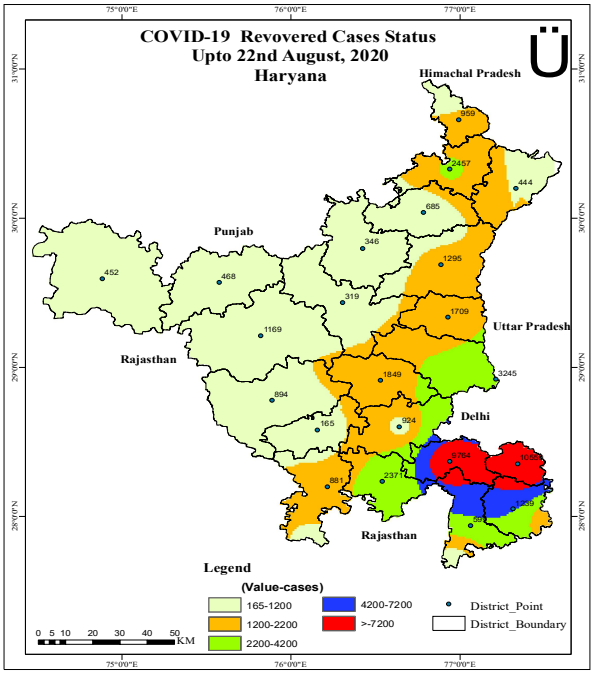

Fig. 4.3: Status of recovered cases

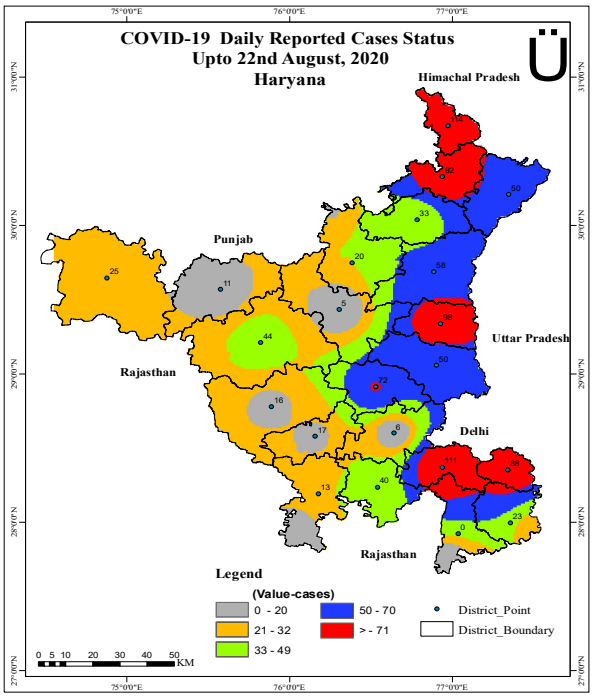

Fig.4.4 Daily Reported cases

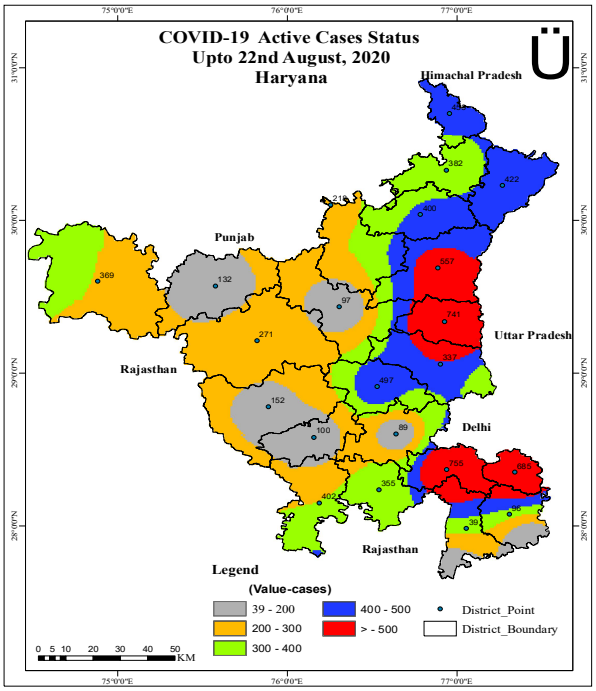

Fig.4.5: Active cases status

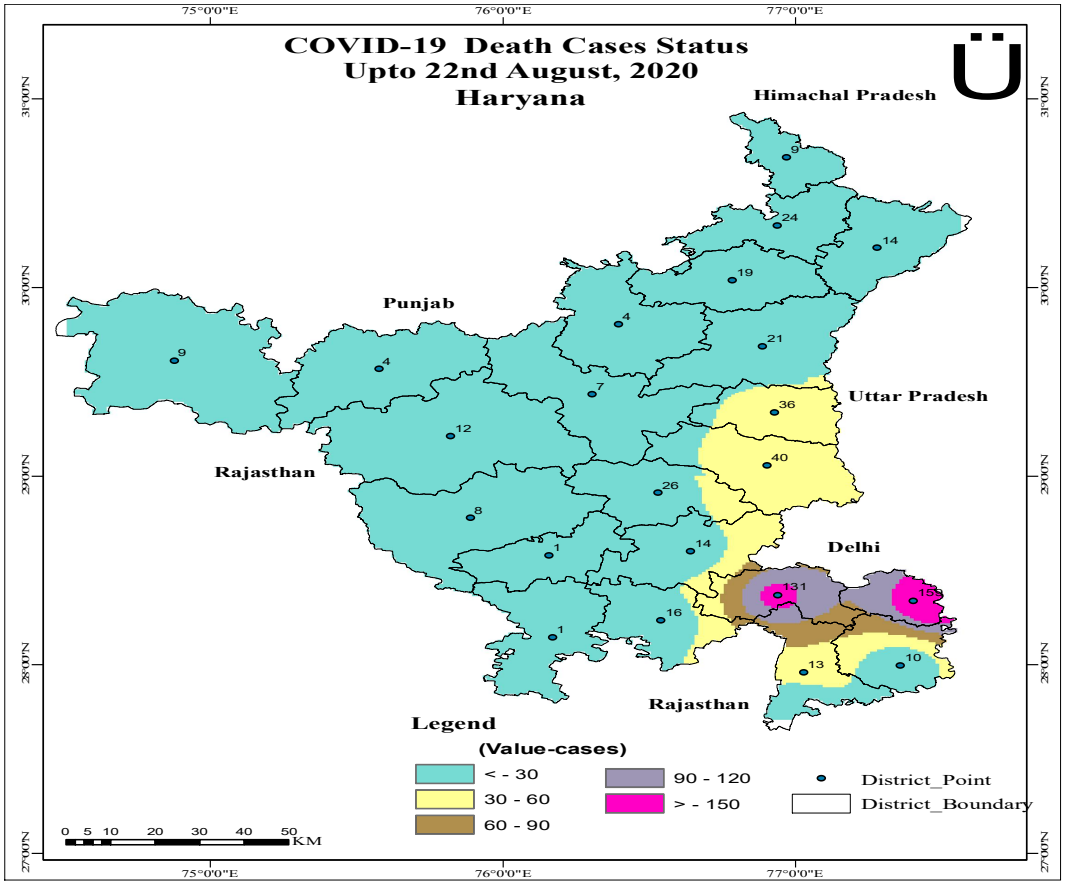

Fig: 4.6: Death cases report

V. GIS MAPPING AND COVID-19 SPATIAL DISTRIBUTION

Spatial-temporal maps and analysis have been applied very effectively by various agencies like UNICEF, WHO, etc., and also by epidemiologists to control the spreading of Zika and Ebola virus. Such maps are very helpful in decision-making. Malaria and Dengue diseases were already tracked by the National Institute of Malaria Research with the help of GIS. Through GIS, vulnerable areas can be identified, surveyed, mapped, and analyzed those factors of controlling and obstacles. GIS helps in mapping different parameters of various diseases affected areas like population, outbreaks of problem, pattern and intensity of the disease, environment, surveillance, and preventive measurements. Prepared database updated regularly to manage and track the epidemic for decision making. Fig. 5.1 provides the epidemics affecting zones information based on daily reported cases. The study area is categorized into five categories very less affected, less affected, medium affected, highly affected, and very highly affected area. According to the map, Panchkula and Ambala districts (Northern Haryana), Panipat (Eastern Haryana), and Faridabad, Gurugram, and the north part of Mewat districts (South-eastern Haryana), Rohtak urban area (Central Haryana) are under in the highly affected area. Western Ambala (Northern Haryana), Yamuna Nagar, Karnal, and Sonipat districts (Eastern Haryana), most parts of Rohtak District (Central Haryana), Eastern part of Jhajjar, the central part of Mewat, and northern part of Palwal districts are in the highly affected area. Most parts of Kurukshetra and 50% of the area (south-eastern) of Kaithal districts (Northern Haryana), Jind (south-eastern part), middle and some southern part of Hisar, Eastern part of Bhiwani and Charkhi Dadri, few patches in Jhajjar districts (Central Haryana), Rewari, Middle Mewat, and middle Palwal districts (Southern Haryana) are under the medium affected area. Based on this map, the appropriate guideline can be issued to control the increasing cases. Sirsa, southern and eastern Fatehabad (North-western Haryana), rest the middle part of Hisar, Bhiwani, Charkhi Dadri districts (Western Haryana), and besides southern part of Mahendergarh districts (Southern Haryana) are under less affected class. The middle part of Jind and Fatehabad districts (Northern Haryana), Middle part of Bhiwani, and Charkhi Dadri districts (Western Haryana), Jhajjar urban area, southern Mahendergarh, and Southern Mewat (Southern Haryana) districts are under in very less affected class.

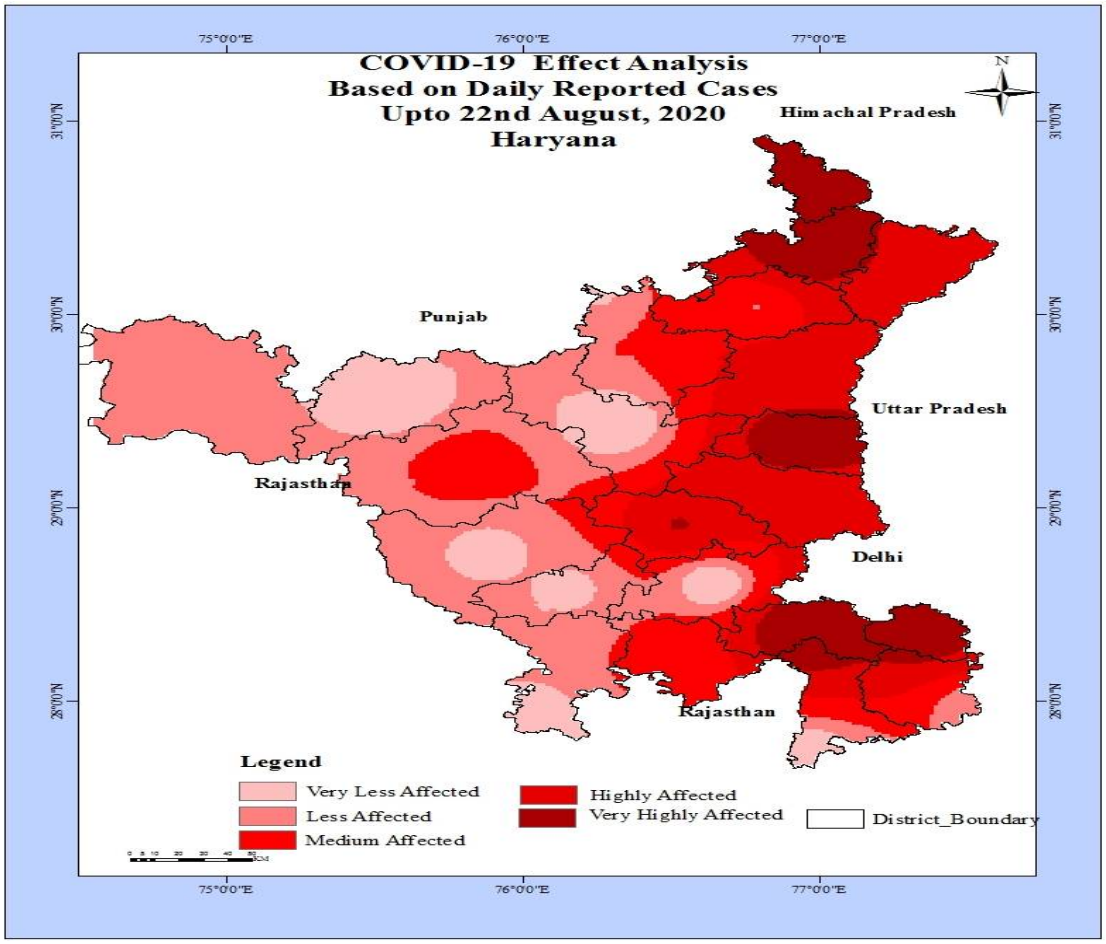

Fig.5.1: Zones mapping

VI. CONCLUSION

GIS as a mapping tool could be a very valuable instrument in decision making, more mobilization, more importantly, and faithful community response. COVID-19's spatial-temporal dynamics are very crucial to its mitigation, which is why research is being conducted at the global level. This is happening because geospatial information-based platforms are available in large volumes at national and international levels. GIS provides location information. GIS capabilities enable us in mapping confirmed cases, active cases, recovered cases, and fatalities cases. So, GIS is needed in the real-time mapping of the infectious area at various risk zones. A suitable plan can be executed after evaluating the available facilities and capabilities and also helpful in making easier coordination among other supporting agencies.

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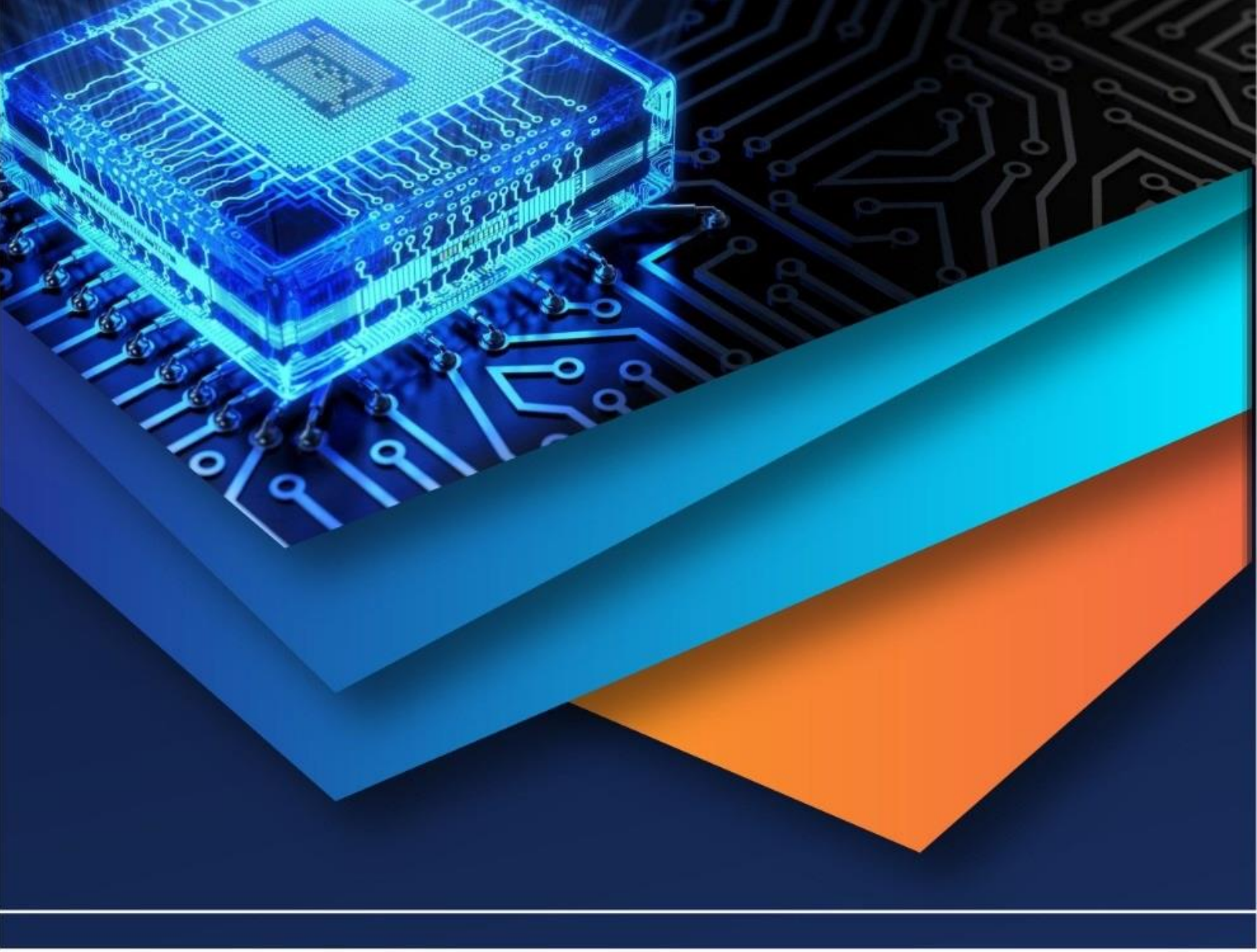

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