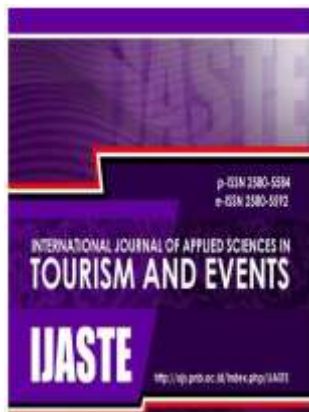


# Utilization of Remote Sensing Technology and Geographic Information Systems for Tourism Development

Riki Ridwana<sup>1</sup>, Shafira Himayah<sup>2</sup>

Geography Information Science Study Program, Department of Geography Education, Faculty of Social Science Education, Universitas Pendidikan Indonesia, Indonesia<sup>1,2</sup>

[rikiridwana@upi.edu](mailto:rikiridwana@upi.edu)<sup>1</sup>, [shafirahimayah@upi.edu](mailto:shafirahimayah@upi.edu)<sup>2</sup>



## Abstract

**Purpose:** This article is to analyze one of the most effective and efficient ways in utilizing remote sensing technology and geographic information systems (GIS) for tourism development.

**Research methods:** This article was created to archive and review some of the findings of the use of remote sensing technology and GIS for tourism management and development, using the literature review method.

**Results and discussions:** The use of remote sensing technology and GIS for tourism development and management has been widely used by various academics and researchers in various countries in the world including in Indonesia. This is acceptable because it is considered effective and efficient, the suitability of tourism development studies, for the study of tourism multimedia development, identification of the most desirable tourist areas, and for the evaluation of ecotourism areas.

**Conclusion:** Following up on the findings and explanations above, further research can take advantage of remote sensing technology and geographic information systems in tourism development and management.

**Keywords:** *Remote sensing, geographic information systems, tourism development*

## Article History

Received on August, 19<sup>th</sup> 2020

Revised on December, 2<sup>nd</sup> 2020

Accepted on December, 26<sup>th</sup> 2020

## INTRODUCTION

Tourism in its development has become the largest industry in generating foreign exchange in various countries (Ridwana et al., 2018). In Indonesia based on Law Number 10 of 2009 tourism is an integral part of national development that is carried out systematically, planned, integrated, sustainable, and responsibly while providing protection for religious values, culture that lives in the community, sustainability and quality the environment, and national interests (Sulaiman et al., 2017). The success of tourism in any country depends on the country's ability to develop, manage and market the tourism facilities and activities of its (Bualhamam, 2009).

Tourism development and management can be done in various ways. One of the most effective and efficient ways is to utilize remote sensing technology and geographic information systems. The development of this technology can provide convenience for the acquisition of data that is actual, with fast and efficient than with terrestrial surveys. That is because the development of remote sensing technology allows the collection of geographical data through images (Hamuna et al., 2018). Current image data can be obtained freely through various unpaid providers such as on the NASA website (Boori & Komal Choudhary, 2015). Various image processing techniques are applied to obtain better results (Ridwana dkk., 2019). The difference in approach to obtaining information from remote sensing images is termed hybrid interpretation, a combination of visual interpretation techniques (based on spatial characteristics of objects) and digital processing according to the spectral characteristics of objects (Himayah dkk., 2020). By definition remote sensing is the science, technology, arts to obtain information about the object, the region, and the symptoms that exist on the surface of the Earth by analyzing the image obtained by the sensor and a electromagnetics wave without direct contact with object being studied (Yanti et al., 2020). More details can be seen in Figure 1 below.

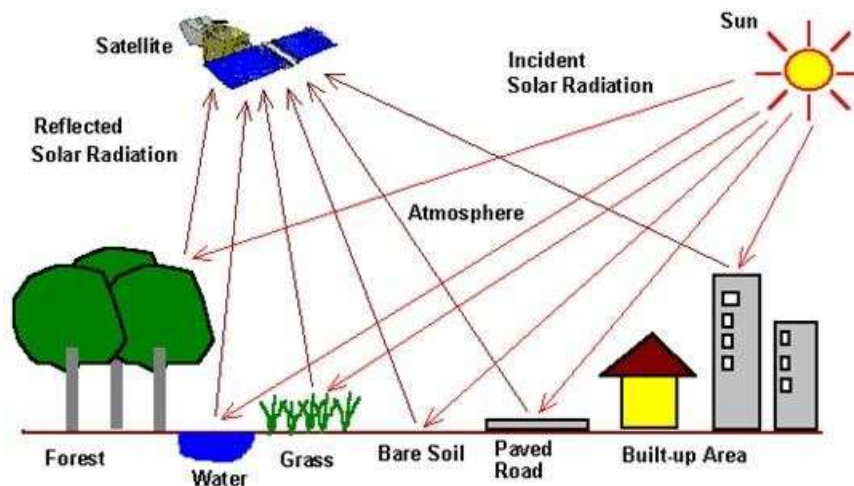


Figure 1. Remote Sensing System  
(Source: Sutanto, 1994)

Geographic information system in the present has been widely recognized as a *tool* that is very useful for managing, analyzing, and displaying large amounts of diverse data related to a lot of the planning and management of both scale workshops I and regionally. Its use in environmental management is greatly increasing. Tourism itself is an activity that is highly dependent on environmental resources. So that if the tourism activity ignores planning and management it will likely erode its environmental base. Therefore, the strength of the planning of tourism can be enhanced with the application of geographic information system for the achievement of the development of sustainable tourism (Pareta, 2013).

The presence of remote sensing technology and geographic information systems provides enlightenment for the ease of planning and managing tourism. Information about objects located at a location on the surface of the earth is taken using satellite or aerospace sensors. Then according to the targeted objectives, information on the object is processed, interpreted, dian a lysis, and presented in the form of spatial information and thematic maps related to tourism using geographic information system (Shalihati, 2014).

Various countries in the world, including in Indonesia, the use of remote sensing technology and geographic information systems for tourism management has been done by many university academics and researchers working in the field of geospatial information and tourism development. Based on that, it is very necessary to archive the findings of the studies that have been carried out, with expectations so that later it is easy to apply them. This

scientific article was created to archive and review some of the findings of the use of remote sensing technology and geographic information systems for tourism management.

## RESEARCH METHODS

This scientific paper was made using the method of tuning literature. Literature review is a translation in the form of descriptions in the form of critical studies in the discussion of themes that have been written by experts in certain fields (Shalihati, 2014). The theme of the study chosen in this scientific article is the study of remote sensing technology and geographic information systems that have been effectively utilized for tourism management. The data was obtained from various scientific journals, proceedings, and literature books.

## RESULT AND DISCUSSIONS

### Remote Sensing and Geographic Information Systems for Suitability of Tourism Development

The criteria for determining the location most suitable for tourism development derived from pengharkatan and estab weight of an every parameter consisting of topography, soils, geology, hydrology, environment, land use, land cover, and infrastructure. Suitability of tourism development is analyzed through the *model builder* developed in ArcGIS application that can be seen in figure 2.

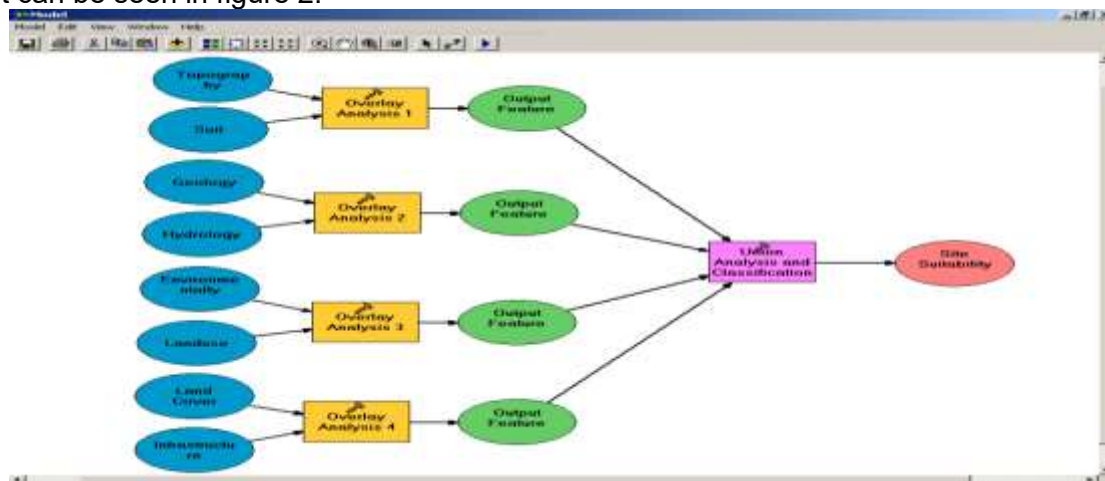


Figure 2. *Model Builder* Conformity Tourism Development Area  
(Source: Pareta, 2013)

Each parameter produces a thematic map which is then overlapped and analyzed produces a map of land suitability for tourism. The final suitability map can be seen in Figure 3, where the map is displayed in gradations of red to green. Areas indicated by green symbols represent the most suitable locations for tourism development. Whereas the area designated with the red symbol is the location with the lowest suitability level. The most suitable area is an area that has an aggregate score close to 10. In addition to seeing the area of the area suitable for tourism development can be seen in Table 1.

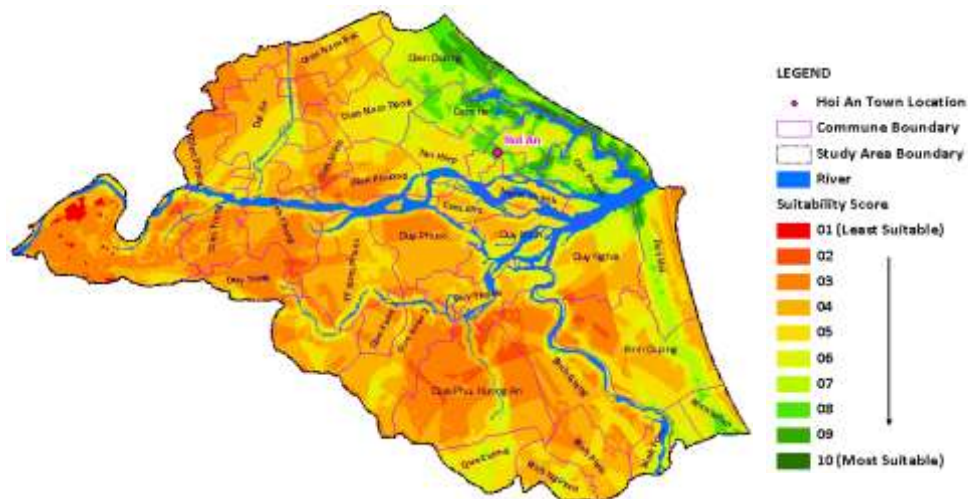
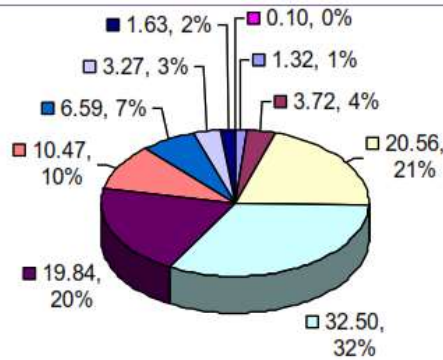


Figure 3. Land Suitability Map for Tourism Development in Hoi An, Vietnam (Source: Pareta, 2013)

Table 1. Table of Area of Conformity of Tourism Development Land

S. No.	Suitability Classes	Area	
		(In Sq Kms)	(In %)
1.	Class - 1	04.83	01.32
2.	Class - 2	13.56	03.72
3.	Class - 3	74.95	20.56
4.	Class - 4	118.50	32.50
5.	Class - 5	72.33	19.84
6.	Class - 6	38.18	10.47
7.	Class - 7	24.01	06.59
8.	Class - 8	11.93	03.27
9.	Class - 9	05.95	01.63
10.	Class - 10	00.36	00.10
TOTAL		364.59	100.00



The same thing has also been studied in Central Java to determine the potential location of astronomical tourism in the Province of Central Java, Indonesia. The distribution of potential locations for the development of astronomical tourism is shown in Figure 4. The yellow area indicates the potential area and is recommended for the development of astronomical tourism. The red area is a potential area for astronomical tourism but is not included in the recommendations. This is because the accessibility to the location is not within < 3 km of the collector or artery road. Both potential and potential areas and recommended are widely available and clustered in the southeast and northeastern areas of the study area. In the northeastern part, most areas are covered in Blora, Grobogan, Rembang, and Pati districts. In the southeast, many of these potential areas are on the southern coast of Gunungkidul district and part of the Karanganyar Wonogiri district. Some other potential areas have a narrower size and have a non-grouped distribution pattern.

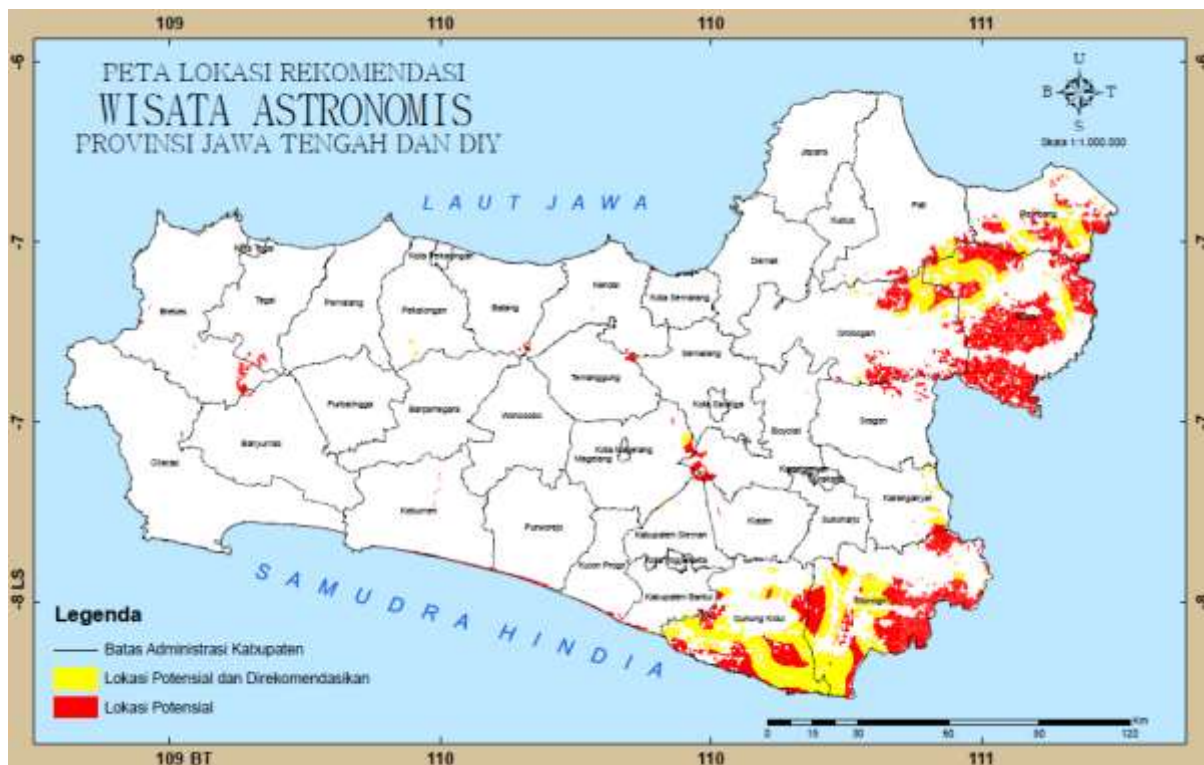


Figure 4. Distribution of Astronomical Tourism Maps  
(Source: Afrizal dkk., 2016)

There is a significant difference between potential locations and non-potential locations. The difference is seen from the appearance of the night sky where the potential location of astronomical objects is easy to observe. Dark environmental conditions so that light pollution is very minimal. The condition of the night sky at the site has no potential for environmental conditions with high artificial lighting/electricity so that the night sky does not look dark which results in unclear astronomical appearance (Afrizal dkk., 2016).

### Remote Sensing and Geographic Information Systems for Tourism Multimedia Development

Existing competition in the tourism industry requires new and innovative strategies to present the tourism area. To reach the intended tourist target group, it is very important to prepare information in the geo-multimedia information system and to display it in different digital media. The implementation of geo-multimedia information systems in the tourism area requires close cooperation with various parties within the framework of the concept of work created over the years.

The basic elements to complete the system in the development of this project can be seen in Figure 4 below. The development of related thematic and geographical data is integrated in a database of interactive multimedia information systems and can be obtained through online and offline with a variety of tourism information in digital media. The system will be integrated with satellite imagery, GPS (Global Positioning System) data, geographic information systems, terrestrial data, and also integrated with tourism information offered through multimedia, 2-dimensional data, 3-dimensional visualization technology, and interactive navigation. Tourism information that is developed based on location and provides tourism area information that can be accessed via the internet, on CD-ROMs, and also mobile devices, can increase tourist interest.

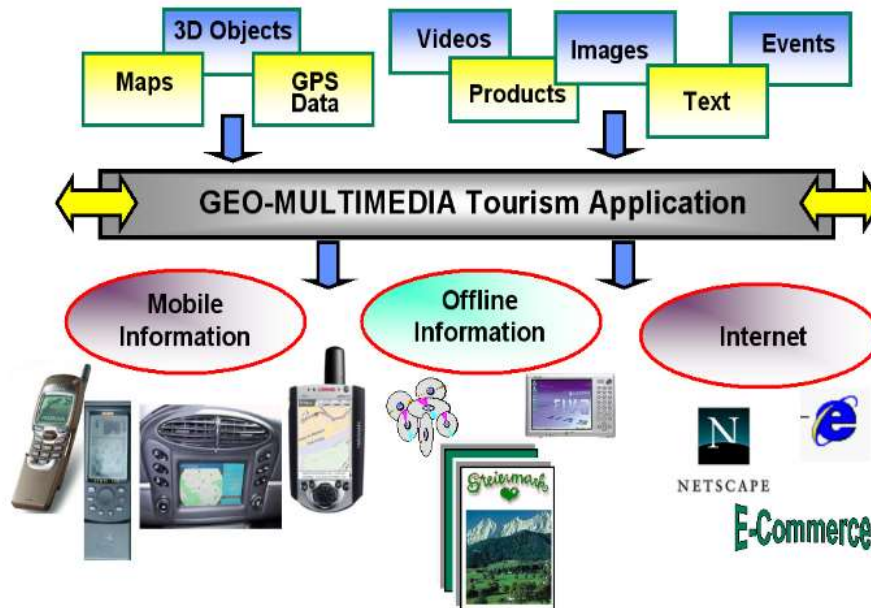


Figure 4. Tourism Geo-Multimedia Application  
(Source: Almer & Stelzl, 2002)

In general, the display of results from geographic data processing and thematic tourism data can be seen in Figure 5 below. Display that can be obtained through the internet and CD-ROM is a multimedia tourist guide in the Dachstein Tauern region. To display 3-dimensional visualization, virtual panoramas, and digital photographs use remote sensing satellite imagery. The digital travel guide contains the latest information on infrastructure, geographical position, sports and events, as well as complete information related to accommodation that is equipped with photos of the building.

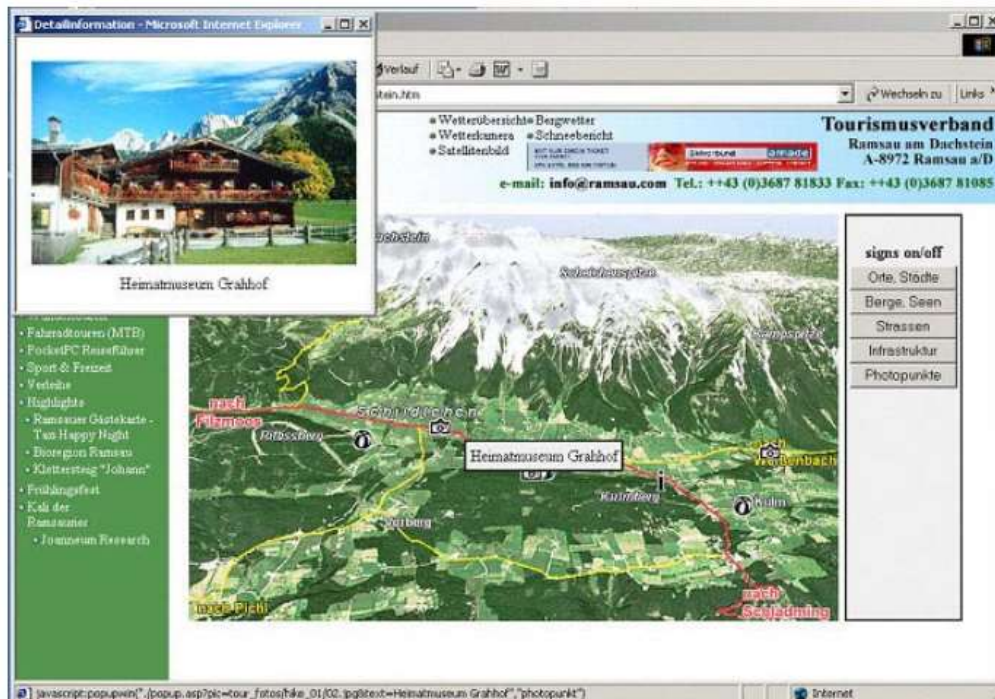


Figure 5. Display 3 Dimensions of Tourism Infrastructure  
(Source: Almer & Stelzl, 2002)

Multimedia visualization for travel information, images, sound, text, and video elements have been integrated in PDAs that have been recorded through mobile devices. Furthermore, cartographic illustrations regarding tourist locations and surroundings are also available, can be seen in Figure 6 below. Users can move on the map to see different areas. The location point that is clicked on the map demonstrates the available multimedia information, including descriptions in the form of text, audio and a short video.



Figure 6. Travel information in the iPAQ application  
(Source: Almer & Stelzl, 2002)

### **Remote Sensing and Geographic Information Systems for the Identification of Tourist Areas of Interest**

Twitter provides voluntary geographical information that can be accessed geographically and can be accessed freely. This study shows that tweets have great potential to map tourist areas even in remote areas and areas that lack data. OSM (Open Street Map) data is freely available and night light data from remote sensing helps in enriching the process of finding TAOI (tourism areas of interest). In this study, geo-tagged tweets are collected and cleaned, and then apply grouping to get the spatial distribution of social media clusters. Furthermore, tourism-related clusters are distinguished from normal clusters by exploring different Twitter metadata along with OSM and NTL (nighttime light) data. The final list of selected TAOI is not only popular among travelers, but also ensures the availability of important related tourism infrastructure in the vicinity. The proposed framework was examined in two different district districts in Nepal with satisfactory results. This framework not only identifies popular TAOI but also helps in finding key tourist locations in the neighborhood. Figure 7 shows Lakeside, part of the city of Pokhara, which is the most popular tourist area in the Kaski district.

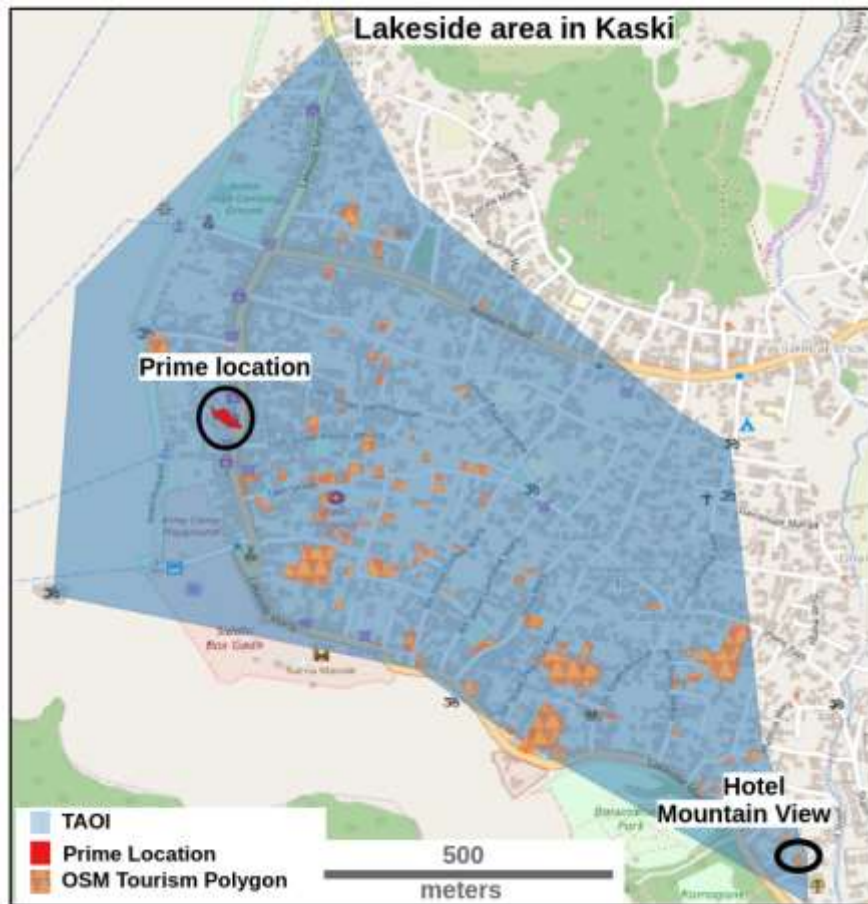


Figure 7. Lakeside Areas as Important TAOI in Kaski with Main Locations  
(Source: Devkota et al., 2019)

The proposed analytical framework will enhance current tourism studies in several directions. First, by finding interesting tourist areas in remote areas that lack data by conducting fusion of free social media data and other free data sources such as OSM and NTL. Second, by devising a method for estimating the value of clustering parameters that can be applied in a variety of scarce data areas. Third, by ensuring the availability of minimum essential facilities recommended by tourist sites. In addition, useful guidelines are determined to identify unclear alternatives from the main tourist sites. Most importantly, the approach outlined in this paper presents a methodological novel that was not previously used in tourist studies.

For example, figure 8 shows the newly emerging tourist relations in the Kaski district. The spots that lie along the shores of Lake Phewa, were once non-tourist. The proposed framework was successful in finding newly formed tourist sites, although most of the data used was relatively long. Therefore, an in-depth investigation of the positive results generated by this system can provide more insight. For example, the presence of foreign tweets in non-tourist areas might signify tourist attractions that appear.



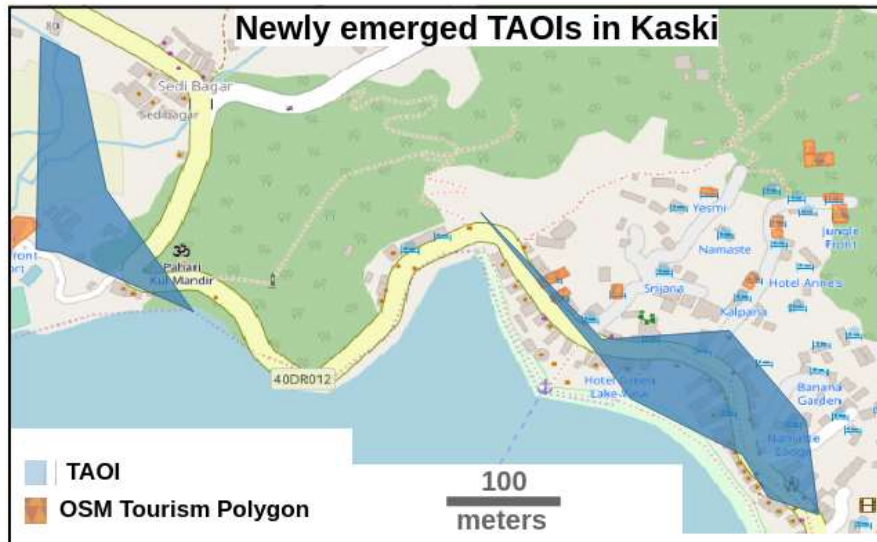


Figure 8. New TAOI that Appears in Kaski  
(Source: Devkota et al., 2019)

The proposed approach examines TAOI findings from social media groups that are located mainly in areas that are built (or well-lit areas). Some TAOI with little media attention or located in areas that are not built (or not lit) can be discarded. A simple way to include these areas in the final selection is to decrease the threshold value.

### Remote Sensing and Geographic Information Systems for Ecotourism Evaluation

Ecotourism is currently the fastest growing segment in the world in terms of tourism. People want to enjoy the world but they must try to do it in a way that does not negatively affect the environment. As such, many conservative programs are followed by countries that mainly receive tourism benefits. Let's say Turkey, the Ministry of Culture and Tourism determine that the Black Sea is an area that will be developed primarily on biodiversity and ecotourism targeted in 2023.

This article aims to determine the most suitable ES in the Black Sea region of Turkey. Thus, a four-step scientific solution approach was developed to determine ES. First, 14 indicators are determined for site selection (figure 9), then these indicators are entered into GIS. Then the criteria are prioritized by AHP and finally, potential sites are ranked using PROMETHEE. When we look at the site selection indicators, it appears that the factor that has the highest priority is "vegetation diversity" and the lowest priority is "temperature". This means that tourists can visit ecotourism sites regardless of temperature and weather, but they are very interested in the diversity of vegetation which means that they wish to see various types of plants. On the other hand, while "land use" has the highest importance, the lowest level is the "climate" dimension.

One limitation of research; the level of importance is determined by local tourism experts and they are determined primarily for this field. But any research can be done with the same technique. As a result of this study, west of Sinop, east of Artvin was determined as a very suitable location for ecotourism among 27 alternatives (figure 10).

On the other hand, the central regions of Trabzon and Rize are determined as inappropriate locations. Both Sinop and Artvin are small cities that have waterfalls, natural parks, wildlife ecology, and rural tourism. Although this area has more than enough resources for ecotourism, there are factors that hinder its progress, namely ineffective publication or lack of investment. Another important issue is the carrying capacity of the economy or ecology for tourism locations.

Thus, monitoring tourist behavior, marketing strategies and management objectives seems to be a suitable area for planning to become an eco tourism city. The results of this paper can be useful for ecotourism planning because the government invests heavily in tourism even though they have scarce resources. Further research can be conducted to

determine the optimal location for various types of tourism such as "religious tourism, hunting tourism, golf tourism, and others".

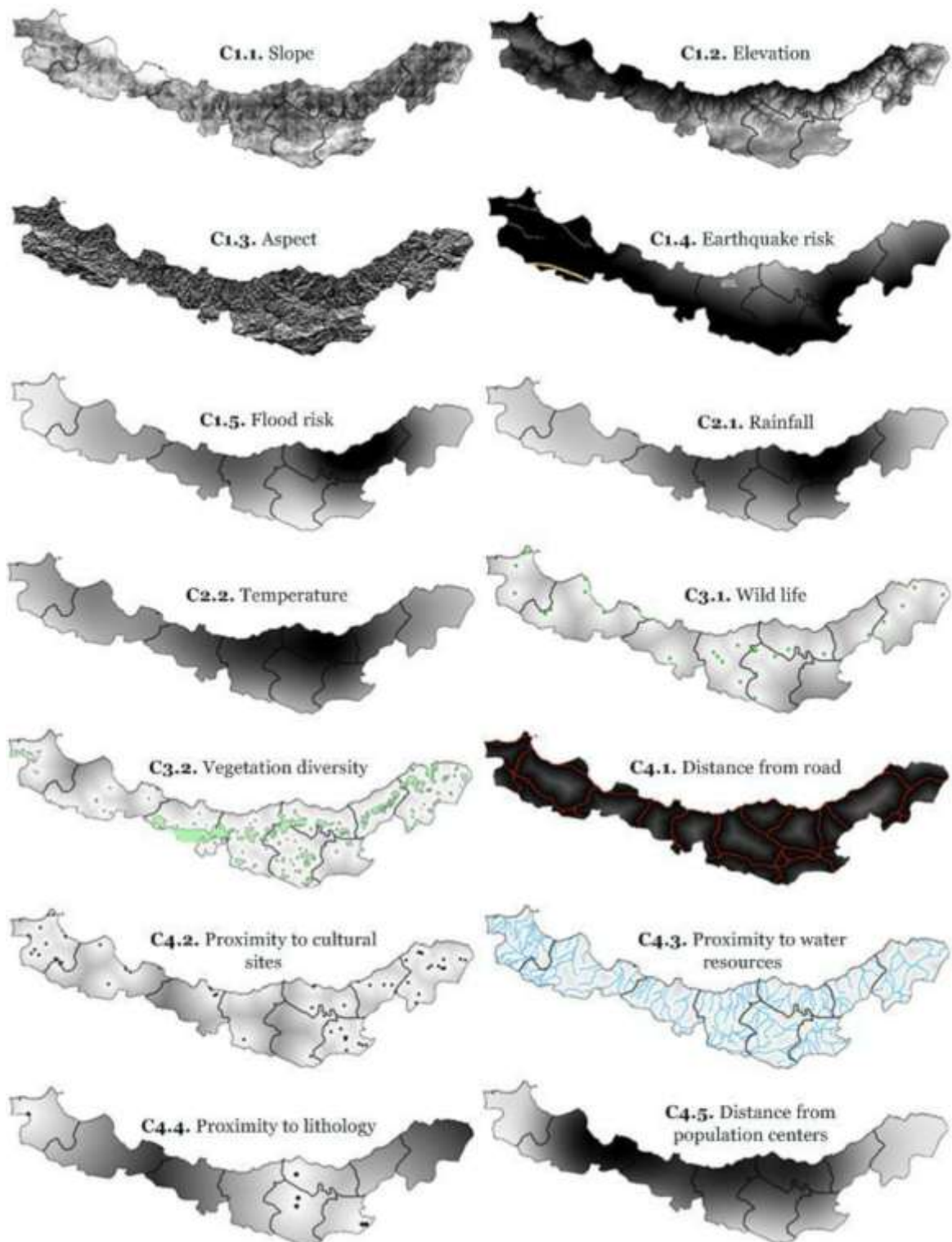


Figure 9. Evaluation of Ecotourism Sites  
(Source: Çetinkaya et al., 2018)

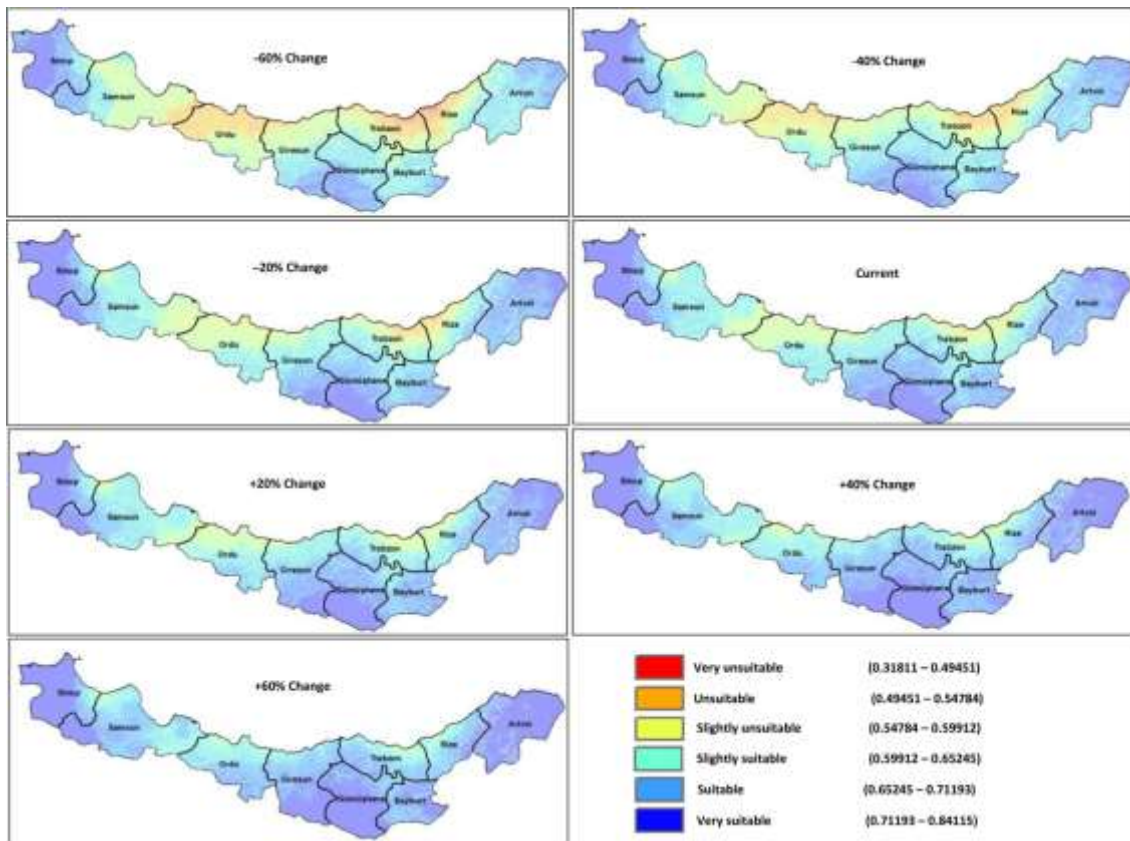


Figure 10. Conformity Map of Ecotourism Areas  
(Source: Çetinkaya et al., 2018)

## CONCLUSION

The use of remote sensing technology and geographic information systems for tourism development and management has been widely used by various academics and researchers in various countries in the world including in Indonesia. This is acceptable because it is considered effective and efficient. As is the case for the suitability of tourism development studies, for the study of tourism multimedia development, for identification of the most desirable tourist areas, and for the evaluation of ecotourism areas.

Following up on the findings and explanations above, further research can take advantage of remote sensing technology and geographic information systems in tourism development and management. Starting from obtaining tourism data, processing, and analyzing data to produce geospatial information.

## REFERENCES

- Afrizal, M. D., Prasetya, R., Yusuf, F. R., Nurbandi, W., & Kamal, M. (2016). *Pemanfaatan Citra VIIRS dan Analisis Spasial untuk Penentuan Lokasi Potensial Pengembangan Wisata Astronomis*. Seminar Nasional Penginderaan Jauh, Yogyakarta.
- Almer, A., & Stelzl, H. (2002). Multimedia Visualisation of Geoinformation for Tourism Regions Based on Remote Sensing Data.pdf. *Symposium on Geospatial Theory, Processing and Applications*.
- Boori, M., & Komal Choudhary. (2015). Land use/cover disturbance due to tourism in Jeseníky Mountain, Czech Republic: A remote sensing and GIS based approach. *Elsevier B.V. on behalf of National Authority for Remote Sensing and Space Sciences*, 18, 17–26. <https://doi.org/10.1016/j.ejrs.2014.12.002>
- Bualhamam, M. R. (2009). The study of urban growth impact in tourism area using remote sensing and GIS technique for north part of the UAE. *Journal of Geography and Regional Planning*, 6(2), 166–175.

- Çetinkaya, C., Kabak, M., Erbas, M., & Özceylan, E. (2018). Evaluation of ecotourism sites a GIS-based multi criteria decision analysis. *Emerald Publishing Limited*, 47(8), 1664–1686. <https://doi.org/10.1108/K-10-2017-0392>
- Devkota, B., Miyazaki, H., Witayangkurn, A., & Kim, S. M. (2019). Using Volunteered Geographic Information and Nighttime Light Remote Sensing Data to Identify Tourism Areas of Interest. *Sustainability*, 1–29. <https://doi.org/10.3390/su11174718>
- Hamuna, B., Sari, A. N., & Megawati, R. (2018). Kondisi hutan mangrove di Kawasan Taman Wisata Alam Teluk Youtefa, Kota Jayapura. *Majalah Ilmiah Biologi Biosfera: A Scientific Journal*, 35(2), 75–83.
- Himayah, S., Ridwana, R., & Ismail, A. (2020). Land surface temperature analysis based on land cover variations using satellite imagery. *IOP Conference Series: Earth and Environmental Science*, 500, 012019. <https://doi.org/10.1088/1755-1315/500/1/012019>
- Pareta, K. (2013). Remote Sensing And Gis Based Site Suitability Analysis For Tourism Development. *International Journal of Advanced Research in Engineering and Applied Sciences*, 2(5), 43–58.
- Ridwana, R., Danoedoro, P., Herumurti, S., Himayah, S., Ihsan, M., Arrasyid, R., & Urfan, F. (2019). Linear Spectral Mixture Analysis Land Cover for Assessment Level Subpixel: A Case Study of Tasikmalaya City Area Based on Landsat Imagery. *IOP Conference Series: Earth and Environmental Science*, 286, 012042. <https://doi.org/10.1088/1755-1315/286/1/012042>
- Ridwana, R., Maryani, E., & Nandi. (2018). Pengembangan Kawasan Situ Gede sebagai Objek Wisata Andalan Kota Tasikmalaya. *Jurnal Geografi Gea*, 18(2), 135–146. <https://doi.org/10.17509/gea.v18i2.11735>
- Shalihati, S. F. (2014). Pemanfaatan Penginderaan Jauh dan Sistem Informasi Geografi dalam Pembangunan Sektor Kelautan serta Pengembangan Sistem Pertahanan Negara Maritim. *Geoedukasi*, III(2), 115–126.
- Sulaiman, A., Irwan, I., & Pabiban, D. (2017). Kajian Obyek Wisata Kota Kupang Berdasarkan Data Penginderaan Jauh Dan Sistem Informasi Geografis. *JURNAL ELTEK*, 11(2), 128–140.
- Sutanto. (1994). *Penginderaan Jauh Jilid I*. Gadjah Mada University Press.
- Yanti, D., Megantara, I., Akbar, M., Meiwanda, S., Izzul, S., Sugandi, D., & Ridwana, R. (2020). Analisis Kerapatan Vegetasi di Kecamatan Pangandaran Melalui Citra Landsat 8. *Jurnal Geografi, Edukasi dan Lingkungan (JGEL)*, 4(1), 32–38. <https://doi.org/10.29405/jgel.v4i1.4229>