Case Study of GIS Application in the Field of Health Care

- The Malaria -

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Summary

This case study focuses on GIS application to the field of Healthcare. The specific interest here is Malaria and people being at risk. In Africa, Malaria is still a great threat to people's living. The distribution of Malaria can be geographically explained by outbreak potentials attributed to climatic and social-economic conditions. Given the opportunity to use the data from the project, "SWAZILAND: THE STUDY ON DIGITAL MAPPING PROJECT FOR THE SMOOTH IMPLEMENTATION OF THE DEVELOPMENT PLAN IN SWAZILAND" by Surveyor General's Department (SGD) of Swaziland and Japan International Cooperation Agency (JICA), it is demonstrated how the final products can be used and also how they can be of use for GIS analysis in the specific field such as health care issue.

1. Background

The JICA project, "SWAZILAND: THE STUDY ON DIGITAL MAPPING PROJECT FOR THE SMOOTH IMPLEMENTATION OF THE DEVELOPMENT PLAN IN SWAZILAND", which started on June 1999 and finished in 25 months, produced the digital orthophoto maps (1/10,000) of the whole country. To finish the project, SGD and the related agencies were invited to the seminar that demonstrated how the project's product can utilize their tasks and also what kind of GIS functions (calculation, analysis, planning) can be applied to the real needs. This case study was primarily prepared in order to present in that seminar.

2. Purpose

The Malaria preventive action shows its effect considerably in some parts of the world, however in Africa mortality rate due to Malaria is still relatively high (WHO1994: 1-2 million annual death due to Malaria is reported in Africa, 3-5 million are infected). This phenomenon derives from the natural environment of Africa that is favorable to Malaria transmission and also from the lack of implementation the systematic approach of preventive plans. As a result, the cost of preventive plan and medical treatment becomes enormous burden on GDP and individual economy. At the same time economic productivity of the individual is declined due to Malaria infection. (WHO: 0.6% of total GDP of Sub-Saharan countries is spent on Malaria control plan), the average family of 5 spends US$55 annually on Malaria prevention and treatment). In Swaziland, the government stated in the development plan of 1996 that it targeted of declining Malaria transmission rate and death rate by 1997.

Based on this circumstance, timely and precise information of Malaria outbreak, transmission, and infection is desired in order to effectively implement a Malaria control plan. Accordingly, the latest topographic maps, meteorological and environmental information, and social-economic census data are most important.

In this case study, the primal intention was to make the people of the related agencies and organizations of the Swaziland aware of how analytical functions of GIS can utilize their works. In addition, by applying the final product data to the case study, it was hoped that all the attendants of the seminar know those data is available to them and they are the ones who need to maintain and expand those data in the future.

3. Data and analysis flow

In this case study, elevation, road network, river network and population census were used as sample data from the project's final product data. Additionally meteorological data that was obtained through SGD was applied in assessing the factors of Malaria outbreaks.

The data and analysis flow is shown in Fig1. Firstly the areas where Malaria is likely to occur was evaluated by geographical conditions and sited (Fig2: Malaria risk map). Also the distribution of population under the Malaria risk was estimated (Fig3: Below 10 years old population distribution), and final map

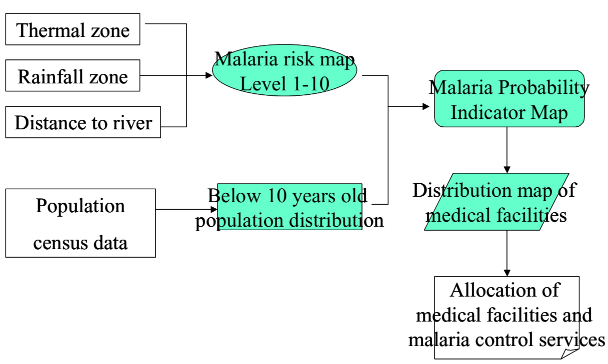

Fig.1 Data and analysis flow

that shows Malaria Probability indicator was created (Fig4: Malaria Probability Indicator Map). By comparing this indicator map and the location of the existing medical facilities, the areas where need to enhance medical facilities and control plans were sited for the future planning (Fig6: Allocation of medical facilities and malaria control services).

4. Thematic map production

4.1 Malaria risk map

This case study focused on temperature, rainfall, and distance to rivers as the factors of Malaria outbreaks. The Malaria outbreak and stable transmission requires the environment with temperature above 22 degree, monthly rainfall above 80mm, and proximity to rivers. Based on this fact, the study area is classified into 10 (1=not suitable for Malaria outbreak…10=suitable) for each factor and zoning maps of each factor were created.

By overlaying those three zoning maps, the factors are integrated and the risk of outbreak is mapped (Fig2). The dark orange part in Fig2 shows the area of high Malaria risk by the evaluation of three factors above.

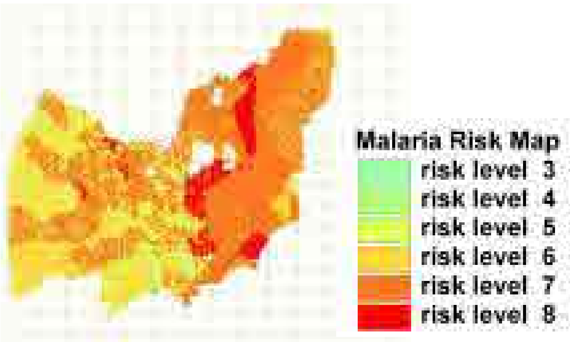

Fig.2 Malaria Risk Map

4.2 Population distribution map (below 10 years old)

Apart from the risk map, the distribution of below-10-years-old population was mapped by the use of population census data (Fig3). The reason I focused on this age group was that mortality rate of infants and children below 10 years old is reported to be higher once they are infected by Malaria. Therefore I believe the medical treatment and preventive controls should be emphasized in those populated areas.

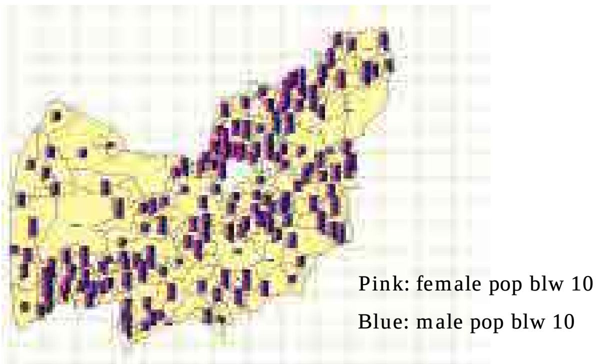

Fig.3 Distribution of blw10 pop

4.3 Malaria Probability Indicator

In assessing the area in urgent need of medical facilities and services to fight against Malaria, the probability of outbreaks based solely on natural conditions is not sufficient but social-economic factors, such as population distribution, should also be included. Because only then, you can site the area where there's high risk of Malaria and at the same time where are populate with people at risk. By the use of ArcView3.2, Malaria risk map (Fig2) and Population distribution map below 10 years old (Fig3) were multiplied and Malaria probability indicator map (Fig4) was created.

Green part in Fig4 shows the area where is at high Malaria risk and populated with age group of below 10 years old. It can be said that those areas should be given priority when implementing Malaria prevention plans and medical services.

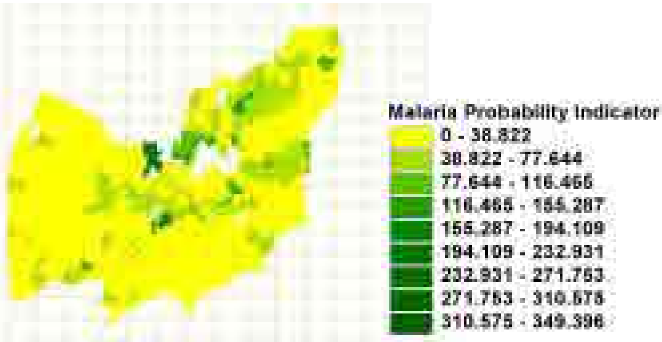

Fig.4 Malaria Probability Indicator

4.4 Medical facility location map

Fig4 illustrated the area of high risk and of populated. In addition, it is necessary to uncover the potential needs and the location of existing medical facilities so that allocation of the new facilities can be done effectively. Therefore I mapped the existing 21 medical facilities and the study area was divided into 21 zones by Euclidean distance according to the distance to the nearest medical facility (Fig.5).

Fig.5 Proximity map to 21 medical facilities

5. Analysis results

Fig.6 shows the value of Malaria indicator for each of the coverage of 21 medical facilities. As the red allows point out, zone 3, 6, 11, and 15 marked high value of Malaria indicator, which can be said that those areas should be given priority on preventive actions and medical services (Fig.7).

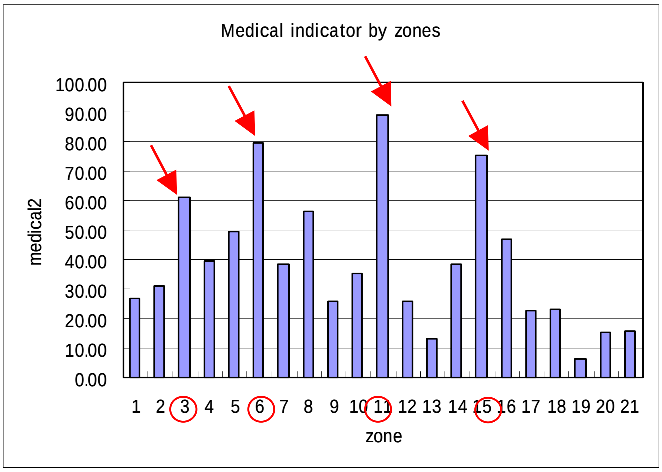

Fig. 6 Medical indicator value by zones

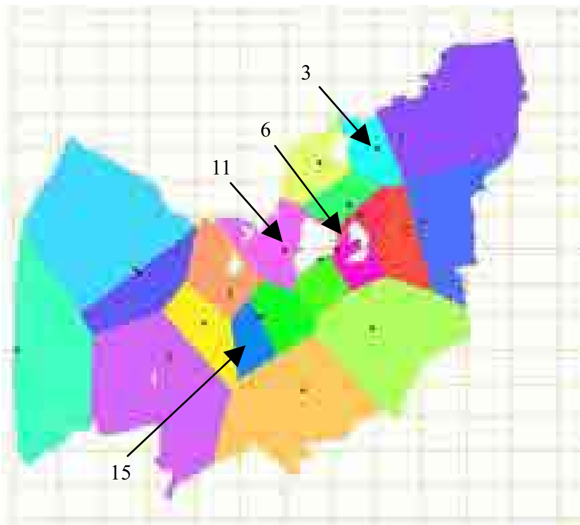

Fig.7 Location of Medical facilities that need priority

6. Conclusion

This is a case study that primarily aims to demonstrate GIS application onto health care field, hence the Malaria outbreak model adopted is very simple (only three factors: temperature, rainfall, proximity to river). In order to improve the model, other natural and social factors should be included and statistical validation should be applied. Also analysis results should be examined and fed back to the model so that it would perform better.

The Swaziland acquired the knowledge and whole country data of GIS and digital mapping through this project with JICA. Hereafter, it is strongly hoped that the people of the Swaziland maintain and expand their data, knowledge, and capacity by their efforts. And I firmly wish this case study and the seminar made the attendants realize the possibility and brought them new ideas for their future.

Planning of the elementary school construction in the Burkina Faso

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Abstract

Supporting the maintenance and management of educational facilities by using map information is the main purpose of this study. House data from 1/50,000 scale national base map, the number of children obtained from the statistic of population for each administrative area, 500m grid mesh data and questionnaire result from each existing school are used for the analysis. According to the result, the school children's location, and then support the planning for class addition and new construction of elementary school were grasped.

1. Introduction

Burkina Faso is a landlocked country located at the southern end of Sahara Desert in West Africa. The agriculture and stock farming of the country has had been seriously influenced by the desertification from north side of the country. Therefore, Burkina Faso government has started the maintenance of the map, which used as the base data for developing agriculture, forest, water and other resources, for the purpose of continuous development and economical growth, which harmonized with environment.

Especially, the southwest part of the country, where development potential is higher than other parts of the county, the technology transfer of digital-mapping (DM) for 1/50,000 scale national base map creation was made by the Japan International Cooperation Agency (JICA), and the map maintenance with Burkina Faso government is under enforcement now.

Under those circumstances, the demand and supply of school children and school facilities is analyzed with created DM data at the southwest part of the country, where population are rapidly increasing.

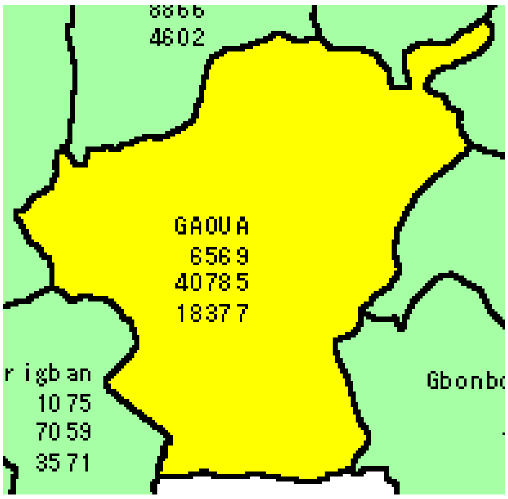

Fig.1: The number of households and population for each area (Upper:the number of house holds, Middle: total population, lower: the number of school children)

In concrete, following themes about school children in the school district are inspected with GIS. Base data for the inspection are house symbols displayed on the map and number of school children in each area from the report of population-statistics office.

-- Whether number of elementary schools are enough or not

-- Which existing school shall be select, in case class has to be added.

2. Data for analyzing

(1) Population data grouping by age and area

(2) Positional information of school facilities (GPS data)

(3) 500m grid mesh data which including the Area

(4) 1/50,000 scale national base DM data (Distribution of House)

(5) Questionnaire data for every school

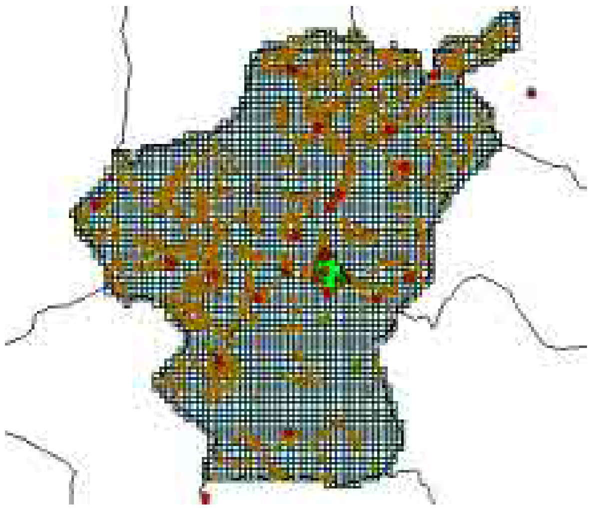

Fig.2: 500m grid mesh, house (brown) and existing school (red)

3. Work method

3.1 Simplified conditions and assumption

(1) All school facilities have no differences in quality and scale.

(2) Every school child is attending to the nearest school.

(3) Every school child are supposed to live in the center of each 500m mesh, so the distance to each school are calculated from the center of each mesh. Moreover, the distance from house to school facilities is measured as simple straight line, and road network is not taken into consideration.

3.2 Work method details

(1) Determination of school district from the existing school location. (Fig. 3)

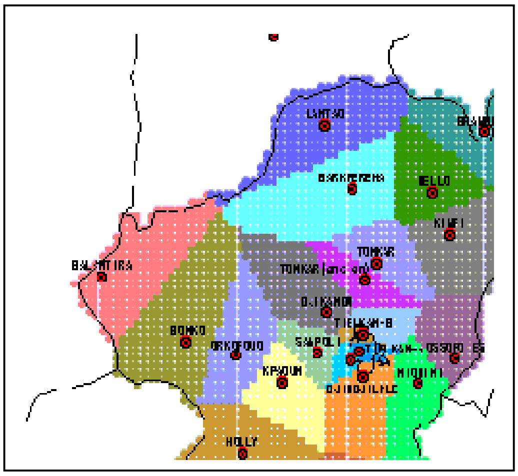

Figure3. Location of existing schools

(2) Measuring of distance between each school children's residential area and nearest school.

Each mesh is colored in gradation according to the distance to each existing school, and house symbols are displayed over the mesh. Consequently, children who live in the long distance from every school are figured. As a result, each school location shall be estimated basis on the distance

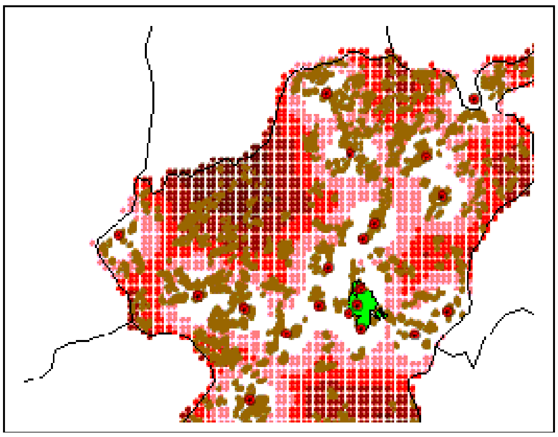

Fig. 4: Distance to each school (deeper red is further)

(3) Estimation of new school location and schools, which has to add classes.

Number of children who are out of accommodation has shown on a chart, by using the questionnaire data such as the number of accommodation children and classes for each existing school. From this result, whether built a new school or add classes have been examined.

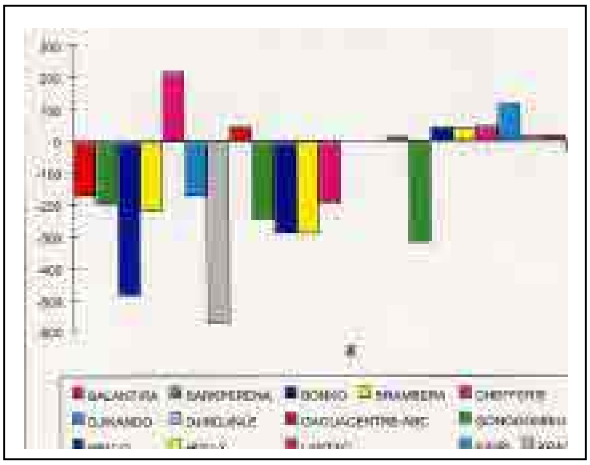

Figure 5. Gap between questionnaire result and number of children at each existing school.

(Minus value: Number of children who are out of

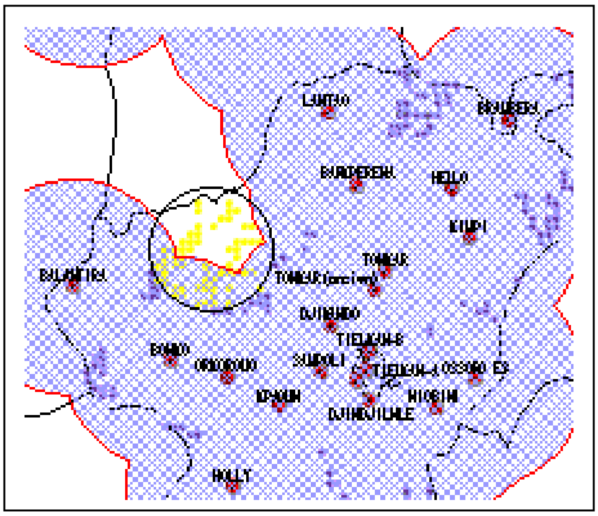

Fig. 6 Location of houses ,which are far from any school

(4) Search houses, which are not covered within 4km circle from each existing school.

Number of children whose home are out of the circle are calculated, and the new facilities adapted to the number of children are planned (Fig. 6).

4. Conclusion

New school construction and adding classes were inspected by using 1/50,000 scale topographic map and GIS function. For the habit of topographic map, houses in city area are generalized in mapped features. And, distribution of houses can roughly be grasped, though house symbol is not drawn one by one.

Therefore, it is considered as proper procedure to replace populous distribution with mesh data, to grasp the tendency and manage as GIS data.

On this project, distance between house and school was calculated with straight line from the center of each mesh to the

nearest school facility. In case of school route is fixed, producing new map with the distance will make evaluation more accurate.

Moreover, the land use potential analysis can be carried out by road, house and contour data, which are extracted from 1:50,000 topographic map data, together with land slope data and soil map data. The result allows evaluating appropriately the agricultural development, forest prevention and relationship between regional village and agriculture. Therefore, demand of GIS basic data is considered to be higher in the future.