Applications of GIS in Healthcare Planning of Lao PDR.

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Abstract: Potential and capabilities of GIS in planning and decision-making is widely known as an experimental tool, but its existence in real-world application is yet to realize. GIS originated in the field of cartography and even at today it is mainly used as a tool for map production. Number of reasons could bring forward for this shortcoming. Limited real-world applications could be a significant one among them.

This paper describe an attempt to use GIS technology in Lao PDR where a study team was involved in formulating a Master Plan for national healthcare system. A database was created for the whole country with spatial and descriptive data gathered from various sources. Attempt was made to demonstrate the potential of GIS by using the database for identifying healthcare status, distribution of resources, recognizing deprived areas and locating areas for future investments based on accessibility and social status. The approach justified the investment on a GIS system and introducing the system in the planning sector from grass-root level to central level.

Key Words: GIS, Healthcare Planning

1.Introduction

GIS is becoming a vital tool in healthcare applications covering database management, planning, risk assessment, service area mapping, location identification etc. One of the reasons for this sudden surge of GIS usage in healthcare application is the spatial dependency of health related factors and limited resources for ever increasing demand. Distribution of services as well as health requirements need to be addressed in spatial domain in order to identify what is needed at individual location rather than looking into a problem as a whole. Countries with least developed healthcare systems required international assistance to develop healthcare system including primary healthcare as well as health services. With continuous support from various international and non-government organizations, it is becoming important to review the distribution of international assistance in a given country and appropriateness of the assistance when compared with localities that should need special assistance. This present approach of assisting communities or special activity is considered more appropriate than assisting at the central level. Thus, it has become important to recognize local healthcare needs given the healthcare demands, social status and services that are available in the locality. This is where GIS could function as a very important tool. In this paper, attempt was made to use GIS functionality to review Lao PDR health requirements given their needs and social status.

2.Objectives

Objectives of the study were to evaluate the use of GIS for the following;

- Identify the discrepancy of service distribution in spatial domain.
- Screen areas with marginal services and recognize appropriate location for providing primary healthcare services.
- Suitability of health center mapping based on serviceable area, proximity to available facilities and population distribution.

3.Study area

Laos is a land-locked country extending in a north-south direction with a population of about 5 million, and land area of 236,800 Km^2. Due to the very low population density (20/km^2), and poor transportation networks, services are not reached every corner of the country with equal opportunities for the entire population.

Health services are very limited due to financial constraints and lack of human resources. On the other hand, poor transport facility restrain providing services in equal basis. In the present study, distribution of health services, physical accessibility and social background of each province and district was compared to identify most deprived areas. Subsequently, identified districts were investigated to recognize appropriate investment given social and accessibility condition of the area concerned. Dakchung district, which was chosen as a deprived area was further discussed in this paper. This district is

located in southeast of Lao PDR bordering Vietnam on an undulating terrain. District hospital is located in the mountain area of the district more than 100 km. away from all year usable roads. It takes about 4 days to arrive at healthcare support during rainy-season. Electricity is not availabble at this district hospital and piped water system is not functioning.

4.Methodology

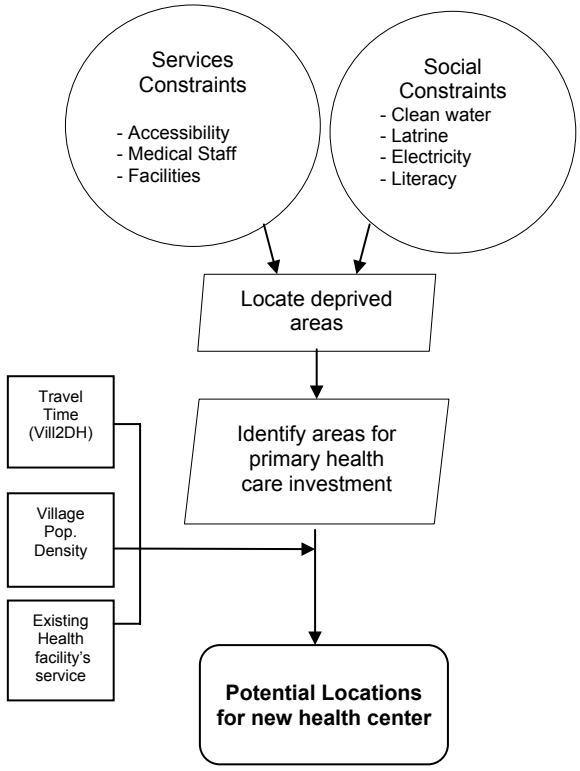

Fig.1. Flow chart of methodology

4.1 Locating remote districts

Initial step of the study was to observe data in national perspective using supply factors in terms of "Services constraints" and "Social constraints" for social factors.

Figure 1 shows the general flow of analysis. Facility data were collected from the district hospital reports of the Ministry of Health. Social-economic data was taken from the National Statistical Center. Transportation data was collected from the Ministry of Communication Transport Post and Construction.

The criteria to locate poor districts was as follows;

Travel time; if it is more than 6 hours from district hospital to provincial hospital both in dry and wet season, means poor physical accessibility. Patients in district hospital need to be transferred to the provincial hospital the case of emergency therefore good referral system should related to the accessibility.

Medical staff; included number of medical doctors, medical assistants and nurses. It was considered at least two from each category is needed for providing basic services.

Facilities; were considered available of X-ray machines and operation theaters. Medical facilities are essential when adequate medical staffs are provided.

Social constraint factors; are number of households which have not accessed to clean water, latrine, electricity and enough literacy level. 50% were used as the margin to separate living conditions good/poor in social factors. Logical querying are displayed in figure 2 and figure 3.

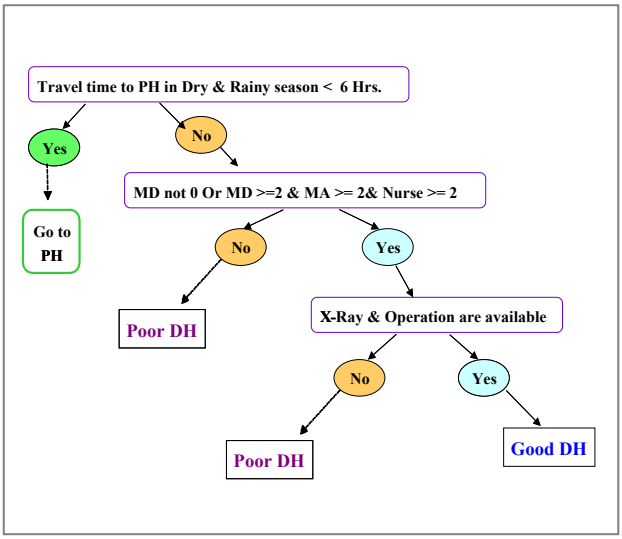

Fig.2. The logical querying sequence of services constraints

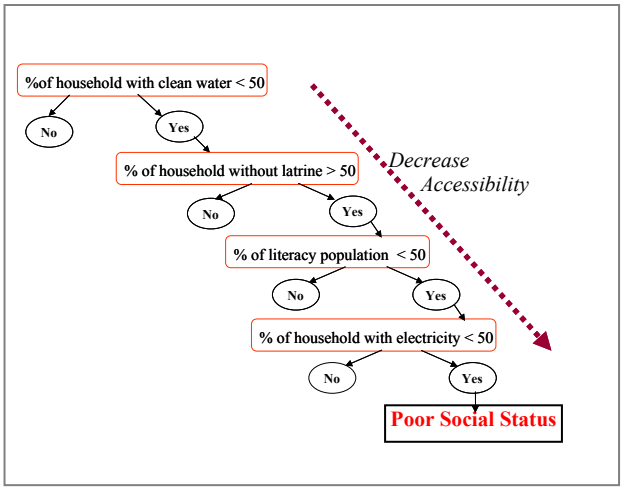

Fig.3. The logical querying sequence of social constraints

4. 2 Identification of the most suitable area for a new health center

In the previous section, the method used to identify the most remote district with respect to accessibility was discussed and the criteria set for the same was defined. Having these criteria as the index for referring "poor" medical service areas, attempt was given to find the best location for investing or re-locating a health center. It is considered that these health centers could provide primary healthcare services until improvement in infrastructure take place to provide medical services.

This paper discusses the situation of Dakchung district, which is one of the most remote districts in Lao PDR due to very poor physical access. This district cannot access by motor transport during rainy season. Electricity is not available for the district, and the district hospital with one medical doctor is not functioning. Water supply and other medical supplies are not available. The project identified primary healthcare services through health centers would be the appropriate approach in Dakchung. In order to identify best location for a future investment for a health center was carried out using GIS database developed. The criterion for the location selection was based on following conditions;

1. Travel time
2. Population density
3. Existing serviceable area of health facilities

Travel time from each village, which was represented by a point, was interpolated to create a surface representing time from any location in the district to the district hospital. Triangulated Irregular Network (TIN) method was used in generating time-surface. Further, time required to reach the district hospital from each location was grouped into 3 classes viz. Longest, Moderate and Least with time ranges 24 hours or more, 12 to 24 hours and less than 12 hours, respectively. Figure 4 shows the time surface and the population of each village.

As with the time, population density was available for each village. Assuming a village is distributed in a spatial space with 2 kilometer radius, population density distribution was calculated. It was possible to obtain population distribution as a surface of population density. Subsequently, density surface was re-arranged into 3 classes; High (density more than 40 person/km^2), Medium (10-40 person/ km^2), and Low (less than 10 person/ km^2). Figure 5 is the population density surface created by village population data.

The third criterion was the serviceable area from available health facilities. It was considered that radius of six kilometers would be the serviceable area of the district hospital and this would be two kilometers for a health center.

As the above analysis generated three different raster data layers, analysis was carried out in raster analysis environment, GRID environment of Arcview software. Ranking of the above criterion was given a numerical value before combining them to a single value representing suitability for a heath facility.

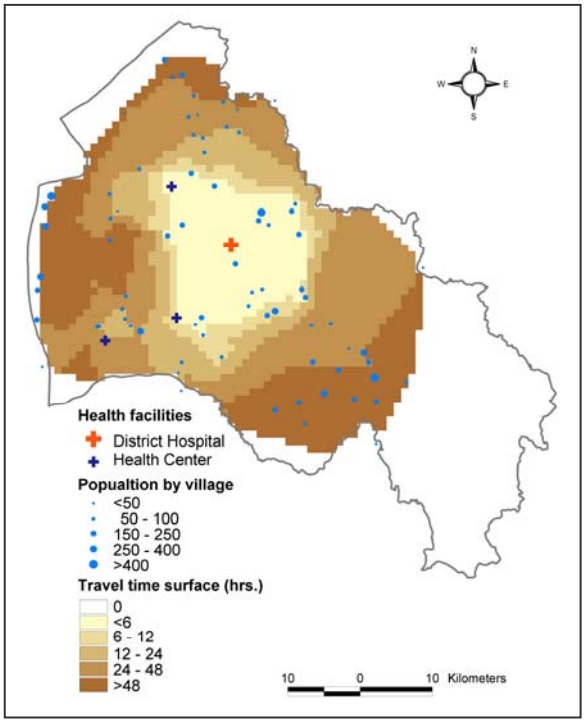

Fig.4. Travel time to district hospital

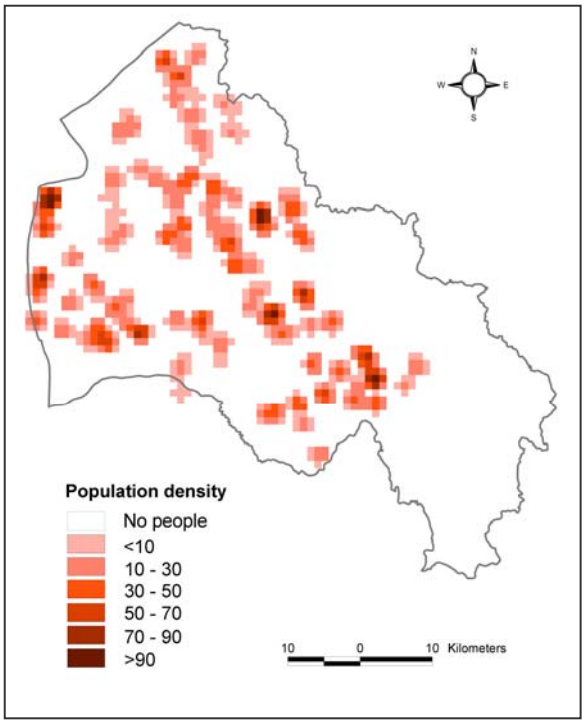

Fig.5. Dakchung district population density distribution

5. Result

5.1 Remote districts

Four districts were identify as remote districts viz. Viangthong and Xam-Tai are in Huaphanh province located at North East, Thapangthong is in Savannakhet province at South West and Dakchung in Sekong province South East of Lao. Figure 6 shows the distribution of remote districts. Three out of four were located in mountainous areas where transportation facilities are very poor. In the other hospital, facilities are poor.

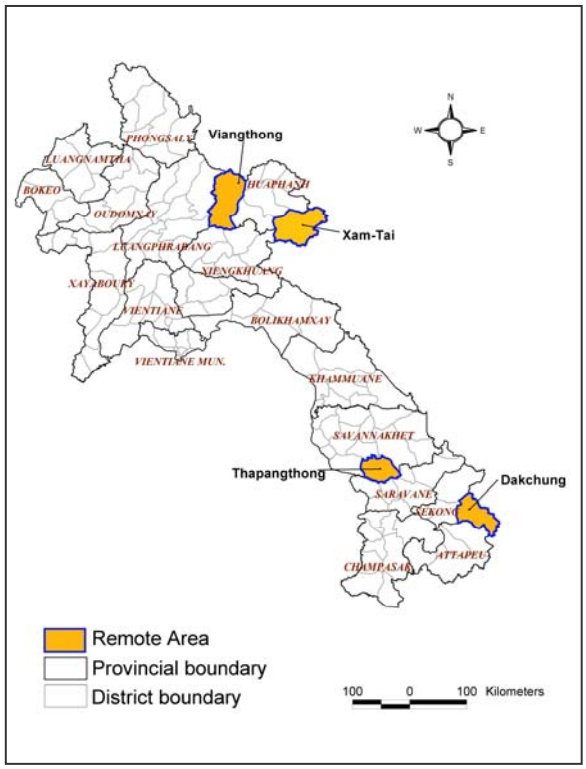

Fig.6. Distribution of remote districts

5.2 Identifying suitable areas for a new health center

Dakchung district was selected to identify potential location for health center. Figure 7 shows the results where black represent most suitable areas, gray moderate areas, white with dots least suitable areas. Service areas of available facilities area excluded as shown in circular zones.

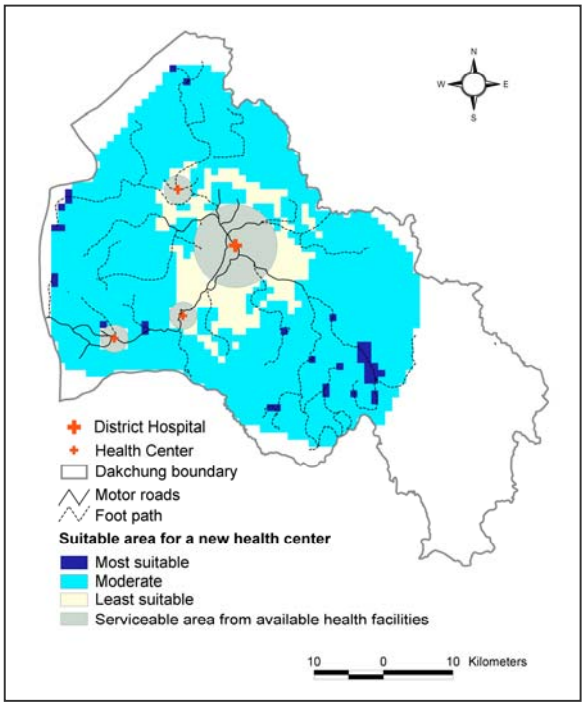

Fig.7. Suitability ranking for locating a health center

6.Conclusion

It was found that GIS is a promising tool for examining health facility distribution, identifying deprived area as recognizing areas for future investment. It can be said that GIS is a better tool for handling spatial and descriptive data. Further, it was observed that GIS functionalities are ideal for evaluating with given constraints. Multi-source data can be analysed together with appropriate derivation of new parameters. The above analysis could be further improved with incorporation of other relevant factors within GIS environment.

Acknowledgement

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