Evaluating Nature Tourism Destination Potentiality in Samosir Regency using Remote Sensing and GIS

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Abstract. Samosir regency is one of the national tourism destinations that has many tourist attractions for both domestic and foreign tourists. The management of sustainable tourism destination requires inventory of tourism assets. Inventory of tourism assets can be determined through natural resources condition in tourism area. Land cover monitoring become useful information to determine natural resources condition in tourism area. Remote sensing technology can be used to monitor land cover changes quickly, accurately and effectively. This research uses a method of digital land cover classification with object-based image analysis (OBIA) approach, because this method effectively used in high resolution image with true colour (RGB). The overall accuracy value obtained from land cover classification using the OBIA approach is 75.4%. This study aims to analyze the potential of tourist attractions using land cover data as the determinants of physical characteristics besides tourist attractions in addition to attractions accessibility and facilities. Determination of tourism potential is obtained by looking at the relationship between the tourism site physical characteristics with the attraction of a tourist object then categorized using the scoring method. The result of multiple regression analysis obtained by correlation coefficient is $R = 0.832$, which means there is relationship between facility variable, land cover, and accessibility to the number of visitors in Samosir regency. Tourist attraction potential of Samosir regency is divided into three that is high, middle and low potential tourist attraction. The level of potential tourism object categories is expected to be used in the development of tourism planning in Samosir District to become a sustainable tourism destination.

1. Introduction

Indonesia has enormous natural resources which has been explored as nature tourism destination resulting tourism sector become important component of national economy. In order to develop a sustainable tourism management, social and environment factor need to be considered together with economic factor. Based on Ministry of Tourism decree No. 14:2016 reference sustainable tourism destination, tourism development is based on natural and cultural diversity, uniqueness and characteristics without neglecting future needs so that it can support national economy growth that
lead to community prosperity. Sustainable tourism destination management, economic utilization for local community, culture preservation for both local community and tourist, and environmental conservation are needed in tourism destination development.

Tourism as the most important sector in Indonesia stays between agriculture and fishery. One of government program in tourism development is comprehensive development of Toba Lake (Kawasan Danau Toba or KDT). This programme gave positive impact especially for Samosir Regency. Samosir regency’s Own-sourced Revenue (OSR) growth in 2017 is 81% in which tourism sector as leading sector.

This research evaluates nature tourism potentiality through tourism assets inventory of Samosir Regency. Based on Ministry of Tourism decree No. 14:2016, tourism assets inventory activity is one of activities needed in sustainable tourism destination. Beside natural resources as main factors in inventorying tourism assets, other resources such as local facilities and accessibility also need to be considered as support to the natural resource’s physical characteristic. Physical characteristics of tourism destinations are compared with tourism attraction through considering tourists number and origin in one tourism destination. Through process above categorization of nature tourism potentiality in Samosir regency were acquired.

Based on the ministry of tourism decree, inventory of tourism assets shall be conducted once a year to provide the most update condition. To support the need yearly updating of tourism assets inventory, a technology that provide update data is needed such as remote sensing. Remote sensing is an effective and low-cost technology compared to field survey in particular situation (Mumby and Harborne, 1999). Utilization of high-resolution image is needed in resources inventory. Since the most accessible remote sensing imagery in Indonesia has true colour format image, object-based classification considered to be more effective than pixel-based classification. Object-based Image Analysis (OBIA) enables problem evaluation through human perception and evaluation making based on criteria such as colour, shape, texture, environmental characteristic (real object captured in the imagery). Pixel-based classification determines information based on value of a pixel while object-based classification determines information based on a group of neighboring pixels called image object. Furthermore, object-based analysis is considered to be more reliable for high and very high-resolution imagery classification compared to pixel-based approach (Laliberte et.al., 2004; Yu et al., 2006). Besides remote sensing technology, GIS technology is needed to support spatial analysis so that every nature tourism object in Samosir Regency is identified comprehensively.

2. Research method

Research area consist of some area of Samosir Regency where tourism object is located as shown in Figure 1. This research utilized SPOT 7 imagery acquired from Indonesian National Aerospace Institution (LAPAN) recorded 20th July 2017. Table 1 lists spectral and spatial characteristics of SPOT7 imagery.

| Channel   | Wavelength | Spatial resolution |
|-----------|------------|--------------------|
| Panchromatic | 450 – 745 nm | 1.5 meters        |
| Blue      | 450 – 525 nm | 6 meters          |
| Green     | 530 – 590 nm | 6 meters          |
| Red       | 625 – 695 nm | 6 meters          |
Near Infrared  
760 – 890 nm  
6 meters

Source: Satellite Imaging Corporation, 2014

2.1. National resource inventory
This research applied object-based image analysis in order to extract land cover/use information as the method of natural resources inventory. SPOT 7 image was geometrically corrected based on Indonesian digital topographic map (Peta Rupabumi Indonesia) scale of 1:50,000 before being processed. OBIA then performed to the corrected image. OBIA consists of two main phases which are segmentation and object classification. Segmentation is process to produce object information (based on image) while classification to extract the land use/cover information. This research applied Fractal Net Evolution Approach (FNEA) for segmentation process. This process run based on 5 parameters which are scale, colour, shape, smoothness and compactness. Value of each parameter then decided based on land cover condition of the imagery. Figure 2 describes process of multi-stage classification approach.

2.2. Tourism object facility inventory
Tourism object facility inventory was done through field surveying on nature tourism destination. This field surveying activity applied purposive sampling as the method in determining sampling locations. Facility here refers to all facility that should be provided in every tourism destination to cover tourist need which consist of primary, secondary and conditional facility.

Primary facility is the main interest of tourism destination which consist of commercial and non-commercial facility. Secondary facility is non-main interest facility and service but own important
factor to fulfill tourists main need such as restaurants and hotel. Conditional facility is tourism infrastructure that determine the condition of a tourism activity such as toilet and parking lot.

2.3. Analysing characteristic of nature tourism destination

This research applied scoring as method in analysis characteristic of nature tourism destination. A score is assigned for every indicator such as land cover, accessibility and existing tourism facility that acquired from field surveying. Table 2 provides the classification and scoring used.

| Table 2. Land cover classification and scoring |
|-----------------------------------------------|
| Indicator                                      | Category | Classification                                                                 | Score |
| Land cover                                    | Land cover| Forrest (homogenous natural trees) has good vegetation condition and visual condition | 3     |
|                                               |          | Crops and agricultural land, has good vegetation condition, good visual quality, has varieties of vegetation | 2     |
|                                               |          | Bush, open land, resident area. It doesn’t have good vegetation condition and has high varieties of vegetation | 1     |
| Tata Guna Lahan                              | Maximum land use | Maximum land use | 3 |
|                                               |           | Enough land use | 2 |
|                                               |           | Land use is not maximum | 1 |
| Vegetation cover                             | Fully covered by vegetation | Fully covered by vegetation | 3 |
|                                               | Partially covered by vegetation | Partially covered by vegetation | 2 |
|                                               | Most of the area covered by building and or open land | Most of the area covered by building and or open land | 1 |
| Primary facility                             | Tourism direction | Complete | 3 |
|                                               | Entering ticket | Not complete | 2 |
|                                               | None | None | 1 |
| Secondary facility                           | Restaurant | Complete | 3 |
|                                               | Hotel | Not complete | 2 |
|                                               | None | None | 1 |
| Conditional facility                         | Toilet | Complete | 3 |
|                                               | Parking lot | Not complete | 2 |
|                                               | None | None | 1 |
| Indicator                  | Category | Classification          | Score |
|---------------------------|----------|-------------------------|-------|
| Number of Visitors        | High     | >30,000 visitor/year    | 3     |
|                           | Moderate | 10,000 – 30,000 visitor/year | 2     |
|                           | Low      | < 10,000 visitor/year   | 1     |

Source: statistical analysis, 2018

2.4. Analyzing tourism destination attraction

This process used quantitative descriptive method where a score is assigned in every class of visitor number and origin. Table 3 presents classification and scoring for number of visitors.

| Indicator                  | Category | Classification          | Score |
|---------------------------|----------|-------------------------|-------|
| Accessibility             | Road class | Collector | 3     |
|                           | Local     |            | 2     |
|                           | Other     |            | 1     |
| Public transportation     | Exist     |            | 3     |
|                           | Not exist |            | 1     |

Source: Maulana, 2013 with modification

2.5. Evaluating potentiality of nature tourism destination

Tourism assets potentiality was determined using spatial descriptive comparative analysis. It compared physical characteristic and attractiveness level of every tourism destination and used tourism destination as analyses unit. The relationship between physical characteristic of tourism destination (tourism attraction, accessibility, and land cover) and level of attraction (number of visitors) was determined using multiple regression statistical analysis. Potential tourism assets categorization was performed for every studied tourism destination.

3. Result and Discussion

3.1. Land cover interpretation of SPOT 7 Imagery using OBIA

This research performed OBIA for land cover information extraction. OBIA was applied partially in appointed locations of nature tourism destination. It resulted 75% accuracy land cover information determined by confusion matrix. Classification errors were resulted from segmentation error or miss classification of pixel due to limited channel provided specially for objects that have similar presence. These errors were reduced through contextual editing in the miss-classification segments. Generally, OBIA classification resulted good quality of information through automation process. It allowed classification process run faster compared to visual classification (on screen digitization)
3.2. Physical characteristic of nature tourism destination

Some text Nature tourism destination in Samosir Regency based on Regional Development Planning Institution (Bappeda) of Samosir Regency consist of 22 tourism destination out of 35 tourism destinations which categorized as exclusive, priority and in-development. This research focused only in 11 nature tourism destination. Some of the tourism destinations are categorized as exclusive and some of them are priority.

The development of tourism destination cannot be separated from infrastructure existence that play a big role in determining the category of a tourism destination. The term facility in this research covered all kind of support facilities that are needed to provide services so that tourist will be able to enjoy their visit.

3.2.1. Land Cover

Land cover information that have been resulted from remote sensing imagery analysis then being categorized in 3 classes; land cover type, land utilization and vegetation cover. Land cover information around a tourism destination is able to be another attraction that support main attraction and potential to be sustainable destination. Table 4 lists category of land cover in tourism destination.

| Tourism Destination | Land Cover                      | Land Utilization | Vegetation Cover                        |
|---------------------|--------------------------------|------------------|-----------------------------------------|
| Efrata Waterfall    | Plantation and agriculture area| Maximum          | Most of the area is covered by vegetation |
| Tele Tower          | Bush/grass, shrub, bare land and settlement area | Maximum          | Some of the area are covered by vegetation and some are built area |
| Batu Sawan          | Bush/grass, shrub, plantation   | Not maximum      | Most of the area is covered by vegetation |
| Aekrangat           | Bush/grass, shrub, bare land and settlement area | Maximum          | Some of the area are covered by vegetation and some are built area |
| Parbaba Beach       | Bush/grass, shrub, bare land, settlement area, plantation | Maximum          | Most of the area is built area          |
| Situngkir Beach     | Bush/grass, shrub, bare land, settlement area, plantation | Maximum          | Most of the area is built area          |
3.2.2. Primary, secondary and conditional facility of the Tourism destination

In Samosir Regency, primary facility which is the main object (main attraction) can be divided into primary facility with commercial and non-commercial tourist attraction. In addition, secondary facility is service and facility that although not the main attraction this facility is used to fulfill visitor’s needs. Secondary facilities that are considered in this research consist of two facilities, restaurant and hotel. The last category of tourism destination facilities called conditional. Conditional facility is tourism infrastructure that determine the condition of a tourism destination such as toilet and parking area. Generally, every tourism destination has these facilities, however some of the facilities are not in good condition (broken or unmaintained). Table 5 represents secondary and conditional facility existed in every tourism destination in Samosir Regency.

| Tourism destination | Primary Object sign | Primary Ticketing | Secondary Restaurant | Secondary Hotel | Conditional Toilet | Conditional Parking lot |
|---------------------|---------------------|-------------------|----------------------|-----------------|---------------------|-------------------------|
| Efrata Waterfall    | Exist               | Exist             | 1                    | 0               | Exist               | Exist                   |
| Tele Tower          | Exist               | Exist             | 1                    | 0               | Exist               | Exist                   |
| Batu Sawan          | Exist               | Exist             | >10                  | 2               | Exist               | Exist                   |
| Aekrangat           | Exist Not exist     |                   | >10                  | <5              | Exist               | Exist                   |
| Parbaba Beach       | Exist               | Exist             | >10                  | 5               | Exist               | Exist                   |
| Situngkir Beach     | Exist               | Exist             | <5                   | <5              | Exist               | Exist                   |
| Tandarabun Beach    | Exist Not exist     |                   | <5                   | 0               | Exist               | Exist                   |
| Batu Hoda Beach     | Exist Not exist     |                   | 1                    | 0               | Exist               | Exist                   |
| Sibolazi Beach      | Exist               | Not exist         | 0                    | 0               | Exist               | Exist                   |
| Pine Forrest        | 0                   | 0                 | 0                    | 0               | Exist               | Exist                   |

Source: Field survey, 2018

3.2.3. Accessibility

Accessibility variable consist of road class and availability of public transportation. Road class information was extracted from digital national topographic map (Rupabumi Indonesia map). The classes are collector road, local road, other road and foot path. There were three types of public
transportation to reach/go from tourism destination in Samosir Regency; AKAP, AKDP and traditional transportation called Becak Motor. Table 6 lists accessibility condition.

**Table 6. Accessibility condition in tourism destination of Samosir Province**

| Tourism Destination    | Road Class | Public Transportation |
|------------------------|------------|-----------------------|
|                        |            | AKAP and AKDP         |
|                        |            | Becak Motor           |
| Efrata Waterfall       | Other      | 0                     |
| Tele Tower             | Collector  | 44                    |
| Batu Sawan             | Foot path  | 0                     |
| Aekrangat              | Local      | 0                     |
| Parbaba Beach          | Collector  | 31                    |
| Situngkir Beach        | Collector  | 31                    |
| Tandarabun Beach       | Collector  | 31                    |
| Batu Hoda Beach        | Collector  | 31                    |
| Sibolazi Beach         | Collector  | 31                    |
| Pine Forrest           | Collector  | 44                    |

Source: data processing, 2018

Land cover, facility, and accessibility were categorized in three class (high, moderate and low) using scoring method. Table 7 presents the scoring result.

**Table 7. Characteristic level of tourism destination**

| Tourism Destination    | Scoring value | Total Score | Category |
|------------------------|---------------|-------------|----------|
|                        | Land cover    | Facility    | Accessibility |       |
|                        | A  B  C  D  F  G | H  I        |            |         |
| Efrata Waterfall       | 1  2  2  3  3  3 | 3  3 | 18 | Moderate |
| Tele Tower             | 1  2  1  3  3  3 | 3  3 | 19 | High     |
| Batu Sawan             | 1  2  1  3  3  3 | 3  3 | 19 | High     |
| Aekrangat              | 2  2  2  3  3  3 | 3  3 | 19 | High     |
| Parbaba Beach          | 2  1  2  2  3  3 | 3  3 | 18 | Moderate |
| Situngkir Beach        | 1  2  1  2  2  3 | 3  3 | 17 | Moderate |
| Tandarabun Beach       | 2  2  3  3  2  3 | 2  3 | 18 | Moderate |
| Batu Hoda Beach        | 2  1  3  3  2  3 | 1  1 | 16 | Low      |
| Sibolazi Beach         | 1  2  1  2  3  3 | 2  1 | 15 | Low      |
| Pine Forrest           | 2  1  2  3  1  3 | 3  2 | 17 | Moderate |

Source: data processing, 2018

**Indicator Note:**

A. Land cover  E. Secondary facility
B. Land use     F. Conditional facility
C. Vegetation cover H. Road class
D. Primary facility I. Public transportation
3.3. **Relationship between attractiveness level and physical characteristic of tourism destination**

Attractiveness level of a tourism destination can be determined by considering the number of visitors which depend on the physical characteristic of a tourism destination itself. Physical characteristic of tourism destination describes every tourism destination condition. To understand if there is relationship between attractiveness level and physical characteristic of a tourism destination this research used multi-regression analysis.

Analysis resulted correlation coefficient $R=0.832$ which mean there was relationship between facility, land cover, accessibility and the number of visitors of tourism destinations in Samosir Regency. The results showed determination value ($R^2$) of 6.92 which mean the variables have 69.2% influence to the number of visitors and 30.8% influenced by other factors that is not considered in this research.

3.4. **Evaluation of nature tourism destination potentiality**

Development of tourism destination in Samosir Regency need to be analysed based on asset that is owned by every tourism destination. Tourism destination asset were determined by categorizing on potentiality owned by every tourism destination. This research categorized tourism destination potentiality using scoring methodology. Table 8 presents scoring result for tourism facility, accessibility and number of visitors in every tourism destination.

**Table 8. Categorization of nature tourism destination potentiality in Samosir Regency**

| Tourism Destination | Physical Characteristic | Tourism Destination Attraction | Potentiality Of Tourism Destination |
|---------------------|------------------------|-------------------------------|------------------------------------|
| Efrata Waterfall    | Moderate               | 46.742                        | Tinggi                             |
|                     |                        |                               | High                               |
| Tele Tower          | High                   | 33.881                        | Tinggi                             |
|                     |                        |                               | High                               |
| Batu Sawan          | High                   | 4.444                         | Low                                |
|                     |                        |                               | Moderate                           |
| Aekrangat           | High                   | 5.235                         | Low                                |
|                     |                        |                               | Moderate                           |
| Parbaba Beach       | Moderate               | 5.235                         | Low                                |
|                     |                        |                               | Moderate                           |
| Situngkiri Beach    | Moderate               | 4.444                         | Low                                |
|                     |                        |                               | Low                                |
| Tandarabun Beach    | Moderate               | 10.243                        | Moderate                           |
|                     |                        |                               | Moderate                           |
| Batu Hoda Beach     | Low                    | 10.725                        | Moderate                           |
|                     |                        |                               | Low                                |
| Sibolazi Beach      | Low                    | 19.872                        | Moderate                           |
|                     |                        |                               | Low                                |
| Pine Forrest        | Moderate               | 2.000                         | Low                                |

Source: Data analysis, 2018
4. Conclusion
Land cover classification using OBIA was effective to be applied for true colour composite of high-resolution remote sensing imagery. Classification resulted accuracy of 75.4%. To support sustainable tourism activity development tourism asset inventory shall be done at least once a year. Since OBIA is effective to map land cover, this method can be applied to support sustainable tourism activity development especially in inventorying tourism asset. Attractiveness of a tourism destination that can be determined by the number of visitors has correlation of 83.2% with its physical characteristic (land cover, tourism facility and accessibility). The facility in a tourism destination and the accessibility serve 69.2% influence to the number of visitors.

Tourism destinations based on potentiality category are divided into 3 classes. Tourism destination categorized as high potentiality are Tele Tower and Paraba Beach. Situngkir Beach, Batu Hoda Beach, Sibolazi Beach and Efrrata Waterfall are categorized as moderate potential tourism destination while Tandarabun Beach, Batu Sawan, Aekrangat and Pine Forrest are categorized as low potential tourism destination. These categorizations can be considered in sustainable tourism destination development planning.

In summarize, OBIA land cover mapping method can be applied as a tool to support not only in sustainable tourism development but also in any other spatial analysis purpose. Based on the result, the approach applied in this research are potential approach to empowered local government in monitoring tourism assets development efficiently since the approach applied automation and utilize free source of remote sending imagery.
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