DYNAMIC MAPPING OF COVID-19 OUTBREAK IN KARNATAKA REGION USING PYTHON-GIS

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Abstract— The main objective of this paper is to create a dynamic map using time series data of corona virus infections in Karnataka using advancement of Python libraries like GeoPandas and Pandas. Interactive maps are useful to clearly convey complex information and are more engaging for viewers than static maps. Pandas provides data structures and data analysis tools whereas GeoPandas extends the data types used by pandas to allow spatial operations on geometric types. This enables to illustrate the complex information in a succinct manner. In order to elucidate the impact of pandemic and to aid the planning and decision making processes, it's very important to understand the spatio-temporal dynamics of COVID-19. The time series data are acquired from the Karnataka State COVID-19 dashboard. Corona virus active cases in all the 30 Districts in Karnataka for twenty weeks were considered for generating the choropleth maps. Spatial maps were downloaded from KGIS (Karnataka Geographical Information System) portal and the spatial and time series data were merged to generate the dynamic mapping using Python. Geo visualization provides an insight on prevailing scenario of Karnataka state's pandemic situation. Projection of spatial diffusion and temporal trends will provide an overview for the decision makers and Government of Karnataka for further action. The sequence of time series data can be further used for forecasting the trend and for better mitigation planning.

Index Terms— COVID-19, Dynamics, Mapping, Pandas

I. INTRODUCTION

Severe acute respiratory syndrome corona virus 2 (SARS-CoV-2) is the virus that causes respiratory tract infection in humans called Corona Virus Disease 2019 (COVID-19) [1]. Workers migrating from rural and peri-urban areas of the country to the cities constitute majority of urban population in the country. During the spread of communicable virus, social distancing measures as to be undertaken as a preventive measure [2]. Congregations of migrant workers in the District borders make the travellers more susceptible to corona virus infection. The exposed individuals may further become the infection carriers and spread this infection to rural localities. Mild illnesses cause common cold whereas lethal varieties cause SARS which affects people in different ways. Surveillance systems with the contingency plan were being implemented for limiting the extent of the disease [3].

II. Lockdown's in Karnataka, India

The positive case of corona virus in the Indian state of Karnataka was first confirmed on 9th March 2020(Department of health and family welfare, Government of Karnataka). In next two days, Karnataka state has become first in India to invoke the necessities of Epidemic Diseases Act, 1897, to curtail the spread of the disease. Till 26th July in Karnataka, 67,420 confirmed cases, with 23,795 recovered and 1403 deaths were reported. In Bengaluru the capital city of Karnataka, first corona virus infected positive case was identified in a software engineer with a travel history. The government of Karnataka has taken insistent measures to control the corona virus spread. Central Government

has implemented Lockdown 1.0 throughout the country from 25 March to 14 April for a period of 21 days. The Central government has recognized Bengaluru city as a model city in managing the COVID-19 pandemic. Government continued the series of lockdown for limiting the spread of the disease even though these shutdowns will negatively impact the economic growth of a state and a normal life of a citizen. Lockdown 2.0 was implemented between 14 April and 3 May. Consequently Lockdown 3.0 started from 3 May to 17 May. Karnataka Government has given more relaxations during the Lockdown 4.0 implemented from 18 May 2020 to 31 May 2020. The Government allowed four state transport corporation buses to operate, except in red and containment zones. Activities excluding hotels, cinema halls, shopping malls, and restaurants were permitted to operate except on Sundays. All the modes of public transports, including auto-rickshaws, buses, cabs and intra-state train services were allowed to operate in Lockdown 4.0. Subsequently, there was a significant rise in the corona virus positive cases throughout Karnataka. In order to slow down the spreading of the virus, the first and the foremost is to be well informed about the presence of virus and spatially how it spreads [4]. The Karnataka Government addressed the daily number of cases and released reports to inform the citizen about the seriousness about COVID-19 and initiated to create Android application to help the citizen by understanding the virus spread and track the neighboring COIVD-19 cases.
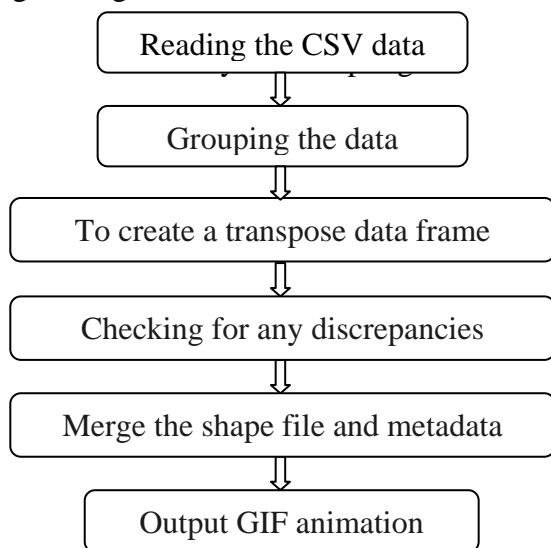

Figure 1 Sequence of steps in dynamic mapping

This section illustrates the power of Python programming language pointedly for geo visualization based on Coivid-19 dataset. Python is a scripting language integrated into Geographical Information System software such as QGIS and ArcGIS mainly used for automating the geo-processes [5]. Python are basically a command-based script, contains various data types and functions that helps in geoprocessing. GIS core functionalities are enhanced by Python libraries [6]. Python scripts were available readily to make it easier for all the end users. Open Python libraries were available for machine learning, graphing, reporting and many more.

To access the extra functionality in python, anyone can pull those libraries by importing them in the Python script and can call those functions as part of the GIS software [7]. In Python, GeoPandas are the open source scripts to work with the geospatial data's easily. For preparing dynamic maps the spatial data in vector format are required [8]. In this study, each District is represented as single polygon in the form of shape file and in order to read and process the spatial data, GeoPandas libraries are imported. The main purpose of this paper is to highlight how to construct Geo-visualisation using available live data and to add new insight into the spreading of corona virus spatially. Moreover, this paper concentrates on generating dynamic map of positive corona virus cases on daily basis. The first positive case reported in Karnataka which was on 9 March to 20 July were considered for this study. QGIS software is utilised for visualizing the spatial spread of recorded data on daily basis.
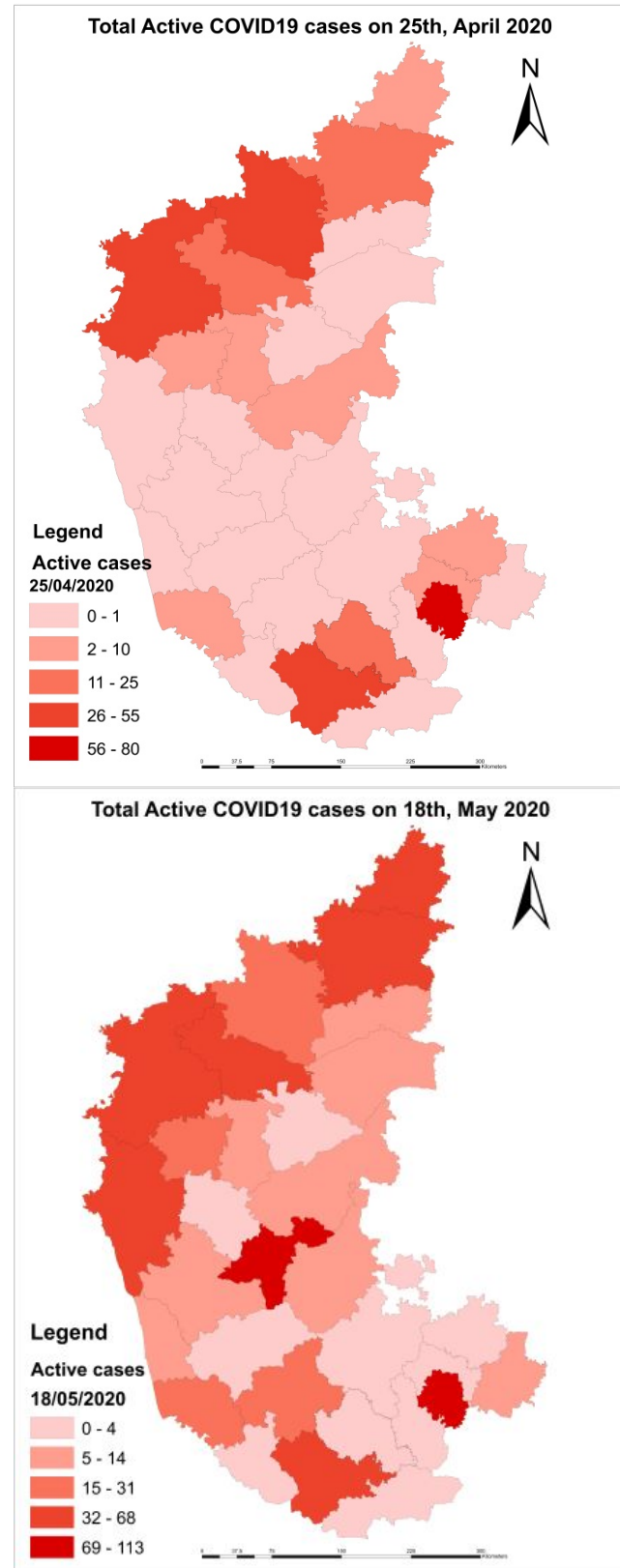
IV. Data Sources
A. Spatial data: District level administrative boundary of Karnataka state in the form of vector data was downloaded from KGIS (Karnataka GIS) portal. The shape file was derived from survey of India (SOI) toposheets on 1:50K scale by Karnataka State Remote Sensing Application Centre (KSRSAC). COVID-19 Geospatial information system developed under KGIS is providing details of affected hotspots in taluk level, geo location of all quarantined people, positive persons travelling history, police jurisdiction boundaries, hospital location, testing labs etc. for entire state.

B. Metadata: Government of Karnataka has released the novel Corona virus, media bulletin through COVID-19 Information portal. District wise abstract of COVID-19 were also included in that report. The total number of confirmed active cases was extracted from the daily report. The data was collected for a period of 20 weeks from 9-03-2020 to 26-07-2020. The data is saved in CSV (Comma Separated Values) format. Python support to process the CSV file easier. Table 1 shows the Number of active cases on daily basis for Karnataka region. Data cleaning was carried out to lessen the anomalies for further analysis. Data were corrected in order to comply with KGIS Standard Schema Attributes which are properly recorded for each district and maintained the uniqueness. District name is considered to be a key feature to do the joining operation between spatial and metadata.

V. Methodology

This section provides the steps associated with data preparation for developing the dynamic map. The Spyder is an open-source platform, used as a python development environment. Initially, all the relevant libraries such as pandas as pd and GeoPandas as gpd were imported for data analysis and visualization. All the polygons under each District names in the database needs to be matched with the shape files and it considered as key attribute while joining both the data sources. Integrated the districts shape file with .csv data file by join operation in python environment. Created a transpose of the data frame for more convenient mapping and where the columns corresponds to dates and rows corresponds to each district.

Karnataka district shape file merged by all the COVID-19 information is considered to be a final base map while creating dynamic maps. GeoPandas provide an inbuilt data frame to read and process spatial data. Python environment allow viewing the type and structure of data frame by a single line query.

Total Active COVID19 cases on 25th, April 2020

Legend
Active cases
25/04/2020
0 - 1
2 - 10
11 - 25
26 - 55
56 - 80

Total Active COVID19 cases on 18th, May 2020

Legend
Active cases
18/05/2020
0 - 4
5 - 14
15 - 31
32 - 68
69 - 113

Total Active COVID19 cases on 22nd, June 2020

Legend
Active cases
22/06/2020
1 - 26
27 - 84
85 - 185
186 - 484
485 - 919

Total Active COVID19 cases on 13th, July 2020

Legend
Active cases
13/07/2020
38 - 183
184 - 447
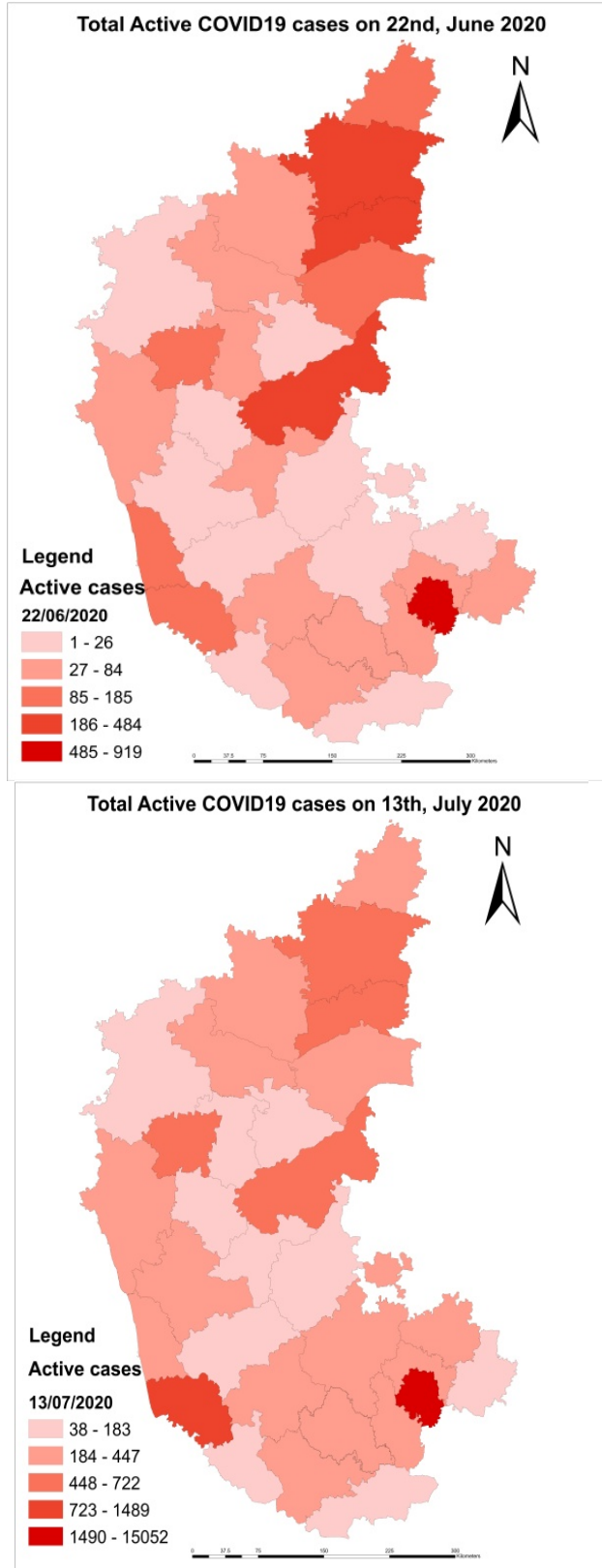448 - 722
723 - 1489
1490 - 15052

Figure 3: Spatial Variation of COVID-19 cases in Karnataka

VI. Spatio-Temporal Analysing of Corona virus spread

The dynamic map portrays the dramatic rise of COVID-19 for the period of study as mentioned earlier for all the Districts in Karnataka. There has been an exponential growth in active corona virus cases in Karnataka. Figure 2 represents the rise in number of active cases of COVID-19 in Karnataka for the study period in the form of line graph. The spatial pattern of epidemic virus is distinct for all the 30 districts in the state. In April, sudden rise in the number of positive cases was noticed just after the Tablighi Jamaat a religious gathering by Muslim missionary organized on 13th to15[th] March, 2020 by ignoring the threat of virus spread. Number of positive cases rose from 560 on April 30 to 3,220 by May 31. Karnataka saw an almost six-fold increase in the number of positive cases in the mid of May. The choropleth map of total number of active COVID-19 cases in Karnataka on 25 April, 18 May, 22 June and 13 July were as shown in the Figure 3. The map clearly depicts that the number of incidence were rising in Bangalore urban, Mysuru, Belagavi and Bijapur on 25th April. Unfortunately, there are around two thousand patients who tested positive in the month of May, were inter-state travellers. This is mainly because, when the lockdown was eased, people started travelling from various states like Maharashtra, Andhra Pradesh and Telangana, some of high prevalence states arrived to Karnataka. In the third week of June Kalburgi, Yadgir, Bellari and Bangalore urban has started reporting more than 500 active cases per day. All the Districts started contributing on an average of 50 cases per day by the mid of July. As Karnataka, continued to break the records of statistics on number of corona virus cases in the month of July, Government has **decided to impose** Sunday curfews. As a preventive measure it was also decided to extend the timing of night curfew from 9 pm to 5 am and all Government offices were closed on all Saturdays.

On April 25, Bangalore urban, Mysuru, Belagavi and Vijayapura districts of Karnataka had reported more than 50 active cases as represented in Figure 4. The districts like Bangalore urban and Davenegere were reporting nearly 100 cases per day by the mid of May and whereas Bidar, Kalburgi, Bagalkot, Belagavi,

Uttara kannada and Mysuru were reporting more than 50 active cases per day as shown in Figure 5. Darwad, Bellary and Daksin kannada were seen a huge hike on an average of 100 to 1000 cases per day between 22 June and 13 July. Figure 6 represents the rise in number of active cases in Dharwad and Dakshina Kannada.

In the present scenario flattening the corona virus curve is the at most important. Because in case of steep curve, health care system were overburdened. Demand for health care facilities is far more than the availability when the curve is steepening day by day. So, it would always be better if the curve is flattened. In order to achieve flattened curve states like Karnataka has to adopt containment strategy. Almost all the states are working towards flattening the curve [8]. A flat curve represents that the number of new corona virus active cases per day in an area are the same and the situation is under control. An early lockdown imposed by the government helped Karnataka in order to reduce the total number of infected people. Lock down is considered to be an effective measure towards breaking the chain of transmission from one person to another.
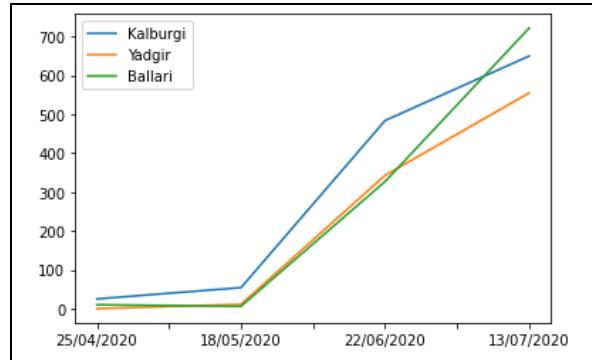
Figure 5: Rise in number of cases in Kalburgi, Yadgir and Ballari Districts
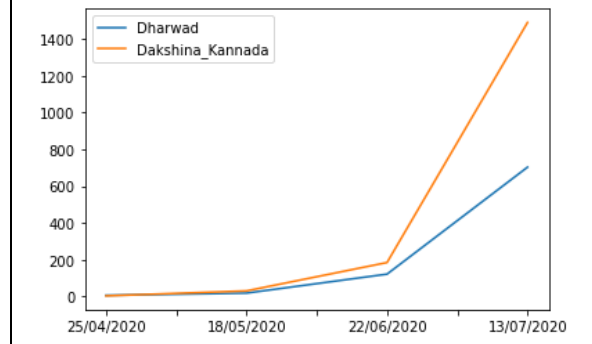
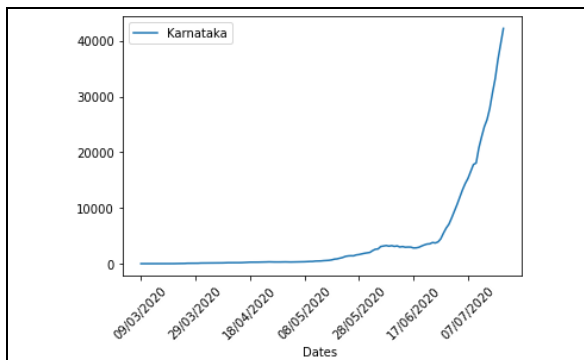Figure 6: Rise in number of cases in Dharwad and Dakshina Kannada

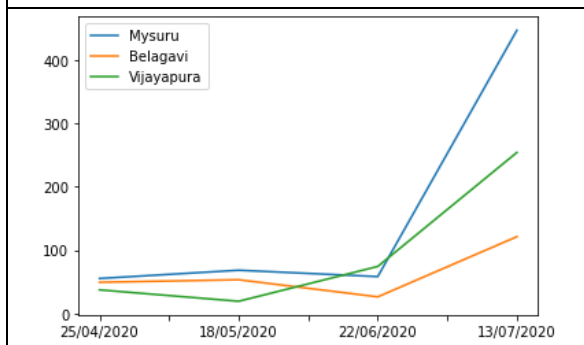**Figure 2: Rise in number of cases in Karnataka**

Figure 4: Rise in number of cases in Mysuru, Belagavi and Vijayapura

VII Discussion

Corona is an infectious disease caused by corona virus. The people infected with this virus may experience a mild to moderate respiratory illness and may recover without any special treatment [9]. People with medical problems, elderly people and people those who have diabetes, cancer, cardiovascular disease, chronic respiratory disease are more likely to experience the serious illness [10].Protect yourself from infection by frequently washing your hands with an alcohol based hand wash will always minimise the chance in getting infected. COVID-19 information portal maintained by Government of Karnataka will continue to provide updates on daily basis. Researchers can make use of this micro level daily time series data for forecasting the trend and implementation of mitigation strategies to reduce or prevent COVID-19 transmission widely. In order to fight COVID-19, it's very important to take up the challenges with a proactive planning in an interdisciplinary perspective. This paper provides useful information on the methodology to generate the geovisualizing maps using python. The analysis

on the spatio-temporal COVID-19 data provides an insight about the Karnataka COVID-19 scenario for decision makers.

Stay safe and stay aware of up-to-date information on COVID-19.

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