Using Geographic Information System (GIS) to Develop Health Information System (HIS) for Srinagar City, Jammu and Kashmir

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Abstract Health Information System (HIS) is a GIS based information system that stores all information about health facilities – their name, location, category, no. of rooms, no. of male doctors, no. of female doctors, total no. of employee, no. of beds, qualification of doctor's, Geographic coordinates of health Centers, availability of medicine, 24 hours service availability, maternity service, canteen facility etc. HIS allows the preservation of the information value of health Centers digitally and offers new exploitation possibilities, like the immediate connection of different kinds of data for analysis, or the digital documentation of these institutes for its improvement. The purpose of this study was to collect appropriate data of Health Centers around Srinagar city and to store the data into the Geodatabase built to manage them more efficiently. The data pertaining to these Health Centers was classified into different categories such as: Public Health Center, Sub Health Center, Allopathic Center, and private Hospitals. At total of 73 Health Centers were mapped out of them 13 were Public Health Center, 29 were Sub Center, 18 were Allopathic Center, 13 were Private Hospitals. The present study focuses on using Geographic information system and integrating with the Health information system to generate a baseline data for the planning, development and maintenance of these health facilities in Srinagar city.

Keywords Health Information System (HIS), Geographic Information System (GIS), Health Centers

1. Introduction

With the onset of the epidemiological transition and as the prevalence of infectious diseases decreased through the 20th century, primary health began to put more focus on chronic diseases such as cancer and heart disease. Previous efforts in many developed countries had already led to dramatic reductions in the infant mortality rate using preventative methods. During the 20th century and early in the next, the dramatic increase in average life span is widely credited to primary health achievements, such as vaccination programs and control of many infectious diseases including polio, diphtheria, yellow fever and smallpox; effective health and safety policies such as road traffic safety and occupational safety; improved family planning; tobacco control measures; and programs designed to decrease non-communicable diseases by acting on known risk factors such as a person’s background, lifestyle and environment.
One of the major sources of the increase in average life span in the early 20th century was the decline in the "urban penalty" brought on by improvements in sanitation (Denis Postle., 2012). These improvements included chlorination of drinking water, filtration and sewage treatment which led to the decline in deaths caused by infectious waterborne diseases such as cholera and intestinal diseases. Meanwhile, large parts of the developing world remained plagued by largely preventable/treatable infectious diseases and poor maternal and child health outcomes, exacerbated by malnutrition and poverty. Since the 1980s, the growing field of population health has broadened the focus of primary health from individual behaviors and risk factors to population-level issues such as inequality, poverty, and education. Modern primary health is often concerned with addressing determinants of health across a population. There is recognition that our health is affected by many factors including where we live, genetics, our income, our educational status and our social relationships - these are known as "social determinants of health" (Burke, 2013). A social gradient in health runs through society, with those that are poorest generally suffering the worst health. However even those in the middle classes will generally have worse health outcomes than those of a higher social stratum. The new primary health seeks to address these health inequalities by advocating for population-based policies that improve health in an equitable manner.

Public health applications of GIS technology are still in the early stages. Many challenges remain that need to be addressed before the full potential of GIS technology can be realized for public health practice, planning, and research. One of the greatest challenges is to incorporate epidemiologic principles and methods into the analysis to be mapped. GIS technology provides public health practitioners and researchers with several new types of data. Public health practitioners can also use digital imagery from satellites or aerial photos to add details to improve the accuracy of a mapping projects. As new GIS methods are developed, they can be added to the "toolkits" of epidemiology and health services research. Exeter in 1998, also concluded that Compared with tables and charts, maps developed using GIS technology can be an extremely effective tool to help community decision makers visualize and understand a public health problem (Richards, 1999). The current study has tried to map each and every health facility located in the Srinagar city in a comprehensive Geodatabase.
format, where in within a single click of the mouse we can know attributes such as location, name of health facility, in charge, no. of doctors, facilities available etc. the study holds significance for our health department which will find it handy for planning various projects relating to the maintenance and development of health facilities.

1.1. Study Area

Srinagar city is located in the valley of Kashmir at an altitude of 1,730 m above sea level. The city lies on both banks of the Jhelum River, a tributary of the Indus River. The city has the unique physiographic setup with steep hills in the east and north east, low lying paddy fields forming floodplain of Jhelum in the south and west and raised plateau lands in the south. The valley is surrounded by the Himalayas on all sides. Srinagar lies between the coordinates 34° 01’ N to 34° 27’N latitude and 74° 36 E to 75° 30 E, of over an area of 105 Sq. km (Figure 1). Winters are cool, with daytime temperature averaging to 2.5°C (36.5 °F) and drops below freezing point at night. Srinagar has Mediterranean type of climate with percentage humidity varying from 90% in winter to 78% in summer months. The average annual rainfall is around 720 mm.

2. Methodology

In this Study, GPS was used to collect the location (geographic co-ordinates) of various Health Centers as per the data provided by Chief Medical officer (CMO). These GPS points were then overlaid on high resolution GeoEye-1 image. The overall methodology adopted for the current study is shown in (Figure 2).

The Health data pertaining to these Health facilities were classified into different thematic maps or layers in Arc Map 10.1 as given below:

1. Public Health Center
2. Sub Health Center (Sub-Center)
3. Allopathic Center
4. Private Hospitals

![Flow chart of Methodology](image_url)
The above generated thematic maps were stored in the Geodatabase format to generate the final geospatial database of Health Centers in Srinagar City.

2.1. Data Sets

To carry out the study following data sets were used:

1. GeoEye-1
2. Global Positioning System (GPS) data
3. Ancillary data

GeoEye-1 was launched on September 6, 2008. The satellite separated successfully from its Delta II launch vehicle at 12:49 pm 58 minutes and 56 seconds after launch (Justin Ray, 2008). The satellite provides 41 centimetres (16 in) panchromatic and 1.65 meter multispectral imagery in 15.2 km swaths. The spacecraft is intended for a sun-synchronous orbit at an altitude of 681 km (423 mi) and an inclination of 98 degrees, with a 10:30 a.m. equator crossing time. GeoEye-1 can image up to 60 degrees off nadir. It is operated out of Herndon, Virginia and was built in Arizona by General Dynamics Advanced Information Systems (https://en.wikipedia.org/wiki/GeoEye).

2.2. GPS Data Collection

In the present study an in-depth mapping of Srinagar city using handheld Juno SB GPS was carried out to generate the geospatial database of Health Centres.

2.3. Ancillary Data

The ancillary data was generated from the data given at the CMO (Chief Medical Office). The ancillary data in the form of hard copy format was then digitized to generate the database of Health Centers of Srinagar city in Excel format. It includes name and location of these institutes.

2.4. Pre-Processing

For the present study a high resolution GeoEye-1 of October 2008 was used as the satellite data source. Same data was first geo-referenced by field GCPs in order to make it reliable for the study. Also, the Health institutional data collected by GPS was processed in GPS pathfinder in order to make the data readable in Arc Map 10.1 and remove errors that had occurred during the field survey.

| Name of Public Health Center | Medical Amenity | Name of the town | No. Of doctors | No. of beds | No. of rooms | Latitude | Longitude |
|------------------------------|-----------------|------------------|----------------|------------|-------------|----------|-----------|
| Facilities available         | No. of nurses and ward boys | Elevator | Blood Bank | Parking | Canteen | Mode of electricity | Infrastructure |

Table 1: Showing the type of data obtained from various Health Centers in Srinagar city, J&K
2.5. Data Integration

The Health Centres database developed in Excel format was converted to .dbf format (Table 1) and integrated with the point locations of Health institutes through a joining process in Arc Map 10.1.

3. Results and Discussion

3.1. Mapping of Different Health Facilities

During this Study, an extensive field Survey was carried out to map Health Centers of Srinagar City using GPS. At present total of 73 Health Centers were mapped out of them 13 were Public Health Center, 29 were Sub Health Center, 18 were Allopathic Center, 13 were Private Hospitals to make a Geodatabase containing the Spatial & Non-Spatial information of each Site. During the field survey following information was also incorporated to develop a robust Health Information System:

- Health records.
- Non-Professional staff.
- Doctors’ data (Number, Qualification, experience, placement).
- Facility inventory data (location, geographic co-ordinates, stories, type, number of rooms, equipment).
- Facilities available.
- Infrastructure.
- Monitoring of internal management initiatives (e.g. special projects).
- No of beds, rooms, ambulances, doctors etc.

3.2. Public Health Centres

These are facilities that serve to protect the health of city residents. They are central institutions for community health and sanitation. Public health Centers conduct specialized programs, such as food sanitation, environment sanitation, emotional health, and tuberculosis/contagious, disease, countermeasures. In addition, in order to provide accessible health services to everyone in the community. These sites were mapped using GPS and the generated point theme was then stored in the Geodatabase. The total of 13 primary health Centers was mapped in Srinagar district. Some of the public health facilities lack the staff, equipment’s, facilities, medicine etc. While most of them are in satisfactory condition. The distribution of these health facilities is shown in (Figure 3).

3.3. Sub Health Center

In the public sector, a Sub-health Centre (Sub centre) is the most peripheral and first contact point between the primary health care system and the community (Shinde et al., 2014). As per the population norms, one Sub centre is established for every 5000 population in plain areas and for every 3000 population in hilly/tribal/desert areas (Shinde et al., 2014). A Sub centre provides interface with the community at the grass-root level, providing all the primary health care services (Sharma et al., 2015). As sub centres are the first contact point with the community, the success of any nationwide programme would depend largely on well-functioning sub centres providing services of acceptable standard to the people.

Of particular importance are the packages of services such as immunization, antenatal, natal and postnatal care, prevention of malnutrition and common childhood diseases, family planning services.
and counseling. They also provide elementary drugs for minor ailments such as ARI, diarrhea, fever, worm infestation etc. and carryout community needs assessment. Besides the above, the government implements several national health and family welfare programmes which again are delivered through these frontline workers. There are total of 29 Sub Health centers in Srinagar city that are mapped here in (Figure 4).

**Figure 3:** Total number of Public Health centers in Srinagar city

**Figure 4:** Total number of Sub Health centers in Srinagar city
3.4. Allopathic Dispensaries

Allopathic means treating disease by using a substance antagonistic to the condition, such as antibiotics to treat an infection; or replaces something in the body. Facilities that handle allopathic medicines prescribed in association with traditional Western treatment may call themselves pharmacy, while those that deal with alternative and complementary medicine like Chinese herbs may be called dispensaries. Trained staff, at dispensary can process written orders for medications, which may arrive electronically if the system is connected to such systems. They can confirm the medication and the dosage, prepare it, and package it appropriately with directions for use. These sites were mapped using GPS and the generated point theme was then stored in the Geodatabase. The totals of 18 allopathic dispensaries were mapped in Srinagar city. Some of these Allopathic facilities lack the staff, equipment’s, facilities, medicine etc. While most of them are in satisfactory condition. The distribution of these health facilities is shown in (Figure 5).

![Figure 5: Total number of Allopathic centers in Srinagar city](image)

3.5. Private Hospitals

A hospital similar to a group hospital except that it is controlled by a single practitioner or by the practitioner and the associates in his or her office (Farlex Partner Medical Dictionary, 2012). A private hospital are owned by a non-profit organization and privately funded through payment for medical services by patients themselves, by insurers. Private healthcare is when doctors, dentists, and other healthcare providers are paid for through private insurance and (occasionally) out of private bank accounts as this is in contrast with a public system, in which they are paid by the government money (http://www.ehow.co.uk/facts_6782488_definition-private-healthcare.html). The biggest distinguishing feature of private health care is that it is run with the goal of making money (http://www.ehow.co.uk/facts_6782488_definition-private-healthcare.html). A total of 13 Private Hospitals from Srinagar city were mapped and distribution of these Health facilities is shown in (Figure 6).
4. Using GIS to develop Health Information Systems (HIS) for Srinagar City, J&K.

Health Information System (HIS) is a GIS based information system that stores all information about health facilities — their name, location, category, no. of rooms, no. of male doctors, no. of female doctors, total no. of employee, no. of beds, qualification of doctor’s, Geographic coordinates of health Centers, availability of medicine, 24 hours service availability, maternity service, canteen facility etc. Health information system allows preservation the information value of Health facilities digitally and offers new exploitation possibilities, like the immediate connection of different kinds of data for analysis, or the digital documentation of these facilities for its improvement.

GIS plays a critical role in the decisions on where and when to intervene, improving the quality of care and accessibility of services, finding the most cost-effective delivery modes, and protecting patient confidentiality while satisfying needs of the research community on data accessibility (Hanjagi et al., 2007). Geographic Information System is able to organize all the routes that a health care professional has to follow and it can take into account other parameters, too (Fradelos et al., 2014). Generally, GIS application areas might be applied towards Strategic Planning, Research and Evaluation, emergency preparedness and both response and location of health care services, too (Smith et al., 2007). Geographic Information Systems provides a tremendous convenience for health care providers as regards the organization and the management of these services (Fradelos et al., 2014). The use of GIS and spatial representation of various health issues make professionals arrive at conclusions in a faster and better way in the field of both public health and decision-making (Hanchette et al., 2003). Hence, the organization and coordination of various services would be easier and more efficient. The healthcare provider may direct quickly and efficiently the patient to suitable health care services (Najafabadi, 2009). The purpose of this study was to highlight Geographic Information Systems also acting as a decision-making tool in health care and contribute to the formulation of policies regarding the health sector in the Srinagar city. Geo Database prepared for different Health facilities (Public Health Center, Sub Health Center, Allopathic and Private Hospital) are shown below (Table 2-5).
Table 2: Attribute Data: Health Information System (HIS) of Public Health Center Hazratbal, Narwara, Nishat & Lal Bazaar areas of Srinagar city.

| S.no | Name of town | Hazratbal | Narwara | Nishat | Lal Bazar |
|------|--------------|-----------|---------|--------|-----------|
| 1    | Medical amenity | Public Health Center | | | |
| 2    | No. of doctors | 7 | 3 | 2 | 2 |
| 3    | No. of male doc. | 4 | 1 | * | * |
| 4    | No. of female doc. | 3 | 2 | 2 | 2 |
| 5    | No of storeys | 2 | 2 | 2 | 1 |
| 6    | No of beds | 4 | 4 | 4 | 6 |
| 7    | No of ambulances | 2 | * | * | * |
| 8    | No of rooms | 12 | 12 | 27 | 8 |
| 9    | No of Op. theaters | 1 | * | * | * |
| 10   | No of ward boys | 2 | * | * | * |
| 11   | No of Nurses | 2 | * | * | * |
| 12   | No of Fmhw worker | * | 2 | 2 | 2 |
| 13   | No of NO’S | 2 | 3 | 1 | 1 |
| 14   | No of pharmacists | 2 | 1 | 1 | * |
| 15   | Facility available | Lab,xray,Usg Etc | Lab | Lab,XRay,Usg Etc | HB |
| 16   | Maternity service | No | NO | No | No |
| 17   | Elevator facility | No | No | No | No |
| 18   | 24 hours service | Yes | No | No | No |
| 19   | Blood bank | No | No | No | No |
| 20   | OPD availability | Yes | Yes | Yes | Yes |
| 21   | Medicine availability | Yes | Yes | Yes | Yes |
| 22   | Canteen facility | No | No | No | No |
| 23   | Parking facility | Yes | No | No | No |
| 24   | Infrastructure | Satisfactory | Satisfactory | Satisfactory | Satisfactory |
| 25   | Mode of electricity | AC | AC/DC | AC | AC |
Table 3: Attribute Data; Health Information System (HIS) of Sub Health Center Jawahar Nagar, Mehjoor Nagar, Kushipora & Rawalpora areas of Srinagar city

| S.no | Name of town        | Jawahar Nagar | Mehjoor Nagar | Khushipora | Rawalpora |
|------|---------------------|---------------|---------------|------------|-----------|
| 1    | Medical amenity     | Sub Center    |               |            |           |
| 2    | No. of doctors      | 1             | 1             | *          | *         |
| 3    | No. of male doc.    | *             | *             | *          | *         |
| 4    | No of female doc.   | 1             | 1             | *          | *         |
| 5    | No of storeys       | 1             | 1             | 1          | 1         |
| 6    | No of beds          | 3             | 4             | *          | *         |
| 7    | No of ambulances    | 1             | 1             | *          | *         |
| 8    | No of rooms         | 5             | 4             | 3          | 3         |
| 9    | No of op. theaters  | *             | *             | *          | *         |
| 10   | No of ward boys     | 2             | *             | *          | *         |
| 11   | No of Nurses        | 1             | 3             | *          | *         |
| 12   | No of Emplyw worker | *             | *             | 2          | 2         |
| 13   | No of NOS           | *             | *             | *          | *         |
| 14   | No of pharmacists   | 1             | 1             | *          | *         |
| 15   | Facility available  | Hb            | Hb            | *          | *         |
| 16   | Maternity service   | No            | No            | No         | No        |
| 17   | Elevator facility   | No            | No            | No         | No        |
| 18   | 24 hours service    | No            | No            | No         | No        |
| 19   | Blood bank          | No            | No            | No         | No        |
| 20   | OPD availability    | Yes           | Yes           | Yes        | Yes       |
| 21   | Medicine availability| Yes          | Yes           | Yes        | Yes       |
| 22   | Canteen facility    | No            | No            | No         | No        |
| 23   | Parking facility    | No            | No            | No         | No        |
| 24   | Infrastructure      | Satisfy       | Satisfy       | satisfy    | Satisfy   |
| 25   | Mode of electricity | AC            | AC            | AC         | AC        |
Table 4: Attribute Data; Health Information System (HIS) of Allopathic Center Chattar Hama, Tengpora, Rainawari & Miskeen Bagh areas of Srinagar city

| S.no | Name of town       | Chatter Hama | Tengpora | Rainawari | Miskeen Bagh |
|------|--------------------|--------------|----------|-----------|--------------|
| 1    | Medical amenity    | Allopathic Center |          |           |              |
| 2    | No. of doctors    | 1            | 2        | 2         | 1            |
| 3    | No. of male doc.  | *            | *        | *         | *            |
| 4    | No. of female doc.| 1            | 2        | 2         | 1            |
| 5    | No. of storeys    | 1            | 1        | 2         | 1            |
| 6    | No. of beds       | 1            | 3        | 2         | 5            |
| 7    | No. of ambulances | *            | *        | *         | *            |
| 8    | No. of rooms      | 4            | 4        | 3         | 6            |
| 9    | No. of op. theaters| *           | *        | *         | *            |
| 10   | No. of ward boys  | *            | *        | *         | *            |
| 11   | No. of Nurses     | *            | *        | *         | *            |
| 12   | No. of Fmphw worker| 1           | 3        | 3         | 1            |
| 13   | No of NO’S        | *            | *        | 3         | 1            |
| 14   | No of pharmacists | 1            | 1        | 1         | 1            |
| 15   | Facility available| *            | hb       | hb        | *            |
| 16   | Maternity service | No           | No       | No        | No           |
| 17   | Elevator facility | No           | No       | No        | No           |
| 18   | 24 hours service  | No           | No       | No        | No           |
| 19   | Blood bank        | No           | No       | No        | No           |
| 20   | OPD availability  | Yes          | Yes      | Yes       | Yes          |
| 21   | Medicine availability| Yes  | Yes     | Yes       | Yes          |
| 22   | Canteen facility  | No           | No       | No        | No           |
| 23   | Parking facility  | No           | No       | No        | No           |
| 24   | Infrastructure    | Rented       | satisfy  | satisfy   | satisfy      |
| 25   | Electricity mode  | AC           | AC       | AC        | AC           |
Table 5: Attribute Data; Health Information System (HIS) of Private Hospitals Gogji Bagh, Hazuri Bagh, Raj Bagh, Bishembar Nagar areas of Srinagar city

| S. No | Name of town       | Gogji Bagh | Hazuri Bagh | Raj Bagh | Bishembar Nagar |
|-------|--------------------|------------|-------------|----------|----------------|
| 1     | Medical amenity    | Ramzana    | Khanam’s    | Modern   | Valley Orthocraft |
| 2     | No. of doctors     | 4          | 4           | 8        | 5              |
| 3     | No. of male doc.   | 1          | 1           | 0        | 5              |
| 4     | No of female doc.  | 3          | 3           | 8        | 0              |
| 5     | No of storeys      | 3          | 4           | 5        | 4              |
| 6     | No of beds         | 35         | 25          | 50       | 18             |
| 7     | No of ambulances   | 2          | 1           | 2        | 1              |
| 8     | No of rooms        | 45         | 50          | 65       | 29             |
| 9     | No of op. theaters | 2          | 3           | 3        | 2              |
| 10    | No of ward boys    | 20         | 5           | 8        | 6              |
| 11    | No of nurses       | 12         | 9           | 40       | 8              |
| 12    | No of Emphw worker | *          | *           | *        | *              |
| 13    | No of NO’S         | *          | *           | *        | *              |
| 14    | No of pharmacists  | 3          | 3           | 12       | 8              |
| 15    | Facility available | Lab, asg, Ecg Xray | Lab, asg, Ecg Xray | Lab, asg, Ecg Xray | Lab, x ray |
| 16    | Maternity service  | Yes        | Yes         | Yes      | No             |
| 17    | Elevator facility  | Yes        | No          | Yes      | Yes            |
| 18    | 24 hours service   | Yes        | Yes         | Yes      | Yes            |
| 19    | Blood bank         | No         | No          | No       | No             |
| 20    | OPD availability   | Yes        | Yes         | Yes      | Yes            |
| 21    | Medicine availability | Yes   | Yes         | Yes      | Yes            |
| 22    | Canteen facility   | Yes        | Yes         | Yes      | Yes            |
| 23    | Parking facility   | Yes        | Yes         | Yes      | Yes            |
| 24    | Infrastructure     | Yes        | Yes         | Yes      | Yes            |
| 25    | Mode of electricity| AC/DC      | AC/DC       | AC/DC    | AC/DC           |
5. Conclusion

The growing rate of diseases, improper health care to women and children is the biggest issue today. Viewing these issues from a historic standpoint is important to understand where and why these issues began. By knowing the historic information, it is easier to discover what has and has not worked, and what issues continually transpire with health in the entire region. During this Study, an extensive field Survey was carried out to map Health Centers of Srinagar City using GIS. At present total of 73 Health Centers were mapped out of them 13 were Public Health Center, 29 were Sub Health Center, 18 were Allopathic Center, 13 were Private Hospitals. During the study it was found the most of the Health institutes (Public Health Center, Sub Center & Allopathic Center’s) lack basic infrastructure and even some of them operate in rented accommodations. Fund allocated by the state & central agencies are not properly utilized and this leads to shortage staff, medicines, latest equipment’s, and Lab facilities etc. Lack of competent Doctor’s & supporting staff, Unbalanced patient - Doctor ratio, Management issue’s, Drug laws and corruption in these facilities has taken a toll on the lives of the people at large. Reluctance by the Doctor’s to serve in the rural areas has affects the lives of the people at large scale, which in turn has resulted in overburdening of these Health institutes which at times leads to the chaos. On the other side Private Hospitals have been flourishing at greater pace, there has been considerable amount of upgradation and improvement in the facilities provided to people.

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