

REGIONAL DISPARITIES IN POPULATION DISTRIBUTION, DENSITY AND GROWTH IN PUNJAB-PAKISTAN: A GEOSPATIAL APPROACH

K. Sharkullah^{1*} and S. A. Shirazi²

¹Department of Geography, Forman Christian College (A Chartered University), Lahore, Pakistan

²Institute of Geography, University of the Punjab, Lahore, Pakistan

*Corresponding Author's Email: khadijashakrullah@fccollege.edu.pk

ABSTRACT: The global population is unevenly distributed and growing at a pace, that is bringing disparities among resources and areas. The distribution and density are two important aspects of population studies and intrigue the attention of geographers, as well as other social scientists across the globe. Population distribution and density are influenced by various geographical, socio-economic, and cultural factors. Therefore, distribution and density cannot alone be determined by a single factor but rather by a multitude of many factors. The present research is focused on various methods to gauge the distribution and density of the population of Punjab for the Census years 1998, 2017 and 2023 on the district level. The use of Geographical Information System (GIS) and CANVA have facilitated the demographic data and analysis which reveals an overall increase in the population and density of almost all the districts during the under-study period; 1998, 2013 and 2023. The GIS techniques helped to extract the regional disparities, trends, and patterns of population distribution and density succinctly.

Keywords: Disparity, Population Distribution, Density, GIS, Geospatial.

(Received 09.04.2024

Accepted 01.06.2024)

INTRODUCTION

The world's population is unevenly distributed, and population density differs widely across the globe. The density of the population of an area reveals how people have spaced over the surface of the Earth and is a spatial phenomenon with temporal dimensions (Smailes, 2002). Distribution of population and density on the other hand is the manifestation of how human beings are living on the earth owing to multiple factors like physiography, climate, availability of water, economic activities, history, culture, accessibility, and government policies (Santini, 2018). Population density is an important parameter to gauge the areal distribution of the population (Chen, 2019), it is also used to identify rural and urban population distribution which is required to highlight the state of urbanization in a region (Li, 2019, Yang, 2020). The distribution, density, and growth rates of the population of an area reveal its socio-economic conditions and prosperity. Population distribution and disparities are among the most studied and researched areas in Population Geography. However, with rapid demographic fluctuations and frequent areal changes, it is difficult to map and analyses these important demographic variables in a region. It is complex and difficult in population sciences due to its complexity and dynamism. Population Geography is all about the spatial distribution and variations of the human population concerning various characteristics over the face of the Earth.

The traditional methods and techniques that are being used by the geographer to map the population and its attributes are now not frequently used. This is now a Geographical Information System (GIS) augmented with various statistical software to help geographers' planners, demographers, and city managers to prepare, store, update, and visually show the numeric information of a geographical territory. The GIS as we are aware of that a modern tool to analyse the phenomenon occurring on the Earth. This study aimed to evaluate trends and patterns of population distribution in the Punjab province of Pakistan which is the largest areal unit in terms of its population size. The study is based on district-wise population distribution, its trends, and changes over time by taking statistical data from the Census of 1998, 2017, and 2023.

MATERIAL AND METHODS

The area under study is the Punjab province of Pakistan. The word "*Punjab*" is a compound of two Persian words "*Punj*" and "*Aab*" meaning land of five rivers. The province is watered by five tributary rivers of Sindh River namely the Jhelum, Chenab, Ravi, Sutlej, and Beas (in Indian Punjab). In terms of population size, it is the largest province of Pakistan with a population of 127,688,922 souls (GoP, 2023). The total area of Punjab is 205,344 square kilometers (kms.), which is 25.9% of the total area of Pakistan, ranking it the 2nd largest province in terms of areal extent. The Punjab has been administratively divided into 36 districts with various socio-cultural and economic conditions. The districts are

also varied in terms of landforms ranging from plains to plateaus. Being the largest cluster of the population as well as with fertile agricultural lands and possessing a well-developed irrigation system, its contribution to the Country's agricultural and economic development has been commendable over the past many decades.

However, agriculture is the mainstay of millions of people living in this province. With this backdrop, the Punjab province is selected as a case study to find the regional disparities and trend patterns in its population distribution for the last three Censuses i.e., 1998, 2017, and 2023.

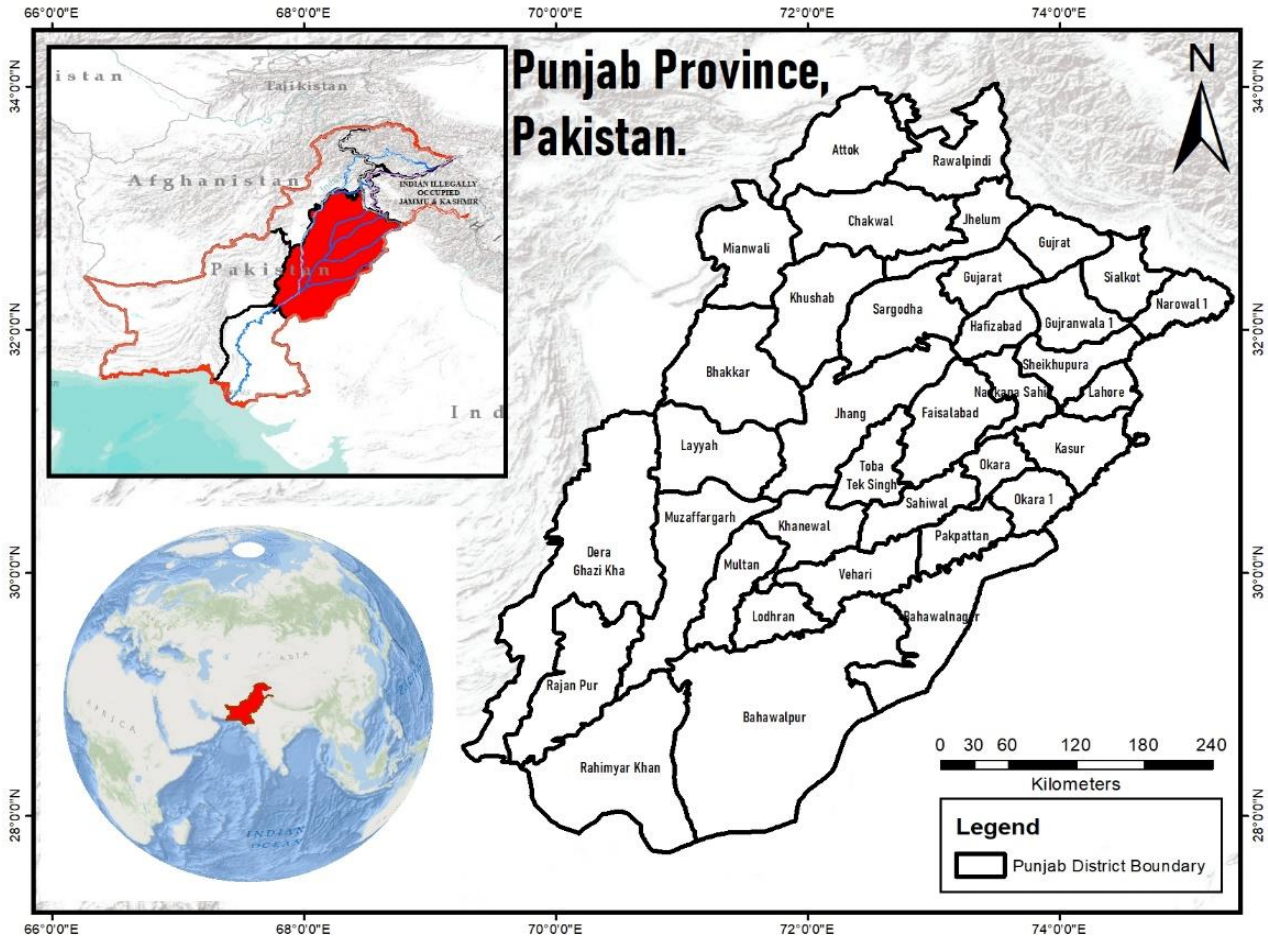


Fig.1 Study area-the Punjab and its Districts,2024

The GIS software is widely used in both natural and social sciences and ArcGIS helped in processing the spatial as well as numerical data. Geographical Information Systems (GIS) and Geospatial techniques are advanced tools used in a range of disciplines to visually manage attribute and spatial data, including demographic data like distribution and density (Chengming, 2002). Population mapping usually represents its extent over an area, especially to quantify the population density (Bielecka, 2005). The effective use of GIS in population analysis has been widely used to map the spatial distribution of population in the State of Mexico during the wake of information technologies (Manzano and Franco, 2009; Manzano *et al.*, 2010).

It can further be utilized in mathematical calculations, visualization of digital data and to perform

geostatistical analysis in a GIS environment. Digital cartography offers a range of map-making and analysis techniques to geographers these days. In ArcGIS, one can set an appropriate query to data, visualize it on screen, and then easily convert it into maps by overlaying different databases related to available data (Ogochukwu, 2013). More options are also available in ArcGIS software to prepare 3D maps Even more, ArcGIS offers the possibility to use not only the 2D maps but 3D too (Mijic, 2018). In this research, we have used the Geographical Information System (GIS) tool to cartographically depict the distribution and density of population in the province of Punjab on the district level to highlight the regional variations by taking the 1998, 2017 and 2023 Census of Punjab-Pakistan. Further to this change and growth of the population has also been

depicted graphically. In this research GIS-based maps related to the population distribution, density, and growth have been prepared first using demographic data in Excel.

After data preparation in Excel then applied different formulas to calculate the population growth and density of each geographical/administrative unit i.e., the district. After that the GIS data processing and analysis were carried out and the district boundary of Punjab imported from the online available database and then the prepared population data in Excel was also imported into the GIS environment. Since GIS-based maps can be prepared using Dot, symbological, distribution method. However, we have used the symbological method which is the most suited way to depict the population growth and distribution during different censuses in view. By employing this method, district-wise change in population can be identified as well as the population growth trends. After successfully importing the demographic data, we applied a join between the population data and district boundaries. By using geospatial analysis and data symbology, GIS-based population distribution and density maps were prepared. Further to this population data was divided into the different classes to show the district-wise population spread and to understand the population change during 1998, 2017 and 2023 Census. By applying the formula to calculate the population density in the GIS database.

After that population and total area, we created GIS-based district-level maps of the Punjab-Pakistan. After importing data in the GIS environment and data integration with a shape file, different GIS-based maps were prepared based on available census data for 1998, 2017, and 2023. Several separate maps showing differences in the percentage were prepared to highlight the change in population by districts in the Punjab province. The data visualization was carried out using a GIS layout while the graphs were prepared in CANVA. It is pertained to mention that CANVA is an online platform, used for the creation of graphs having international standards. For this, we imported Excel data in the CANVA dashboard then selected the appropriate graph style and input the desired data. After analysis desired graphs were exported in desired format for visualization.

RESULTS AND DISCUSSION

The maps prepared in the GIS environment revealed that the population of the province has shown a continuous increment since the 1998 Census. It is not just in number but density as well. Almost all the districts have registered an increase in population size and density (Table 1).

The population of the province of Punjab is unevenly distributed and is largely influenced by several socio-geographical factors like historical settlements, accessibility, manufacturing, economic stability, topography, climate, fertile soils, water availability, agriculture, irrigation system, and political will. Present research reveals that all 36 districts have shown significant strides in all sectors of development. The economic prosperity during 1998-2023 and beyond is a determinant element. In addition to natural increase, rural-urban migration has also played an important role in population increment. Population growth in most of the districts can be attributed rapid growth of the urban population as the process of urbanization is taking place in all major districts of the Punjab, like Lahore, Faisalabad, Rawalpindi, Multan, Gujranwala, Gujrat, Sargodha and many more. Urban growth and development are reducing arable lands near the city boundaries which in turn is responsible for environmental degradation. It is therefore suggested that the Government of the Punjab should encourage vertical growth by building high-rise residential apartments. As table-1 indicates the population of almost all districts has shown a consistent increase in population which in turn increases the burden on resources. This growth in the population size of each district has impacted the regional disparities and inequalities of population density. A glance at Fig.3 revealed that the most densely populated districts are located in the east-central parts of the Punjab while districts with relatively less density are found in the extreme northern, southern, western, and southeastern. This distribution is the depiction of population distribution in the Punjab. This can be attributed to old settlements with stable agricultural systems, industries, and socio-cultural hearth which provide stable economic conditions leading to support more population. In all the censuses under consideration in this research, Lahore remained on top in terms of population size and density followed by Faisalabad. Currently, the districts of Gujranwala, Rawalpindi, Multan, Sialkot, Sargodha, and Gujrat have population distribution and density above 1000 persons per sq. km. All the aforementioned districts are also developed and have industries, a stable socio-cultural environment, health facilities, educational institutes, and multiple facilities. In contrast to this, the districts located in the south and southwest namely Dera Ghazi Khan, Rajanpur, Bahawalpur, Mianwali, Khushab, Jhang, Chakwal, Layyah, Bhakkar, have less population density with less population number. The possible factors behind this disparity can be the harsh weather, difficult terrain, difficult-to-practice agriculture, water scarcity, and meagre industrial presence. Rajanpur and Bahawalpur have a density of population less than 100 people per sq. km. in the 1998 Census while in 2017 and 2023 both recorded 147&173 and 162&173 persons per sq. km. respectively.

Table-1 Population Distribution and Density of the Punjab by Districts,1998,2017and 2023

Sr. No.	Districts of Punjab	Area/sq. kms.	1998 Population	Density 1998	2017 Population	Density 2017	2023 Population	Density 2023
1	Attock	6,858	1274935	186	1,886,378	274	2,170,423	316
2	Bahawalnagar	8,878	2061447	232	2,975,656	335	3,550,342	400
3	Bahawalpur	24,830	2433091	98	3,669,176	147	4,284,964	173
4	Bhakkar	8,153	1051456	129	1,647,852	202	1,957,470	240
5	Chakwal	6,524	1083725	166	1,495,463	229	1,734,854	266
6	Chiniot	2,643	965124	365	1,368,659	518	1,563,024	591
7	Dera G. Khan	11,922	1643118	138	2,872,631	240	3,393,705	285
8	Faisalabad	5,856	5429547	927	7,882,444	1344	9,075,819	1,550
9	Gujranwala	3,622	3400940	939	5,011,066	1384	5,959,750	1,645
10	Gujrat	3,192	2048008	642	2,756,289	863	3,219,375	1,009
11	Hafizabad	2,367	832980	352	1,156,954	488	1,319,909	558
12	Jhang	8,809	1869421	212	2,742,633	311	3,077,720	349
13	Jhelum	3,587	936957	261	1,222,403	340	1,382,308	385
14	Kasur	4,796	2354506	491	3,454,881	720	4,084,286	852
15	Khanewal	4,349	2068490	476	2,920,233	671	3,364,077	774
16	Khushab	6,511	905711	139	1,280,372	196	1,501,089	231
17	Lahore	1,772	6340114	3,578	11,119,985	6278	13,004,135	7,339
18	Layyah	6,291	1120951	178	1,823,995	290	2,102,386	334
19	Lodhran	2,778	1171800	422	1,699,693	612	1,928,299	694
20	Mandi Bahauddin	2,673	1160552	434	1,594,039	596	1,829,486	684
21	Mianwali	5,840	1056620	181	1,542,601	264	1,798,268	308
22	Multan	3,720	3116851	838	4,746,166	1275	5,362,305	1,441
23	Muzaffargarh	8,249	2635903	320	4,328,549	523	5,015,325	608
25	Nankana Sahib	2,960	1044865	353	1,354,986	458	1,634,871	552
24	Narowal	2,337	1265097	541	1,707,575	731	1,950,954	835
26	Okara	4,377	2232992	510	3,040,826	694	3,515,490	803
27	Pakpattan	2,724	1286680	472	1,824,228	669	2,136,170	784
28	Rahim Yar Khan	11,880	3141053	264	4,807,762	405	5,564,703	468
29	Rajanpur	12,319	1103618	90	1,996,039	162	2,381,049	193
30	Rawalpindi	5,286	3363911	636	5,402,380	1322	6,118,911	1,158
31	Sahiwal	3,201	1843194	576	2,513,011	786	2,881,811	900
32	Sargodha	5,854	2665979	455	3,696,212	632	4,334,448	740
33	Sheikhupura	5,960	3460426	581	3,460,004	580	4,049,418	679
34	Sialkot	3,016	2723481	903	3,894,938	1291	4,499,394	1,495
35	Toba Tek Singh	3,252	1621593	499	2,191,495	673	2,511,963	772
36	Vehari	4,364	2090416	479	2,902,081	663	3,430,421	786

* Persons per sq. km

Source: Census Reports of Pakistan,1998,2017and 2023

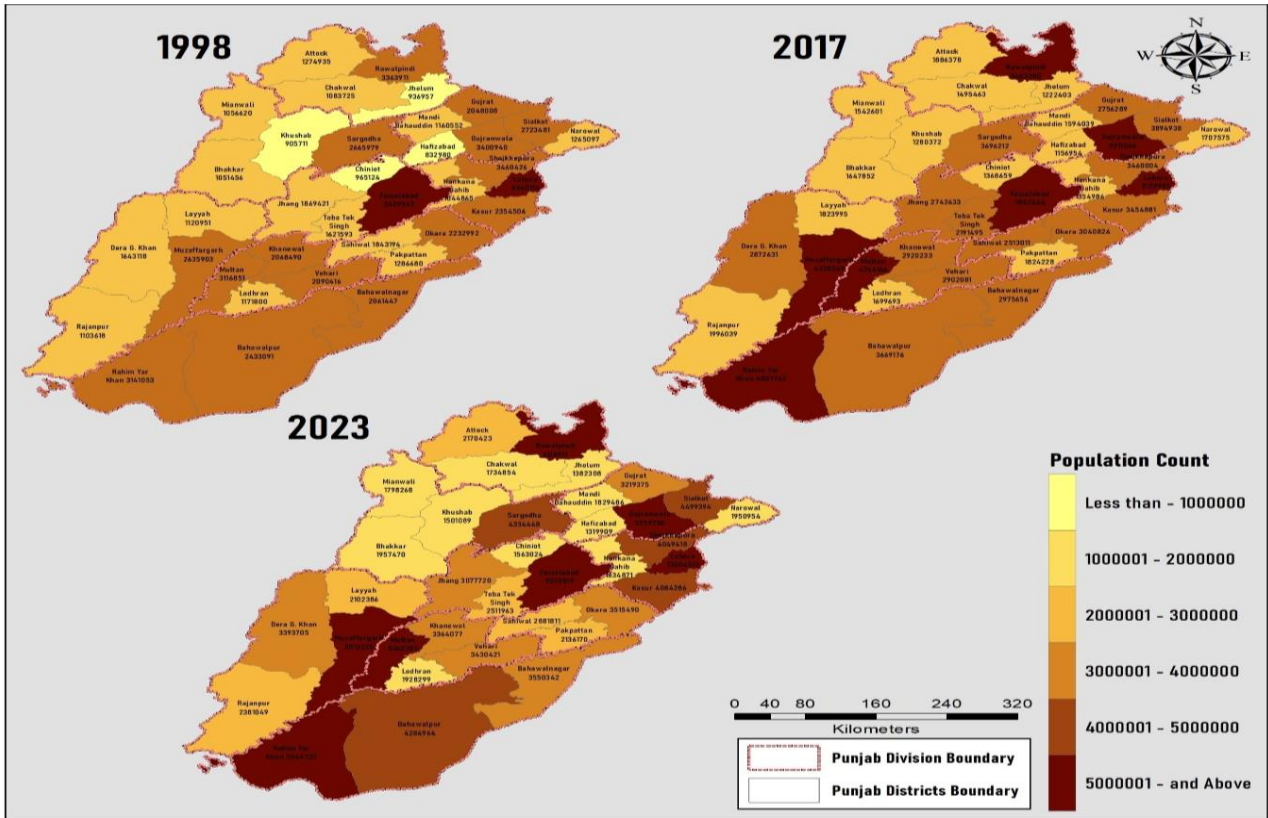


Fig. 2 Population Distribution in the Punjab by Districts, 1998, 2017 & 2023

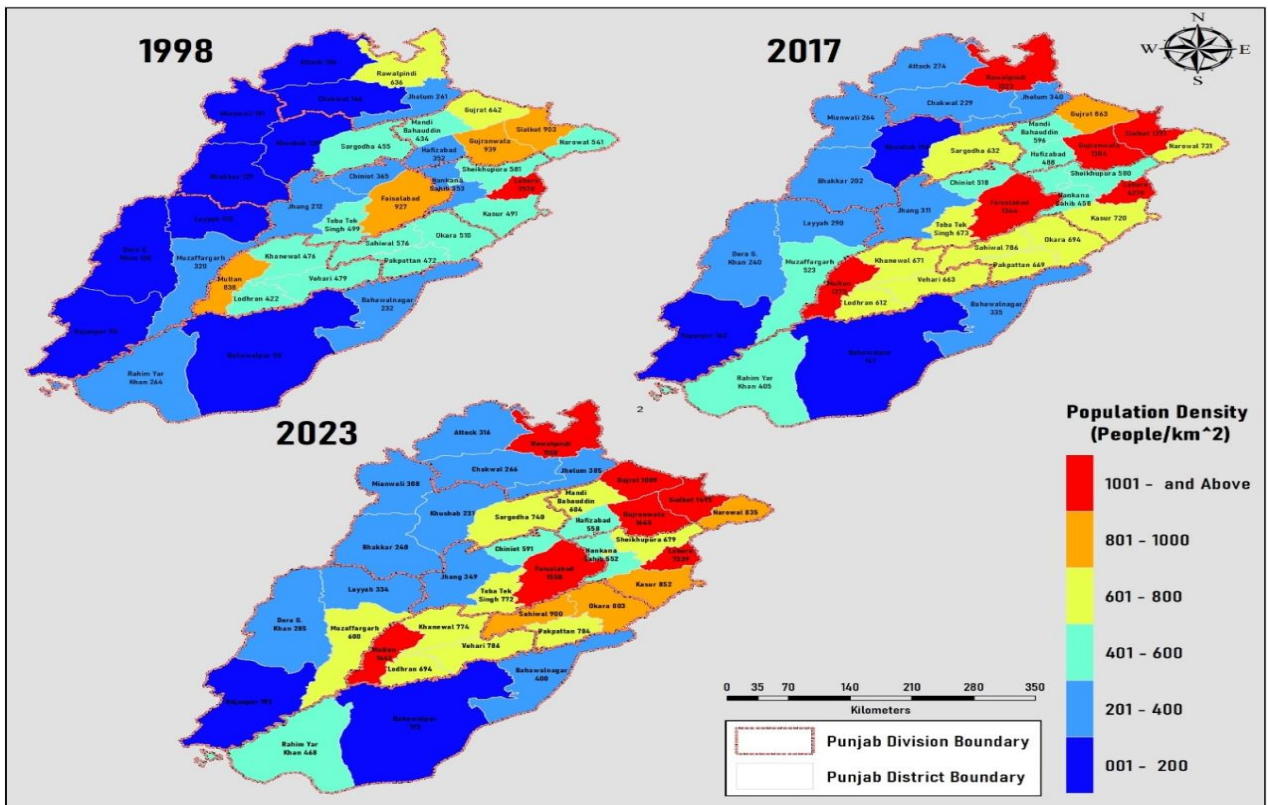


Fig.3 Population Density in the Punjab by Districts, 1998, 2017 & 2023

Population Change in Punjab by Districts ,1998-2023

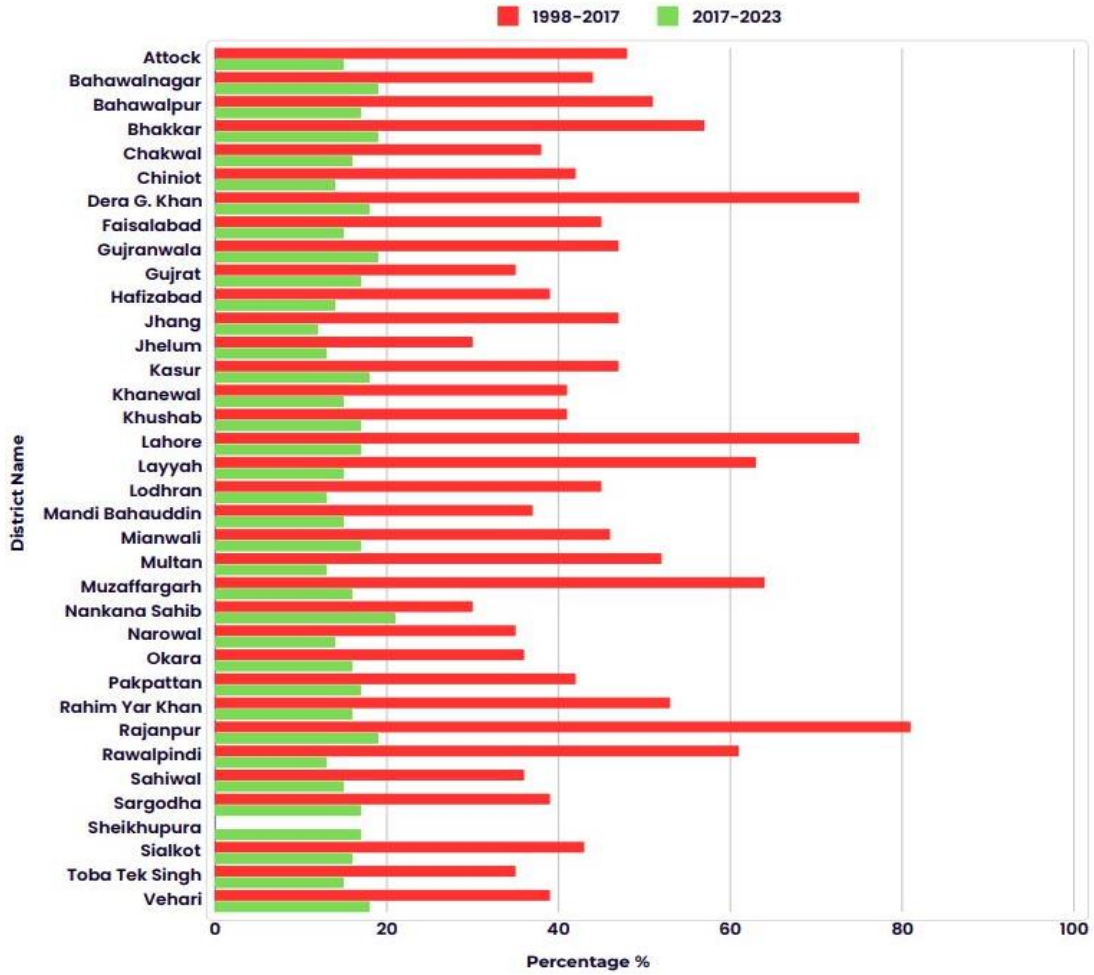


Fig.4 Population Change in the Punjab by Districts, 1998,2017 & 2023

Population Growth in Punjab by Districts ,1998-2023

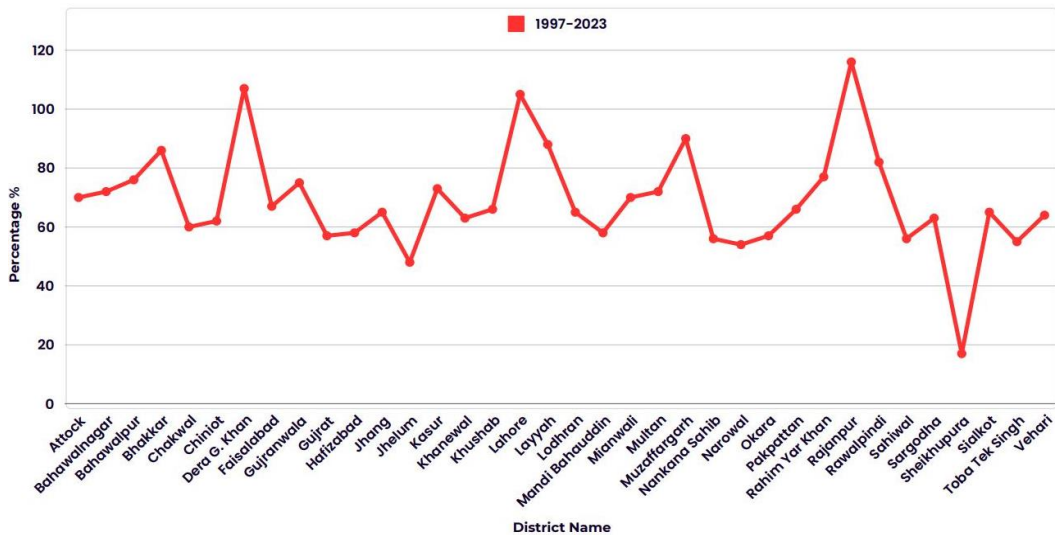


Fig.5 Population Growth in the Punjab by Districts, 1998, 2017 & 2023

Conclusion: In conclusion, it is inferred from the results that the population density and distribution of Punjab by districts have consistently shown an upward trend since the 1998 Census. All the districts have shown an increase in their population as well as in density. This depicts an overall impact of socio-ecological and historic-economic factors which have a net impact on the regional disparities in demographic conditions. The maps prepared in the geospatial environment are very useful for studying the characterization of district-level attributes of population and socioeconomic characteristics of each spatial unit. These maps are also very helpful to city and regional planners, agricultural planners, urban planners, infrastructural managers, and policymakers. Further to these solid waste management, civic amenities, disaster risk management and assessment, socio-economic policies, the well-being of residents, and consequently quality of life are the areas of prime importance in this regard.

REFERENCES

1. Bielecka, E. (2005). A Dasymetric Population Density Map of Poland. ICC2005—International Cartographic Conference, Corunna. <http://www.cartesia.org/geodoc/icc2005/pdf/oral/TEMA5/Session%209/ELZBIETA%20BIELECKA.pdf>
2. Chen, M., Sui, Y., Liu, W., Liu, H., & Huang, Y. (2019). Urbanization patterns and poverty reduction: A new perspective to explore the countries along the Belt and Road. *Habitat International*, 84, 1-14.
3. Chengming L., Zhongjian L., Yin J. Investigation on Application of GIS in Population Management. *Journal of Photogrammetry and Remote Sensing*. 2002. Volume XXXIV Part 4.
4. Govt.of Pakistan (2023) Census Report of the Punjab, Population Census Organization of Pakistan, Islamabad
5. Mijic, N. and Ateljevic, J. Demographic Analysis Using Modern GIS Software Tools—Case Study of the Republic of Srpska (Bosnia and Herzegovina). In *Advanced Technologies, Systems, and Applications II*. Springer Nature Switzerland AG. 2018. p 571-591.
6. Ogochukwu C. O. and Inyama H.C. Utilization of Geographic Information System (GIS) In Demographic Analysis of Census Data in Awka Metropolis in Anambra State, Nigeria. *The International Journal of Engineering and Science*. 2013; 2(7): 25-29.
7. L. R. Manzano-Solís and R. Franco-Plata, “Modelo en SIG Para Inferir la Distribución Espacial Continua de la Población a Partir de Datos por Localidad,” *Proceedings memorias del XI Seminario Internacional La Dimensión Humana en las Ciudades y Metrópolis*, Jalisco, 2009, pp 649-663.
8. L. R. Manzano-Solís, R. Franco-Plata and N. Sosa, “Propuesta Metodológica Para la Generación de imágenes de Superficie Continua con Distribución de la Población en un-7. Territorio Mediante una Aplicación de SIG,” *Proceedings Memorias del Quinto Coloquio Geográfico Sobre América Latina*, Toluca, 2010.
9. Smailes, P. J., Argent, N., & Griffin, T. L. (2002). Rural population density: its impact on social and demographic aspects of rural communities. *Journal of Rural Studies*, 18(4), 385-404.
10. Santini, L., Isaac, N. J., Maiorano, L., Ficetola, G. F., Huijbregts, M. A., Carbone, C., & Thuiller, W. (2018). Global drivers of population density in terrestrial vertebrates. *Global Ecology and Biogeography*, 27(8), 968-979.
11. Yang, J., Shi, Y., Yu, C., & Cao, S. J. (2020). Challenges of using mobile phone signalling data to estimate urban population density: towards smart cities and sustainable urban development. *Indoor and Built Environment*, 29(2), 147-150
12. Yang, J., Shi, Y., Yu, C., & Cao, S. J. (2020). Challenges of using mobile phone signalling data to estimate urban population density: towards smart cities and sustainable urban development. *Indoor and Built Environment*, 29(2), 147-150.