IDENTIFYING SPATIAL CONTEXT AND ASSOCIATED FACTORS OF POVERTY USING SPATIAL STATISTICS AND GIS

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ABSTRACT: Mapping poverty has become increasingly useful in identifying poverty traps or pockets of deprived communities as well as identifying underlying factors those associate with poverty in a locality. This information assists with the targeting of interventions or recognizing appropriate development projects. The ability to analyze relationships between different data sources in a spatial context using GIS and spatial statistics also provide important insights into possible associated factors of poverty that are not readily accessible in any other means of analysis. This paper investigates the potential of descriptive statistics, GIS, and spatial autocorrelation in identifying poverty association of rural context of northeast Thailand. It was showed that GIS is a useful tool in identifying some of the associated factors related to spatial segregation of poor households and spatial autocorrelation could satisfactorily used in recognizing similarities or dissimilarities among households examined in this work.

1. INTRODUCTION

Poverty is a global issue, it is defined as deprivation in well-being including lack of basic facilities and supplies such as education, health care, nutrition, etc (World Bank, 2010). In Thailand, poverty is still a problem in many parts primarily concentrated in North and Northeast regions. During the launch of the Thailand Human Development Report 2009, the United Nations Development Program (UNDP) resident representative mentioned that richest Thais earn 14.7 times more than the poorest and the bottom 60 percent of the population's share of the income is only 25 percent. National Economic and Social Development Board of Thailand reported that in 2006 two third of people in Northeast are poor and almost 90% lives in rural areas (NESDB, 2007). This shows that poverty has spatial dimension. Also, a World Bank reported the spatial dimensionality of poverty in Thailand and the possible use of poverty maps to identify poverty pockets that are not otherwise visible (Somchai Jitsuchon and Kaspar Richter, World Bank Report, 2009). Poverty concentrates within a given locality and varies from place to place (Minot et al., 2006; Okwi et al., 2007). The complexity of poverty, its underlying factors as well as the spatial variation can be analyzed and visualized with GIS, which is a very promising tool in handling physical and social factors in a comprehensive manner. This study aims to investigate the combination of descriptive statistics, GIS and spatial statistics to identify the spatial associated factors to poverty.

2. STUDY AREA

The study was located in the Samrongthap district, Surin province in the northeast region of Thailand with a total area of 277 km^2. Surin province is designated as one of the top five provinces with the highest poverty incidence in Thailand with 37.8, 57.84, 38.61, 33.43 percent in the years 1998, 2000, 2002 and 2004 respectively (Kaenmanee et al., 2003; NESDB, 2008). There are 10 sub-districts (Tambon), 100 villages and 10,572 households in the Samrongthap district (NSO, 2006). Major types of land use include paddy cultivation covering 86% of the total cultivated lands in the study area (Figure 1).

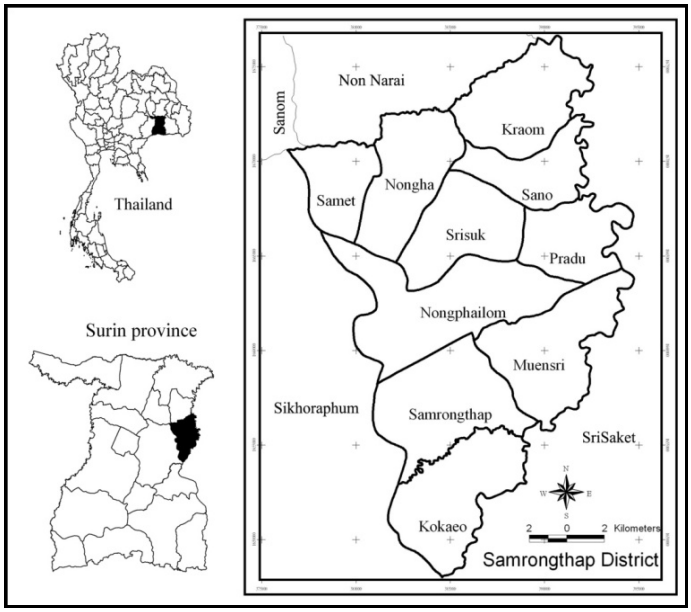

Figure 1 The study area

3. METHODOLOGY

Research methodology is described in the following steps

3.1 Data collection

In this research, the social, physical, and household characteristics in the study area was carried out using household questionnaires collecting primary data such as household and farming related information, demographics, socio-economic and institutional data, farm production, farm management activities, and agricultural problems. The Household locations with respect to farm locations were identified by using the Global Positioning System (GPS). The secondary data was gathered from a variety of sources both spatial and non-spatial data. According to random sampling method, 195 household samples were chosen from a total of 9,736 households in the study area.

3.2 Data analysis

Poverty measurement and household characteristics

It is reported that in Thailand there are about 4.7 million farm households with an average land holding of about 3.6 has. per farm household (OAE, 2008). In the same report, it is said that the annual average in the rural farm household was about 196,389 baht. It is said that this income is half of a self-employed non-farm worker or one third of a blue collar worker. The farm income of the rural community is changing with many factors and some of the decisive factors are market prices, weather patterns, labor, and land availability. The poverty measurement of this study used Surin's poverty line from the National Economic and Social Development Board (NESDB) to identify poor and non-poor households based on the consumption approach (1,057 Baht/person/ month or 12,684 Baht/person/year). The descriptive statistics were used for analysis of the basic characteristics of the household in a study area among poverty groups. (1US$ = 30Bhat, 2011)

Factor influencing to NFI

In this study, the Net Farm Income (NFI) was considered as a contributor to rural poverty. The correlation and multiple regression analyses were conducted using SPSS version 11.5 and a regression equation was developed to identify the factors influencing NFI.

Underlying factors related to NFI and spatial pattern of NFI

GIS analysis was conducted to investigate the underlying factors related to NFI through visualization. The simple spatial analysis functions such as overlying, buffering and geo processing in GIS were used to created maps based on the household survey data. The flood potential map, rice suitability map, and farm holding map were created to visualize the spatial factors that could associate NFI.

Spatial autocorrelation (SA) was conducted to analyze spatial patterns. The Moran's index was used to investigate the spatial clustering patterns of NFI of households. The global Moran's I and the local Moran's I were calculated on the global and local scales using equations 1 and 2 (Wong and Lee, 2005).

$$I = \frac{n \sum\sum w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{W\Sigma(x_i - \bar{x})^2} \quad \text{(Equation 1)}$$

Where x_i is the attribute value of area unit i, $\bar{x}$ is the mean value in the study region, w_{ij} is the spatial weight matrix, W is the sum of all cell values in the spatial weights matrix, and n is the number of area units in the entire study area.

$$I_i = z_i \sum_j w_{ij} z_j \quad \text{(Equation 2)}$$

Where z_i and z_j are deviations from the mean for corresponding x or $z_i = \frac{x_i - \bar{x}}{\delta}$ where δ is the standard deviation of variable x.

The local indicator of spatial association (LISA) was conducted to explore the clustered NFI locations at the local level. The LISA cluster map showed 4 relationship categories as follows,

- The high-high relationship shows the location of high NFI household with high NFI neighbors or positive spatial autocorrelation.
- The low-low relationship shows the location of low NFI household with low NFI neighbors or positive spatial autocorrelation.
- The high-low relationship shows the location of high NFI household with low NFI neighbors or negative spatial autocorrelation.
- The low-high relationship shows the location of low NFI household with high NFI neighbors or negative spatial autocorrelation (Anselin, 1995; Anselin et al., 2005).

4. RESULTS AND DISCUSSION

Based on Surin's poverty line based on consumption approach, it was found that 136 households (70%) out of 195 households were poor. It was observed that NFI is the major source of household income which is shared more than half of the household income. In the descriptive statistical analysis, it was found that the poor households are associated with fewer years of education, larger family size, lower income as well as expenditure, smaller farm size, low rice yield, smaller number of livestock, less participation in agricultural training, large area of crop damage, and high occurrence of agricultural problems. Based on the results it could be said that the low educational level limits the opportunities to access high salary jobs or off-farm opportunities for income generation. It was found that paddy and livestock are the major sources of income for rural households. Therefore, poor households with small farm size, low rice yield and less number of livestock has limited opportunity to increase their farm income. The NFI model developed for the study area showed the amount of income from livestock, rice yield, total area cultivated and participation in agricultural training were the main contributing factors to NFI. These variables could explain 70% of total variation of NFI. These result showed the situation of rural household in Thailand with respect to agriculture.

Based on household survey data, it was found that some households are faced with flood, water shortage problems, low land quality and lack of land for cultivation. These households also responded these problems impact on their crop yield and income.

Figure 2 shows the use of GIS to identify underlying factors related to poverty. Figure 2a shows 34% of study area covered by high flood potential area. 16 households said to be faced with floods (red points), and 10 of the total 16 households are located in flood potential areas (black stars). Figure 2b shows the moderately suitable and not suitable area for rice cultivation in the east of study area. It was found that 30 households located in moderately suitable areas where the rice yield could have affected leading to low farm income. Figure 2c shows average farm holding sub-districts, the darker shade represent the size of average farm holding less than the average found in the study area. Comparing with NFI quintile, the low NFI quintile is located in the low average farm holding sub-districts. In summary it could be said that GIS is a very valuable tool to identify some of the external factors that could have contributed to the decrease or lower NFI in the study area.

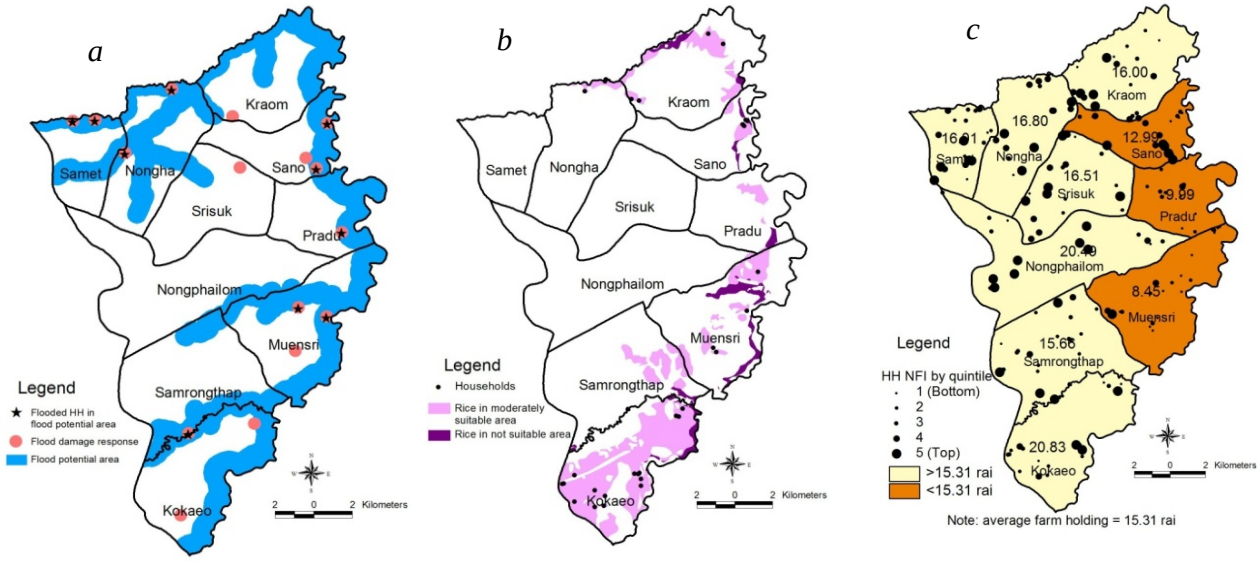

Figure 2 Underlying factors related poverty using GIS analysis

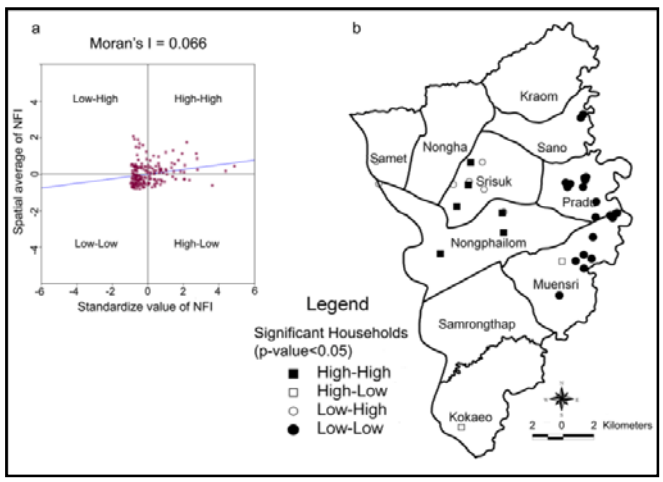

Figure 3 Moran scatter plot and LISA cluster map: **a** Moran scatter plot matrix, **b** LISA cluster map of household NFI ($p < 0.05$)

Figure 3 shows the result of SA analysis, it was found that 39 households with significant local spatial autocorrelation (p-value<0.05). 23 out of 39 households belonged to low-low relationship were clustered in the east of the study area in Pradu, Muensri and Sano sub-districts. These households had low NFI and surrounded by low NFI households. Moreover, it was found these households have similar underlying problems related to poverty. For example large family size, households faced with agricultural problems and household without land holdings.

GIS and SA analysis also showed underlying spatial factors that related to poverty and similar results of poverty distribution in poverty context. Therefore, it can be said that GIS and SA could help in indicating and visualizing the associated factors related to poverty that could be useful and help in monitoring the poverty situation and address the poverty alleviation interventions by considering the cluster of households rather than providing monetary assistance to each household.

5. CONCLUSION

NFI is one of the contributors to household income and rural poverty in study area. More than half (52%) of household income was generated by NFI and it was found that the area of cultivation, rice yield, the amount of income from livestock, and participation in agricultural training the main contributor to NFI in this study area. It was possible to use GIS analysis to identify the spatial distribution of poverty and its relationship with other spatial factors satisfactorily. It was found that SA is a tool that could help in identifying spatial relationship of poor household with their neighboring households. It is observed that SA can satisfactorily use in locating households with similar characteristics or similar underlying factors affecting the poverty to help policy makers to consider appropriate counter measures treating them as a group. Therefore, the combination of GIS and SA analysis is suitable to identify associated factors of poverty, and indicated the spatial pattern of poverty and targeting interventions more effectively.

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