

Original Article

Integrating Remote Sensing and GIS for Effective Management of Primary Health Care Facilities in Northern Satpura Region of Jalgaon District

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Abstract

This research paper focuses on the integration of remote sensing and GIS technologies for the effective management of primary healthcare facilities in the northern Satpura region of Jalgaon district. By leveraging geospatial data and advanced analytical tools, the study aims to improve healthcare access, resource allocation, and planning in underserved areas. The findings emphasize the importance of strategically locating primary health centres, analysing population growth trends, and advocating for evidence-based policies to enhance health equity and quality of care. Recommendations include establishing new primary health centres, addressing existing facility deficits, and promoting data-driven decision-making in healthcare management. The study underscores the significance of utilizing remote sensing and GIS technologies to drive positive change in healthcare delivery, resource allocation, and community well-being in the region.

Keywords: Remote Sensing, GIS Technologies, Health Management, Geospatial Data, Healthcare Access, Community Well-being.

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INTRODUCTION

A healthy lifestyle is a need for all people. It is, in fact, a vital part of people's social needs. Governments should strive to achieve social justice policy agendas by providing low-income groups equal access to primary healthcare services. Government investments prioritize the monitoring and evaluation of health care services (HCS) in response to this policy agenda (Ahmed, 2013). PHCCs are a health-oriented strategy that goes beyond the conventional healthcare system and centres on social policies that promote health equity (World Health Organization). The Alma-Ata Declaration was approved at the PHCC International Conference (WHO, 1978). A structured collection of resources, actors, and institutions that are arranged under the funding, supervision, and delivery of health actions that offer HC to a specific population is known as a health system. India has a very diverse healthcare system with many public and private providers.

To effectively manage primary healthcare facilities, the integration of remote sensing and GIS

technologies is critical. This integration enables the collection and analysis of spatial data essential for understanding the spread of diseases and their risk factors (Khan et al., 2010). By leveraging remote sensing data such as satellite imagery and combining it with GIS tools, healthcare practitioners can assess the accessibility of healthcare facilities in specific areas and identify areas with limited access to primary healthcare. Furthermore, integrating socioeconomic variables into the collection and analysis of spatial data can facilitate equity-oriented decision-making and policy development (Guagliardo, 2004). This integration of remote sensing and GIS technologies provides a comprehensive approach to the management of primary health facilities, enabling informed decision-making, targeted interventions and efficient resource allocation. Furthermore, integrating socioeconomic and spatial variables into survey routines is critical to facilitate equity-oriented decision-making and policy.

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By integrating remote sensing and GIS technologies, primary healthcare facilities can effectively manage and meet the health needs of their communities. Additionally, integrating remote sensing and GIS can also help with site planning for new healthcare services.

Geographic information systems can be used to assess the accessibility of healthcare facilities in specific areas and to help primary healthcare administrators identify areas with limited access to health services. This integration also enables analysis of disease patterns and risk factors, providing valuable insights for public health strategies and interventions.

Population access to quality health services critically depends on the management of primary health facilities (Kuldeep et al. 2017). According to Misra et al. These centres are at the forefront of providing health services that are both preventative and curative, promoting health and addressing community needs. (Mishra et al., 2019). The health of a population can suffer if primary health facilities are not well managed, leading to large gaps in both healthcare quality and access (Oinam et al. 2020). To identify areas with limited access to healthcare, better understand the spatial distribution of diseases, and make informed decisions about the allocation of resources and interventions, remote sensing and GIS technologies should be integrated into the management of primary healthcare facilities. By ensuring that new health services are strategically placed to meet population needs, this integration also facilitates efficient site planning (Oinam et al. 2020, Khashoggi and Murad, 2020). Primary healthcare facilities can strategically allocate resources and interventions in most underserved areas Using remote sensing and GIS technologies to gain valuable insights into the geographical distribution of diseases and risk factors (Oinam et al. 2020, Khashoggi & Murad, 2020). Furthermore, the inclusion of socio-economic helps Variables included in the analysis in identifying regions with populations that are at risk and may need more support and resources. The effectiveness and efficiency of health service delivery are generally improved through the integration of remote sensing and GIS technologies in the management of primary health facilities. Primary healthcare facilities are better equipped to manage the spatial distribution of diseases and assess access to healthcare in different regions through the use of GIS and remote sensing technologies. This data can then be used to make decisions about how best to allocate resources, design interventions, and improve healthcare quality and outcomes. By combining remote sensing and geographic information system (GIS) technologies, managers of primary healthcare facilities can gain important insights into the geographic distribution of diseases, pinpoint regions with poor access to healthcare, and make data-driven decisions about the distribution of resources and interventions. In addition, it improves the planning and management of primary healthcare facilities, ensuring that they are strategically positioned to eliminate health inequalities and meet the needs of the population. In summary, the

management of primary healthcare facilities can benefit from the integration of remote sensing and GIS technologies by enabling a comprehensive understanding of the spatial distribution of diseases, identifying regions with limited access to healthcare, and making informed decisions regarding the allocation of healthcare resources and interventions. In summary, integrating GIS and remote.

By providing precise spatial data on disease distribution, access to healthcare, and resource allocation, remote sensing and GIS integration in healthcare management aim to improve the planning and management of primary healthcare facilities (Kuldeep et al. 2017). This integration makes it possible to identify regions with poor access to healthcare, gain a comprehensive understanding of the spatial distribution of diseases, and make informed decisions about the distribution of resources and interventions. Decision-makers can gain important insights by using geospatial technologies such as GIS and remote sensing in healthcare management. Decision-makers can automate the process of determining appropriate locations for healthcare facilities in rural areas, prioritizing areas in need of healthcare services, and planning effective resource allocation through the use of geospatial datasets, remote sensing, and GIS technologies. Additionally, by integrating remote sensing and GIS, decision-makers can prioritize healthcare facility allocation and identify suitable locations by considering factors such as road connectivity, demographics, and the location of existing healthcare facilities.

The component of PHCCs that focuses on health and community services (HCS) is primary care, which includes community development, advocacy, diagnosis and treatment of illness and injury, and health promotion. A PHC unit should serve a certain number of people and a PHC unit should cover an area within a certain radius. These are the two pillars on which international standards and guidelines on HCS are built. The international guidelines within the international standards are taken into account by the Indian Public Health Standards (IPHS) in India. The infrastructure, human resources, medicines, diagnostics, equipment, quality and governance requirements of PHCs are governed by the Indian Public Health Standards (IPHS), which serve as guidelines for the various parts of the healthcare system. Providing comprehensive primary health care to the community; Achieving and maintaining an acceptable standard of quality of care; IPHS goals for PHCs include improving responsiveness and sensitivity of services to community needs. The Basic Minimum Services Program (BMS) or the Minimum Needs Program (MNP) in India is the framework that state governments use to establish and manage Primary Health Centers (PHCs). A medical officer, 14 paramedics and other staff work together to staff PHCs. The PHC acts as a referral unit for six sub-centres and houses patients in beds 4 to 6. A specific population of 20,000 people in rural areas and 30,000 people in hill, tribal and desert regions is covered by PHCs. PHCs are located between a community health

centre at the block level and a sub-centre at the outermost level. PHCs will be set up for 20,000 people in hill and tribal areas and 30,000 people in plains and rural areas. 3,000 people live in hill and tribal areas and 5,000 people live in plains where sub-centres have been set up.

Improving and maintaining the health and well-being of the tribal peoples in the study area presents several challenges to health care. Population pressure on the health system comes from population growth and longer life expectancy. Anger and annoyance, or, on the other hand, reluctance towards what the person is doing, result from an incomplete understanding and awareness of duties and responsibilities. The main goal of the PHC system is to maximize the health status of a population over their lifetime. Primary care takes into account all health-related factors and puts the patient at the centre. By offering preventative, curative and rehabilitative services, primary care addresses the biggest issues facing the community. PHC centres are considered one of the essential backbones for efficient and first-class healthcare in the study area. The present study was conducted in the northern Satpura region situated in the Chopda, Yaval, and Raver tehsil of Jalgaon district in Maharashtra, India.

RESEARCH PROBLEM

The primary research problem addressed in this study is the inadequate management and distribution of primary health care facilities in the northern Satpura region of Jalgaon district. Despite increasing population and health needs, the current healthcare system lacks efficient resource allocation and strategic planning. This leads to inequalities in access, quality and healthcare outcomes, particularly in mountain and tribal areas compared to the plains where sub-centres are established. The challenge is to optimize the management of primary healthcare facilities to ensure equitable access to health services, address population growth trends, and improve the overall health and well-being of the community. By integrating remote sensing and GIS technologies, this research aims to provide data-driven solutions to improve the effectiveness and sustainability of primary health services in the region.

AIM AND OBJECTIVES

This study aims to enhance the management of primary healthcare facilities in the Northern Satpura Region of Jalgaon District through the integration of remote sensing and GIS technologies.

By leveraging these advanced tools, the goal is to improve the accessibility, efficiency, and quality of healthcare services in the region. To achieve the above aim following objectives have been served:

1. To assess the current status of primary healthcare facilities in the study area and identify areas for improvement.
2. To integrate remote sensing data, including satellite imagery, for spatial analysis of healthcare infrastructure and population distribution.
3. To develop a comprehensive database incorporating administrative boundaries, PHC geolocation data, and demographic information for effective healthcare planning.
4. To propose strategies for the establishment of additional primary healthcare centres to address the existing deficit and meet the healthcare needs of the growing population.

METHODOLOGY AND DATABASE

The following information was collected: administrative boundaries based on SOI; extremely high-resolution LISS-IV satellite imagery; Ground Control Points (GCPs) and GPS-based Control Points (CPs); clinical data from fieldwork and records; and demographic or population data obtained from the Census of India. The proposed initial approach is straightforward and can be used in a variety of health-related areas. In subsequent phases, this approach will rely on state-of-the-art methods in GIS, remote sensing and population forecasting based on a variety of models, including exponential models and census data. The following measures were proposed: data collection (satellite images, maps, administrative boundaries) for the study area; Getting GCP, CP and PHC location using handheld GPS on site; pre-processing of satellite images; registration of satellite images; Assessing the Accuracy of Corrected Satellite Image Registration Using RMS; a subset of images; Designing databases for primary health care centres that should include different types of clinics, laboratories, staff, medical facilities and other elements; and the distribution and location of state PHCs. The process of this project includes creating vector layers, forecasting the population to 2030, calculating the supply of primary care centres, applying international and Indian policies, calculating the demand for primary care centres and determining which citizens and areas will be served and which will not. as an evaluation of the results. Buffer and overlay analysis were carried out in the ArcGIS 10.8 software.

Table 1 Estimated Population of tehsils with 14.71% growth rate.

Sr. No.	Tehsil	Population (2011)	Population (2021)	Population (2031)
1	Chopda	312815	1,233,957	4,867,580
2	Yaval	272242	1,073,910	4,236,241
3	Raver	312082	1,231,066	4,856,174

(Source: Calculated by research and Census of India)

RESULT AND DISCUSSIONS

Based on clinical information from fields, records and corrected images. PHC centres provide free vaccinations medical examinations and treatment services at various clinics for a small fee. PHC clinics

typically offer internal medicine, gynaecology, paediatrics, prenatal care, immunizations, emergency care, delivery, family planning, laboratory services and pharmacy services. A vector map was created showing the administrative boundaries of the research

area and the locations of the PHC centres (Fig.). The results showed the favourable geographical distribution of the two PHC centres (Hingone and Bhalod) throughout the study area. The results also showed poor geographical distribution of the two PHC centres Vaijapur and Pal, from which other PHCs are 94 km or more away. The idea behind the PHC is that patients can easily reach it on foot. The proximity of different PHC centres to the patient's residence and the level of poverty are the main determinants of accessibility. The minimum income that is considered sufficient to cover one's basic needs is called the poverty line.

Most PHCs are located on the main road where there used to be public transport. The road network in the study area consists of two types of roads: paved and unpaved roads. Paved roads are designed to transport buses and cars. Dirt roads are narrow roads that citizens use to reach their living space. Access to each health centre is by various means such as walking, public transport, taxi and private car to the nearest point to the centre location. Public transport only runs on the main road. Easy accessibility of all PHC locations for patients on foot or by public transport to the nearest bus stop, unless PHC Hingone and Bhalod are located in a densely populated area and far from public transport via paved roads. PHC Vaijapur and Pal were on a dirt road, far from public transport. Access to these centres is by foot, taxi, mini-tricycle car or private car.

The population size was projected from 2011 to 2031 based on census data using an annual population growth rate of 14.7%. The population growth projections for three tehsils (Chopda, Yaval and Raver) between 2011 and 2031 are shown in the table. Between 2011 and 2021, the population of all three tehsils increased significantly, with Chopda recording the largest increase (almost four times the 2011 population). By 2031, Chopda's population is estimated to increase nearly sixteen times compared to 2011, indicating that this trend will continue. It is important to remember that these are only estimates and that the actual population growth rate may be different.

The need for PHCs was calculated based on Basic Minimum Services Program (BMS) guidelines and standards. There were two criteria: (1) The PHC centre should serve 20,000 residents: The results showed that the total unserved population is 32,082 residents, so the required number of PHC 18 centres to meet criterion number 1. (2) Covered area by zones 2 km radius (Fig.1): The results showed that according to criterion 2, the required number of PHC was 5 centres. Therefore, there is a deficit in the number of health centres. The conclusion is that the deficit of PHC centres is mainly related to the overall population.

For the construction of a new PHC, the situation was studied and it was found that there is no land in the area of 1200 m² (according to BMS) that falls within the study area. So, the solution is to look for donors to solve the problem or replan and redistribute the land. The lack of PHCs is more

theoretical than practical, as the study examined that there are many other governorates and private health services. The governorate's health services such as public hospitals and health insurance clinics. Private healthcare services such as private hospitals and private clinics. Dear centre directors, there is pressure from the investigators on the centres, which can be avoided by expanding the centres, in particular by increasing the number of clinics and by working overtime or working two shifts. The study area requires further steps in the planning of new PHC facilities, taking into account changes in policies and the development of knowledge and science when planning future PHC centres.

CONCLUSION AND SUGGESTIONS

In conclusion, the integration of remote sensing and GIS technologies for the effective management of primary healthcare facilities in the northern Satpura region of Jalgaon district represents a promising approach to address the challenges in healthcare access, resource allocation and planning. By leveraging geospatial data, population trends and advanced analytical tools, this study has highlighted key aspects that can significantly impact the delivery of healthcare services in the region. The results of this research highlight the importance of strategically locating primary health centres to ensure equitable access for all residents, particularly in underserved areas such as mountain and tribal regions. Analysis of population growth trends and health needs from 2011 to 2031 highlights the need for proactive planning and infrastructure development to meet the evolving health needs of the growing population.

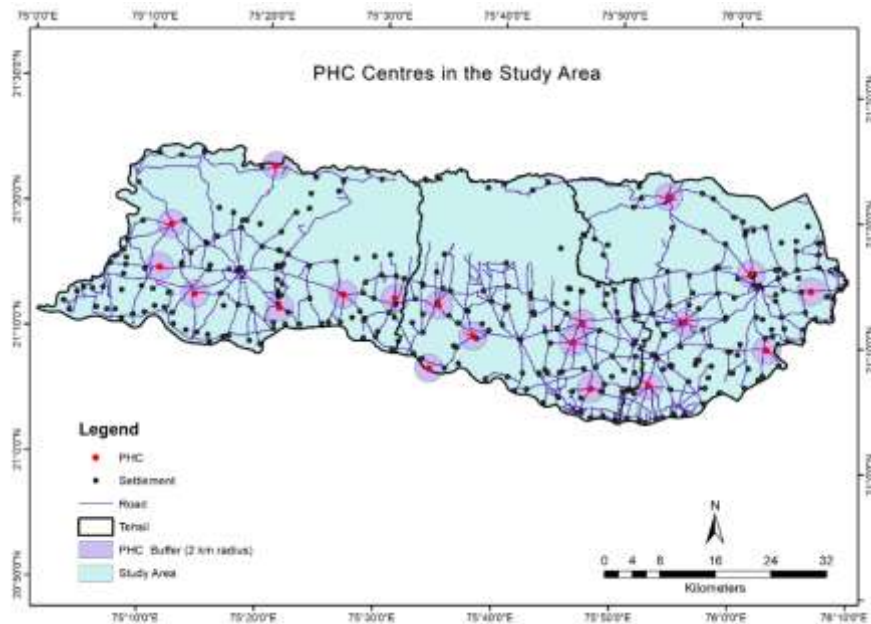
Additionally, the study emphasizes the role of data-driven decision-making in healthcare management and advocates for evidence-based policies and interventions that emphasize health equity and quality of care. By recommending strategies for establishing new primary health centres and addressing the existing health facility deficit, this research contributes to the advancement of health planning practices in the region. Overall, the importance of integrating remote sensing and GIS technologies in healthcare management cannot be underestimated. This study lays the foundation for future initiatives aimed at increasing access to healthcare, improving resource allocation and promoting health equity in the northern Satpura region. Policymakers, healthcare administrators, and stakeholders must use the insights of this research to drive positive change in the healthcare landscape and ensure community well-being.

To improve health management, future research should focus on several key areas. First, long-term studies can track the effectiveness of implemented strategies. Second, engaging communities ensures that services meet their needs. Third, research into health technologies such as telemedicine can improve access in remote areas. Fourth, training health professionals can improve service delivery. Fifth, policy assessment can identify areas for improvement. Sixth, collaboration between different experts can lead to better solutions. Finally,

quality assurance systems can ensure continuous improvement in healthcare. By taking these aspects into account, those involved can create a more

effective and sustainable health management system for the region.

Figure 1 PHC centres location map and its GIS analysis.



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Conflicts of interest

There are no conflicts of interest.

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