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

1Orawit Thinnukool, 2Noodchanath Kongchouy, 3Channein Choonpradub and 3Cornelia Appianing
1College of Arts, Media and Technology, Chiang Mai University, Muang, 50200 Chiang Mai, Thailand
2Department of Mathematics and Statistics, Faculty of Science,
Prince of Songkla University, Hat Yai Campus, Hat Yai, Thailand
3Department of Mathematics and Computer Science, Faculty of Science and Technology,
Prince of Songkla University, Pattani Campus, Thailand

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 affected

Corresponding Author: Orawit Thinnukool, College of Arts, Media and Technology, Chiang Mai University, Muang,
50200 Chiang Mai, Thailand
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 Assencov, 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°53N and longitude 98°24E. 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 m² 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 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 (Thinnakool 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 10x10 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. 1: Phuket Island map body](image)
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
### Table

<table>
<thead>
<tr>
<th>Land-use group type</th>
<th>Type/land-use code</th>
<th>Define land-use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>[A1XX] Rice farm</td>
<td>A1XX Temporarily farm</td>
</tr>
<tr>
<td></td>
<td>[A2XX] Field crop</td>
<td>A2XX Farm house</td>
</tr>
<tr>
<td></td>
<td>[A3XX] Forestry</td>
<td>A3XX Aquatic plan</td>
</tr>
<tr>
<td></td>
<td>[A4XX] Orchard</td>
<td>A4XX Aquacultural land</td>
</tr>
<tr>
<td></td>
<td>[A5XX] Agriculture</td>
<td>A5XX Integrated farm</td>
</tr>
<tr>
<td>Forest</td>
<td>[F1XX] Evergreen</td>
<td>F1XX Swamp</td>
</tr>
<tr>
<td></td>
<td>[F2XX] Deciduous</td>
<td>F2XX Plantation</td>
</tr>
<tr>
<td></td>
<td>[F3XX] Mangrove</td>
<td>F3XX Agro forestry</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>The characteristic of forest such as disturbed or dense</strong></td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>[M1XX] Rangeland</td>
<td>M1XX Mine</td>
</tr>
<tr>
<td></td>
<td>[M2XX] Marsh</td>
<td>M2XX Other</td>
</tr>
<tr>
<td>Urban</td>
<td>[U1XX] City-town</td>
<td>U1XX Utility</td>
</tr>
<tr>
<td></td>
<td>[U2XX] Allocated land</td>
<td>U2XX Industrial land</td>
</tr>
<tr>
<td></td>
<td>[U3XX] Institutional</td>
<td>U3XX Other</td>
</tr>
<tr>
<td>Water body</td>
<td>[W1XX] Natural water</td>
<td>W1XX Reservoir</td>
</tr>
</tbody>
</table>

### Fig. 4

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

### RESULTS

This study takes Phuket Island as the research area and as convert it's map to square kilometer with 11000 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 bubble 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 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.
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 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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