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Urbanization of Tourism Areas in Phuket Island, Thailand: A Case Study of Patong, Kammala and Karon

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Abstract: The factors influencing the urbanization growth of tourism industry have been debated and discussed by developers about tourism literature and the issue continues to be one of the most popular topics for research. Using Phuket tourism areas as the target population, researchers assessed areas such as Patong, Kamala and Karon. This study aims to review available approaches to model land-use change and thus identify priorities for future urbanization growth. A Logistic Regression Model was fitted separately to predict these outcomes since, 1975 to 2009 with those locations and the land-use 8 years earlier as determinants. The results of this study, therefore, do not only provide sufficient information on the urban growth in three places of Phuket tourism areas from 1967 to 2009 but they also provides quantitative information about urban change by simple geographical from freely available Software R Program. For the areas that had much than each locations, researchers found substantial changes in Patong, Kamala and Karon with 24.2, 13.0 and 19.5% of other land-use type, respectively, becoming urbanized while 93% of urban land did not change whereas the estimated urban growth of the island on the East-coast was higher than West-coast.

Key words: Grid-digitized, predictions, land-use, logistic regression, Phuket Island

INTRODUCTION

Recently, tourism industry in the world conducted economic growth, the report of research note from 1990 to 1995 was annual growth of 8.2% whereas growth in the world tourist increased at a rate 4.7% (Choy, 1998). Corresponding to the study of Wong, upland resort development will continue to have negative impacts on the coastal environment in Southeast Asia. Although, the tourism industry could provide increasing economic growth, the results of the management for supporting the tourist industry changed urbanization. The impacts of urbanization gains are well known and observed. Currently, in Southeast Asia there have been many buildings such as the five-star hotel, resorts and floating bungalows (Lee, 2010).

The contribution of travel and tourism to GDP (in 2009) from the studies of Wong *et al*. (2011) was 11.0% in ASEN community. The direct effect of growth for tourism industry was changed of land-use. In Malaysia, the reported of Lee said, the increased in coastal resort is mainly due to decreasing forest, agriculture and beach. The coastal tourism growth in Malaysia, East-coast area was relatively new to coast resort development whereas the information on aquaculture and habitat (mangroves) loss from 1970 to 1988 was 0.3-4% per year. In Pattaya (Thailand), the increasing of most intensely developed urban has been strongly effected to the environment, traffic and land-plan (Wong, 1998).

Without tourism industry, over 45% the world's population live in urban or city or commercial areas and the annual population growth rate is around 2.4% in a year in urban areas compared to around 1.7% in a year in non-urban areas (UN, 1997; Wu and Murray, 2003). Increasing of urbanization is a major problem and a form of environmental change that impacts directly on the quality lives of human.

Estimating, urban growth in Tokyo 40 years ahead, urban or new built-up density decreased in the metropolitan inner core as the city center experienced depopulation whereas urban growth out site the city increased (Bagan and Yamagata, 2012). In Beijing, the prediction of urban growth from 2020 to 2049 increased and hence urbanization will disturb other land-use (Long *et al*., 2009). In London studied, the limitation of urban growth in London's street network which effected

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to the urban growth up corresponding to the street, the results showed that the trend of urban area was increased (Masucci *et al*., 2013). Moreover, Liao and Wei (2012) predicted urban growth in Dongguan, China which the outcome was found that the urban area increased by 1,181% in 1988 to 2006. Focusing on Southeast Asia, especially in the popular of tourism area such as Phuket, Bali, Hanoi, Langkawi, etc. there are places which have been disturbed by urbanization urbanization (Martin and Assenov, 2008). Following the topic of the city in 2050 of Brown (2013), the effect from gain of the city was been constructed from rural to urban which needed to plan and manage the recourses such as infrastructure, transportation and regional planning to support the gain.

The current research focused on the Southern part of Thailand which has the highest percentage of the urbanization in particular Phuket Island which is one of the provinces in Thailand that has fast grown by tourism industry more than the other regions. The objective of this study is to predict future urbanization by logistic regression analysis with Remote Sensing (RS) data. Based on Grid-Digitized Method the computed RS data outcome is binary, these data can be analyzed by logistic regression as either the specific land-use of interest (urban land for example) or not. Finally, the thematic map and geographical display by freely available Software R Program are implemented to simulate spatial distribution of urbanization from 1967 to 2009; three locations of tourism areas such as Patong, Kamala and Karon are assessed.

MATERIALS AND METHODS

Study area: The Phuket Island is located between latitude 7°53′N and longitude 98°24′E. Phuket Island is divided by mountain ranges that extend the entire length of the Western coast, all fronted by wide sandy beaches. The balance of the island is somewhat flat with green hills and valleys and a rich, tropical feel. Neighboring provinces are Phang Nga and Krabi, since Phuket is an island it has no land boundaries. It is situated off the West-coast of Thailand near the Andaman Sea (Fig. 1).

The population density of Phuket Island has been reported by National Statistical Office which was >239 people per 1 m^3 whereas population is growing at a constant rate of 2.99% per year from 1990 to 2000 (NSO, 2000). This population density has placed considerable pressure on the city's infrastructure and is the point driving force of urbanization for the support of tourism industry. The current trends in urban development are currently most apparent in the

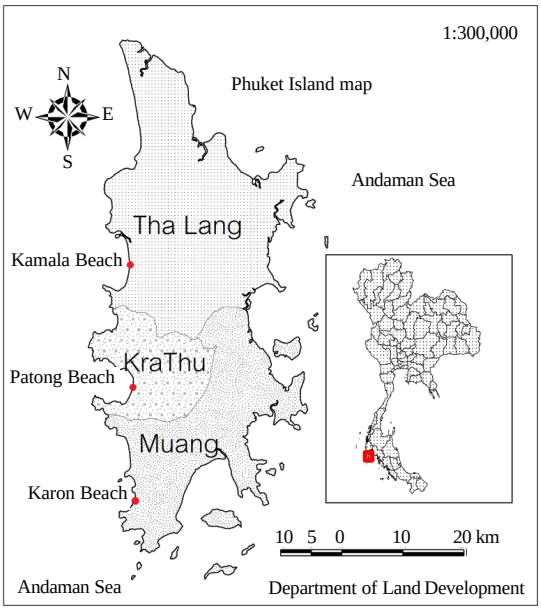

Fig. 1: Phuket Island map body

suburbs of the tourism area particularly at Patong, Kamala and Karon where numerous new resorts, hotels and tourism zones are located. The population density in that place increased drastically at the beginning of the 1990s due to rapid tourism industry. Consequently, the direct effect of growing of tourism industry such as traffic jams, flooding are becoming serious problems for Phuket's province government.

Management data: For this study, the steps for data management and use of data for analysis are summarized in Fig. 2. Data for this study were derived from RS data conducted by the Thai Department of Land Development. Data were collected through Grid-Digitized Method which involves converting the polygonal data (RS data) to grid-point data (Thinnukool *et al*., 2013). Researchers such as Huh *et al*. (2011), Stehman and Wickham (2011), Frazier and Wang (2011), Bach *et al*. (2006), Guo *et al*. (2013) and Whiteside *et al*. (2011) studied and described the use of pixels, blocks and polygons to construct accurate maps. They also confirmed that pixel-based construction can accurately show land-use and the pixel can be accepted for representative of land-use data. The concept of this method was connected from the polygonal coordinates to those based on the gridding in which one point is the area 10×10 m. R Program was used to compute RS data after loading its sp library which contains the function point.in.polygon (The R Development Core Team, 2012). Examples of grid-digitized outcome illustrated in Fig. 3, there are quite substantial and accepted accurate

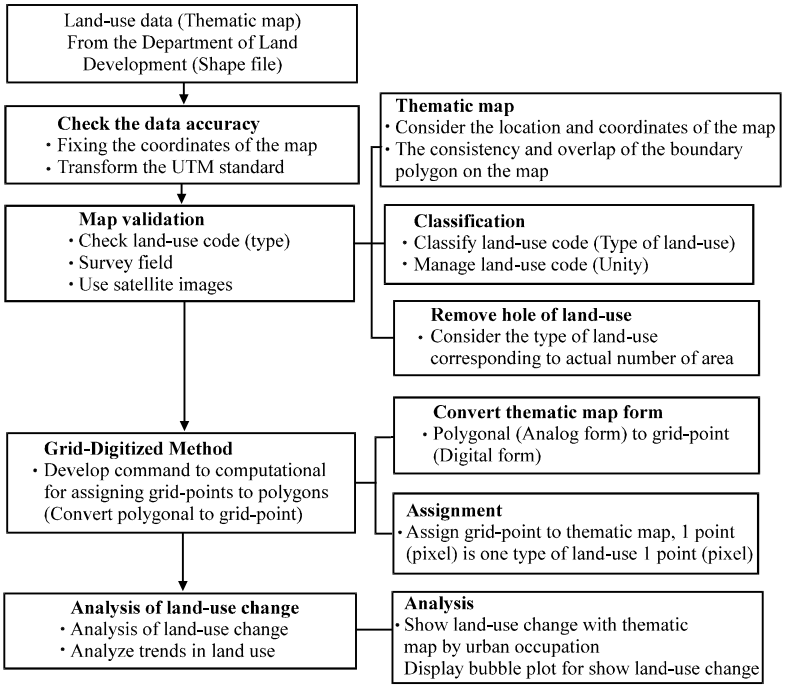

Fig. 2: Step used for data management and data analysis

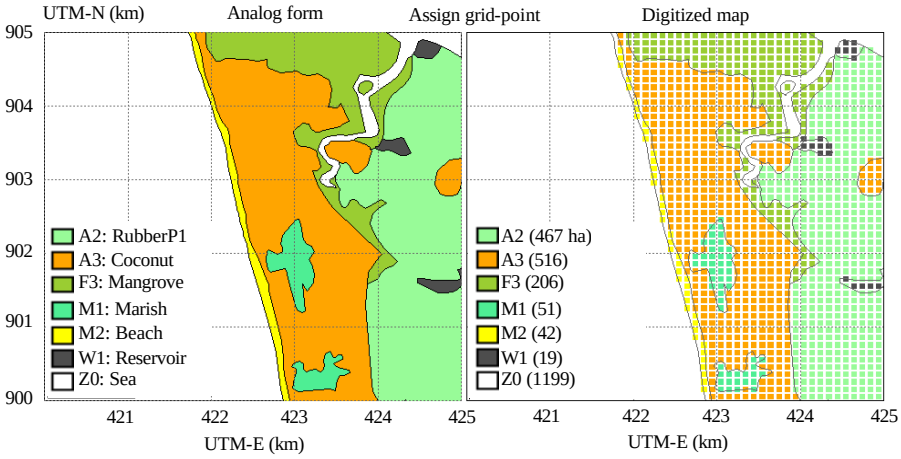

Fig. 3: An example to shows the conversion of polygonal representation (left panel) to digital representation (right panel) in digital form by digitized land-use data from North of Phuket Island in 1967

measurement of land-use which is provided to analyze land-use. To detect urban change in Phuket Island, data classified by the Thailand Department of Land Development were used in this study. After the data in polygon form had been transformed to grid-point (digital data), the data were managed considering the land-use categories (urban, non-urban). Thailand land-use type had 48 categories in which that data have been change into 2 type of land-use, Fig. 4 describes how to classify land-use type.

Analysis urbanization: Statistical modeling and forecasting of land-use are complicated by changing boundaries of polygonal land-use plots. Land-use in polygonal form can be improved by gridding. The polygons that vary in shape and size are replaced by a regular and unchanging set of grid points on which the land-use is defined.

These data can be analyzed by logistic regression because the outcome at each grid-point is binary: it is either the specific land-use of interest (urban-land for

Land-use group type	Type/land-use code	Define land-use
Agriculture	A1XX Rice farm A2XX Field crop A3XX Perennial A4XX Orchard A5XX Horticulture A6XX Temporally farm A7XX Farm house A8XX Aquatic plan A9XX Aquacultural land A0XX Integrated farm	Non-urban
Forest	F1XX Evergreen F2XX Deciduous F3XX Mangrove F4XX Swamp F5XX Plantation F6XX Agro forestry F10X **The characteristic of forest such as disturbed or dense	Non-urban
Miscellaneous	M1XX Rangeland M2XX Marsh M3XX Mine M4XX Other	Non-urban
Urban	U1XX City-town U2XX Allocated land U3XX Institutional U4XX Utility U5XX Industrial land U6XX Other	Urban
Water body	W1XX Natural water W2XX Reservoir	Non-urban

Fig. 4: Define type of land-use code for Phuket island, urban and non-urban are assessed

example) or not. The handle the substantial spatial correlation that exists between data from grid-points within the same land-use plot, researchers use a method based on covariates inflation factors (Rao and Scott, 1992). This method computes effective sample sizes for each land-use plot based on their sample variances from which standard errors are applied to fitted values from the logistic model to compute confidence intervals. In the simple situation where no covariates are considered the binary dependent variable Y represents the land-use for each grid-point in a specified year and X is the corresponding land-use for a preceding year, the model is formulated as:

$$P\left(Y=1\middle|Y=\frac{1}{1+e^{-(a+bx)}}\right) \quad (1)$$

From Eq. 1, P (Y = 1|X) is the probability of the specified land-use at a grid-point given its value is X at the previous survey. This method can be extended to situations using covariates such as location. Analysis is performed using the R Program (The R Development Core Term, 2012).

RESULTS

This study takes Phuket Island as the research area and as convert its map to square kilometer with 1:1000 scale. Land-use classification was formed in which it was grouped into 48 categories and two groups (urban, non-urban). Figure 5 demonstrates a thematic map for Phuket Island from 1967 to 2009 with land-use type urban and non-urban (other land-use type). There are three places in rectangles were important tourism areas and urban percentages have been shown in the bobble plot matrix in Fig. 6. To understand and focus on the area of this study, Fig. 7 shows the thematic map of Phuket's tourism areas which heighten on the shape and show the percentage change from Non-urban (N) to Urban-land (U).

Land-use data analysis: Urbanization of tourism area in Phuket Island, the bar chart shows percentages of urbanization in three locations 8 years earlier. In 1967, total of areas urban in 1975 were 48, 14 and 78 ha whereas non-urban were 90, 96 and 1186 ha of three places. This pattern was not repeated in the period from 1967 to 2009 when over 15% of urban of three tourism areas remained urban and the other land-use type also became urbanized. The blue vertical line segments denote 95% confidence intervals which are much wider than those for independent error. In Fig. 8, greater urbanization occurred in Patong tourism area and the percentage of other land-use that became urbanized in the following 4 periods.

Estimation of urbanization for Phuket tourism areas, Fig. 8 shows percentages of urban land which denote 95% confident interval. The results of urban growth were 0.87, 0.18 and 0.21 for three places for Phuket tourism areas from 1967 to 1975. From 1975 to 1985, urban growths were 0.20, 0.14 and 0.23. Next period from 1985 to 2000, urban growths were 0.49, 0.22 and 0.14 whereas 2000 to 2009 were 0.41, 1.32 and 0.27 times. Although, urbanization growth in Phuket, especially the tourism areas are located at West-coast, in the East-coast of Phuket, urbanization

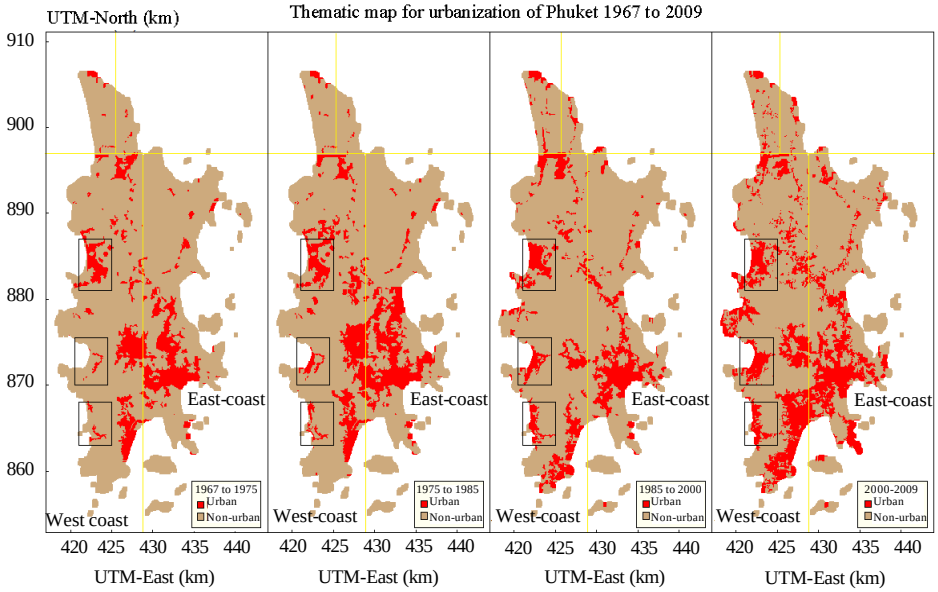

Fig. 5: Thematic map was used; illustrate urbanization in three places in Phuket Island (top rectangle was showed Kamala tourism area whereas middle rectangle showed Patong tourism area and bottom down rectangle show Karon tourism area

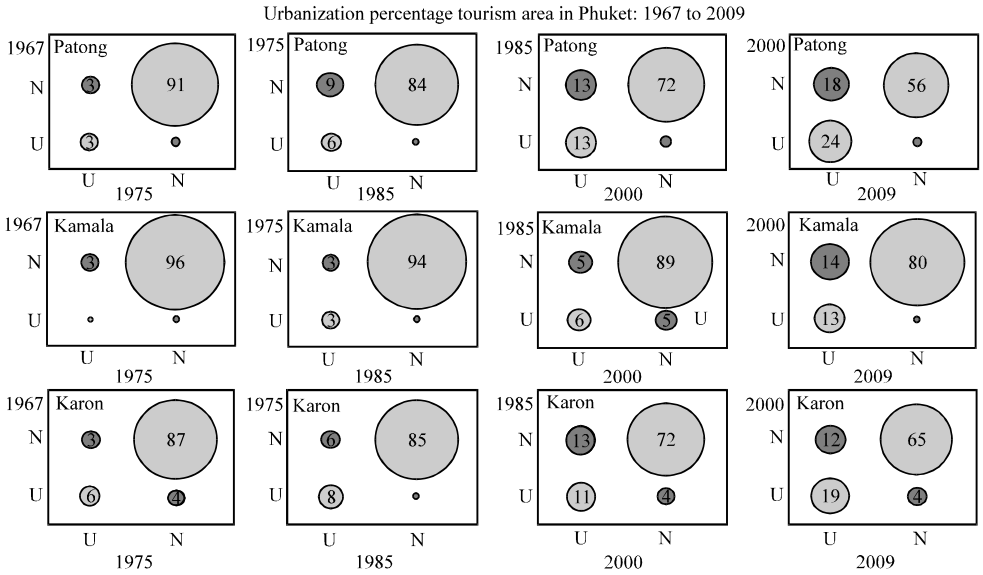

Fig. 6: Summary of urbanization in 3 places in Phuket Island, 4 periods are assessed

has occupied the entire city (CBD). Researchers have considered the urban growth and compared the trend of growth, Fig. 9 shows percentages of urban land between West-coast and East-coast.

According to the results of Fig. 9, the urban growth in West-coast had an estimate of 3.93 times for 1967 to 1975 and East-coast was 6.48 times. In second period (1975 to 1985) urban growth were 8.84 and 14.87 times because during this period Thailand open the tourism area and the government support the tourism industry. After that in 1985 to 2000 the growth of urban decreased, they were 1.95 and 3.70 for West-coast and East-coast. In 2009, the estimated urban growth on the West-coast was 3.4 times higher than in 2000 whereas the estimate of the growth on the East-coast was 4.95 times higher/larger.

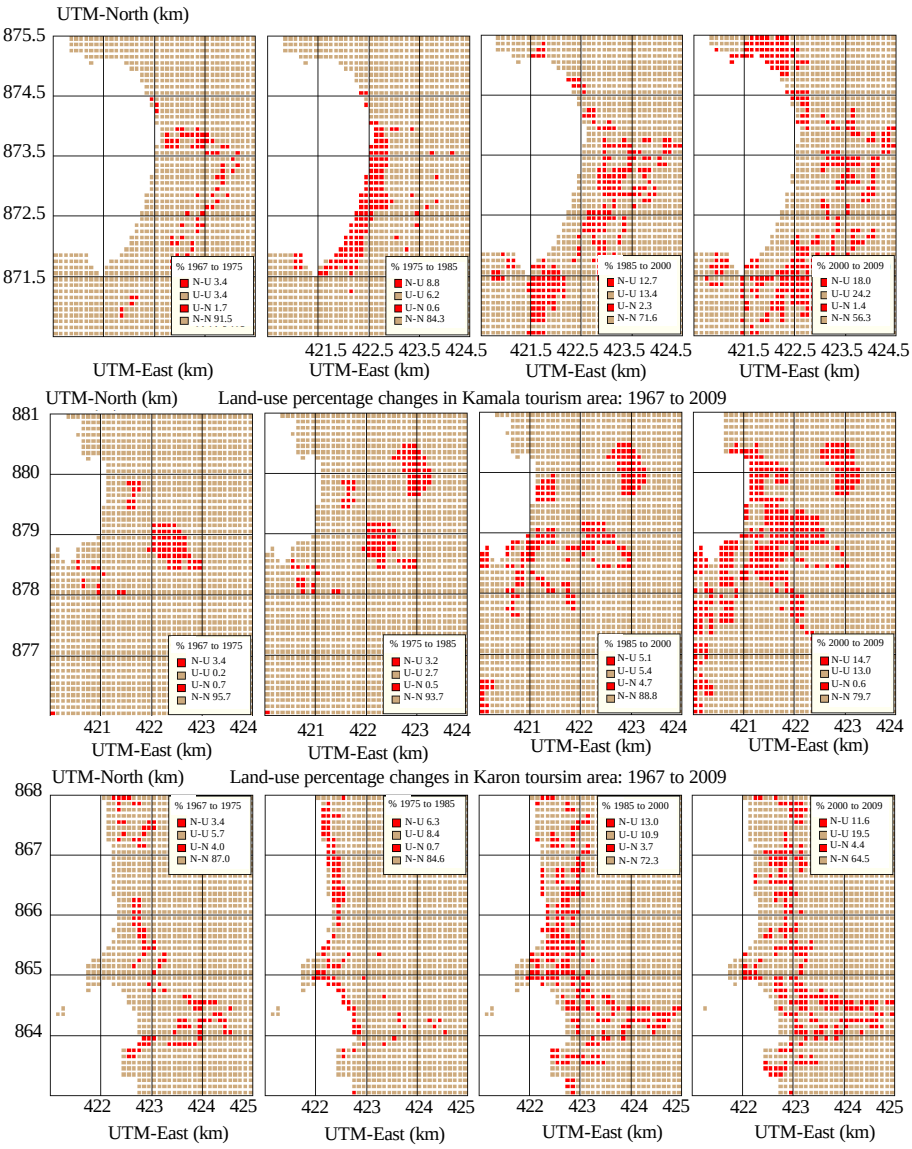

Fig. 7: Thematic map illustrates land-use change with urbanization in three places in Phuket Island in 4 periods

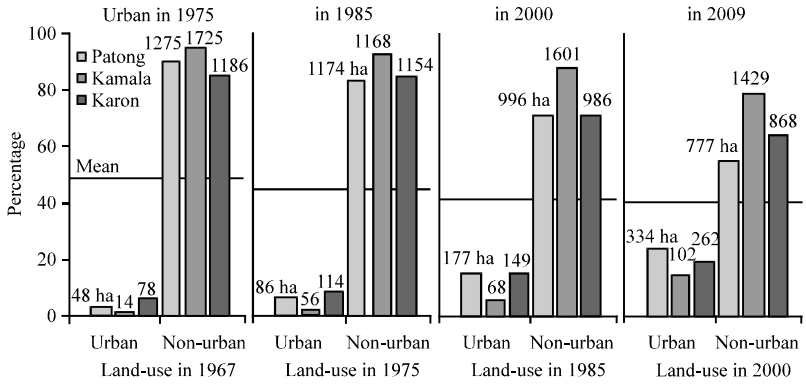

Fig. 8: The bar chart shows percentages of urban land which denote 95% confident interval from Logistic Regression Model using Rao-Scott Variance Inflation Method to account for correlation within land-use plots

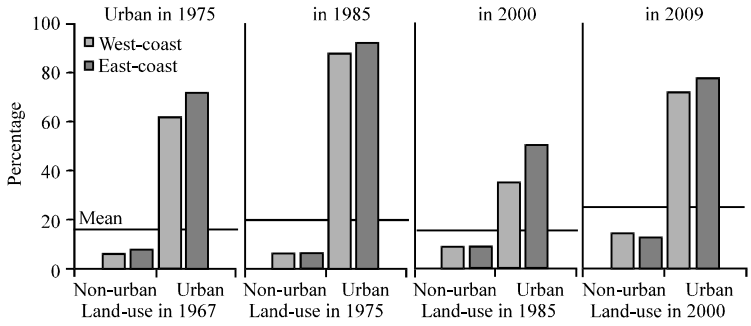

Fig. 9: The bar chart shows percentages of urban land which denote 95% confident interval from Logistic Regression Model, the prediction of urban growth of West-coast and Eas-coast for Phuket Island

DISCUSSION

In this study, researchers used graphical thematic map by Grid-Digitized and Statistical Method by logistic regression to estimate urbanization of Phuket tourism areas which it fit a model for predicting the percentage of future urbanization. Consideration between West-coast and East-coast, proportion of urban growth West-coast had been occupied by urban especially three places of Phuket tourism areas and East-coast occupied by urban at CBD.

Focusing on the tourism areas, researchers found the urbanization growth in Patong, Kamala and Karon in which the used methodology allowed us to clearly show the patterns of urbanization in Phuket tourism areas over the past 42 years. In 1967, Phuket Island was relatively naturally abundant with few developed areas. By 1967 to 1975, Patong, Kamala and Karon areas had been occupied by a few urban-lands whereas 10 years later, Patong and Karon have urban growth more than Kamala.

In 2000, the following period of rapid urban land expansion occurred through the conversion of other land such as agriculture, forest, grassland and farm areas (non-urban group) to tourism developed areas. Increasing of urbanization in Patong, Kamala and Karon due to the expansion of the tourism industry was closely correlated with the increase in the number of tourists, corresponding to the report of Tourism Authority of Thailand which numbers hotels in Southern part to be more than the rest of the regions 25% (TAT, 2009).

CONCLUSION

The results of this study therefore not only provide sufficient information on the urban growth in three places of Phuket tourism areas since 1967 to 2009 but also provide quantitative information about urban change by simple geographical from freely available Software R Program. For example, the analysis revealed urbanization associated with the urban development of Phuket Island. The rapid development of tourism industry resulted in increase in other land-use areas by becoming urban areas located mainly to the coast and up-land area of the tourism areas of Phuket Island. Applied geographical of remote sensing by grid-digitized is a valuable method for studying urbanization. However, the limitation of the methodology was derived based on comparisons of thematic maps only land-use data from shape-files was used. Future studies need to focus on using other land-use data such as characteristic of soil or the land-use price which information is also valuable to planners and developer.

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