Land Conversion Analysis in Buleleng District, Bali: An Outlook for Sustainable Tourism Development

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Abstract. Buleleng District, Buleleng Regency, Bali is one of the main tourism destinations that offer various types of tourism activities. This region is also included in one of the National Tourism Strategic Areas which will intensify tourism activities and induce land conversion from non-built-up to built-up area to satisfy tourism sector demands. Departing from that background, this paper aims to analyze the land conversion that happens and study the impacts as the foundation in contextualizing sustainable tourism management to this case. For the land conversion analysis, Sentinel-2 satellite imageries capturing 2017 and 2022 images are used and the classification is done using the Semi-Automatic Classification Plugin in QGIS. As a result, satellite imageries show that there was land conversion happening with Banyusari, Beratan, and Ligundi Villages having the highest land conversion proportion. Land conversion impacts tourists’ thermal comfort and disrupts food security as many agricultural areas were converted. As the paddy field holds a crucial role in the culture of the Buleleng Resident, it may also impact the cultural institution. Sustainable tourism development will control the land conversion and mitigate the negative impact and can be deployed together with the adat institution approach.

1 Introduction

Tourism development is a strategic action to develop national and regional tourism and increase economic and social contributions to improve the quality of life in tourism destinations [1]. Indonesia implements its tourism using a policy for developing National Tourism Strategic Areas (Kawasan Strategis Pariwisata Nasional (KSPN)) which is regulated in the 2010-2025 National Tourism Development Master Plan. This regulation aims to optimize the strategic value of regional tourism so that regional physical and social development can occur evenly. The central government of Indonesia, according to that policy appointed a KSPN in North Bali and its Surrounding Areas and focused on the northern coastal area of Buleleng Regency, especially in the coastal area between the former Buleleng Harbor in Singaraja to Seririt District. The appointment is based on consideration that Bali Island or administratively, Bali Province is the most visited tourism destination in Indonesia. Bali island is very well-known due to its green and pristine landscape, social setting, and the hospitality of its people.

Tourism development policies need to pay attention to the balance between natural sustainability and economic interests. Tourism development that focuses on developing the physical, environmental, economic, and social aspects of society in a balanced manner will produce sustainable tourism. The challenges of developing sustainable tourism often come from the interest of developing the economy without paying attention to environmental sustainability. The development of tourist attractions in various places can cause changes in land use which can cause a decline in environmental ecosystem services. Tourism development in coastal areas can take the form of developing facilities such as parking, tourist attraction services, trade and services, and hotels.

The development of tourism facilities includes the conversion of empty land, ponds, and rice fields into organizational land use, parking areas, and trade areas [2]. Land use change factors include natural and human factors [3]. Policy is a product of human thought that can encourage development. In developing countries, government policies tend to focus on allocating resources to provide economic benefits, so that the use of land as a regional resource is generally carried out in the interests of increasing welfare [4].

On the other side, the determination of KSPN has a positive impact on increasing the productivity of tourism activities and the community's economy. The status of KSPN North Bali also acts as a catalyst for the development of tourism business and tourism support services along the northern coast of Buleleng Regency. However, this may have a knock-on effect on increasing employment which is an attraction for migration. In the long term, urbanization that occurs because of the migration incoming will increase demand for certain land uses and cause urban development that cannot be separated from changes in land use [5–7].

The conversion of non-built land use to build land use for tourism purposes is carried out to accommodate

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the needs of tourists and residents. Whether carefully planned or not, tourism will change ecosystems through the conversion of land from forests and agriculture to land construction, resulting in the loss of ecosystem services [8–12]. Most of ecosystem and the services it delivers stems from land use and land cover hence, it is crucial to have a study on how land cover dynamic happens and how it is related with sustainable development. Moreover, Buleleng Regency as one of the primary tourism destination experience an intense pressure from tourism development.

Tourism development in rural areas is slowly hurting the preservation of the natural environment [13]. People who previously worked in the agricultural and fisheries sectors are slowly switching to the service sector because they are adapting to the higher income opportunities in the service sector. This is not in accordance with sustainable tourism development because the economic and socio-cultural factors that have been formed in society are not maintained [14]. Then, the growth of accommodation services is an unexpected form of tourism development in rural areas because there is a change in the use of agricultural land to built-up land. This condition is also not in accordance with sustainable tourism development because it does not pay attention to ecosystem functions.

As one of the KSPNs and one of the most visited tourism destinations, Bali needs to maintain its primary attraction of human-nature interaction. Land use could be considered as the mediator in this relation hence, conserving its land use will be fruitful to maintain tourism attraction. This paper aims to study how sustainable tourism management as a framework and tourism sector as a pressure is related to land cover as the state proxy to the environment and change its condition in a certain period and discuss the impacts induced along with the strategies to deal with. Studying how tourism altered the land cover in Buleleng District is expected to contribute to the implementation of sustainable development and benefit the Buleleng District and Bali as a KSPN. Additionally, it will enhance understanding of sustainable tourism management in mitigating and managing the impact on the environment, in this manner from the land conversion.

2 Method

To achieve the research objectives, this study employed a tourism geography approach powered by a Geographical Information System tool to unrevealed the land use change from non-built-up to built-up areas. Data acquisition and analysis was conducted in May 2023. Conceptually, we utilized the tourism facilities as the feature that reflected the tourism sector.

2.1 Research Setting

2.1.1 Research Location

In general, the research location was Buleleng Regency, one of the 9 regencies in Bali Province. This regency spanned west to east and occupied two-thirds of Bali Island's north coast. Physically, Buleleng Regency consisted of a mountainous range in its southern part and with coastal area in the northern part. It induced a variety of economic sectors and people jobs.

The tourism sector in Buleleng Regency, and Singaraja City in particular was lagged compared to their counterparts at the southern island. The existence of an international airport in the southern part significantly attracted people to spend their stay on this side and the mountainous range also hampered the tourists to come and visit the northern part. Nevertheless, some highly visited tourist sites were developed near this city including the famous Pemuteran Beach and Buleleng Harbour [15,16].

Singaraja City is the capital of Buleleng Regency which is in Buleleng District and acts as a center for social and economic activities in the regency. This city experiences rapid growth in economic activity and development. This growth triggers a land use change to accommodate the people’s increased needs. Singaraja City used to be the capital city of Bali and Nusa Tenggara region hence it was filled with old buildings. The setting and research location can be seen in Fig. 1.

2.2 Data Collection

This study used two different types of data, which are primary and secondary. Primary data is collected by researchers directly from field surveys. The survey aimed to observe and record the physical and ecological characteristics of the land at predefined observation points. These observation points were selected to encompass the built and non-built-up land cover in this region. On this map, observation points are marked with black dot symbols, and each point is assigned a unique identification number. These data were collected using measurement instruments such as Mobile smartphone GPS devices. We observed 30 points of observation with 15 points for each built and non-built observation. We used a purposive sampling method and allegedly chose two types of land use for the analysis and observation.

Satellite imageries we used to obtain the built-up and non-built-up were Sentinel-2 considering their temporal resolution and spatial resolution [17–20]. We downloaded the imageries from Sentinel hub using the EO browser as the interface tool. However, we also encountered a technical problem with our imagery where the 2017 image contains cloud features and its shadow where these features could have influenced the interpretation. Thus, cloud samples were also inserted in SCP classification training [21]. To obtain the spatial context of the image, we used base map features from RBI Map collected from Ina Geoportal. The data used in this research can be seen in Table 1 below.

<table>
<thead>
<tr>
<th>Name</th>
<th>Types</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satellite Imagery 2017 &amp; 2022</td>
<td>Primary</td>
<td>Sentinel Hub/EO Browser</td>
</tr>
</tbody>
</table>

Table 1. Data Used in This Research
2.3 Data Analysis

2.3.1 Built-up Change Analysis

To calculate the area of land use change in Buleleng District, an analysis was done using an unsupervised method from Semi-Automatic Classification Plugin, a tool inside QGIS software [22]. The map is based on temporal images of Sentinel-2 2017 and 2022. For the classification, we created a false color urban area using Band 04, 11, and 12. This tool overlays two different maps about land use change in Buleleng District from 2017 and 2022 which produced a map about non-built-up area change to built-up area in Buleleng District. A built-up area is an area that is intentionally built by humans to support their activities such as settlement and infrastructure, as the non-built-up area includes an area for vegetation, a water body, and an open field [23].

The classification results are then overlaid with administrative boundaries shapefiles. This combination helps to understand the area of built-up or non-built-up land in every district where the change occurred. The land use change map can be used to help observe the existing condition of the region to validate the image interpretation. Some sample dots need to be determined to help increase the effectiveness and efficiency of the observation and validation process. The result of observation could be used to explain why the land use changes and what will happen to the environment of Buleleng Regency regarding this land use change.

2.3.2 Accuracy Analysis

To obtain the accuracy of our interpretation, we used Kappa index calculation as a type of matrix that measures the levels of observer agreement in making categorical assessments and Overall Classification Accuracy (OCA) [21]. We also employed the calculation of User Accuracy (UA) and Producer Accuracy (PA) to obtain the accuracy. Kappa index’s range starts from -1 to 1 with an interpretation that if the kappa index reaches 1 then the observer agrees that the classification is good. If the value reaches 0, the observer’s agreement is assumed to be random or coincidental. If the value reaches -1, then the observer’s interpretation is bad and the classification is considered wrong.

OCA, UA, and PA calculation, in general, compared the total number of correct interpretation and the total number of points. while OCA used the total point, UA and PA only used the point in each category. The verification was done using direct field observation and the calculation of OCA, UA, and PA were done using equation (1) below [24–26].

\[
OCA = \frac{\text{Total correct points}}{\text{Number of observed points}} \tag{1}
\]

\[
UA = \frac{\text{Number of correct points in a category}}{\text{Number of observed points in the row}} \tag{2}
\]

\[
PA = \frac{\text{Number of correct points in a category}}{\text{Number of observed points in the column}} \tag{3}
\]

3 Results and Discussion

3.1 Built-Up Changes in Buleleng District

Singaraja City, in 5 years from 2017-2022, has seen 371 hectares of land that changed from non-built-up to built-up area. On the other hand, 151 hectares of land changed from built-up to non-built-up. This clearly shows that the balance of land use conditions in Buleleng District has shifted significantly.

In Fig. 2, the built-up area is shown in red and the non-built-up area in green. Most of the red area is located on the north side of the Buleleng District, near the coast, especially in Singaraja City. This indicates that people’s activities are focused around this region. It is aligned with the existence of collector roads alongside the coastline. However, Buleleng District is still mostly covered up with non-built-up areas in 2017. In 2022, the built-up area still focuses on the northside area of the district, but it branches out to the southeast part. Small activity centers are starting to appear in the southeast part but are still randomly spread out. This could be caused by the emergence of public service facilities and infrastructure around it. Tourism activities might have an impact on the changes too. Although the built-up area is significantly increasing, the non-built-up area is still covering up most of the Buleleng District.
Fig. 2. Map of comparison of Built-Up Areas in 2017 & 2022 and the change that happened

The changes are almost evenly distributed in Buleleng District and vary in size. This means the region is growing and the population is increasing. The changes reach out to a deeper part of the Buleleng District, especially in the southeast area. These changes might have several effects on the district, depending on which aspect to discuss. For example, economically speaking, these changes could contribute to a better GDP caused by the increase in service facilities. On the other hand, these changes could affect the environmental stability caused by the decreasing area of water infiltration. In administrative boundaries, the percentage of land conversion can be seen in a map in Fig. 3.

Fig. 3. Percentage of land conversion per village administrative unit.

Administratively, Fig. 4 demonstrates that Banyuasri, Beratan, and Ligundi Villages are three villages that experienced the largest non-built-up conversion in the 2017-2022 period where more than 6% of these villages' total area is altered to a concreted or built-up area. Those villages are situated in the center of Buleleng District and at the urban center of Singaraja urban area. Another notable region is the southwest area where Kalibubuk, Tukad Mungga, Pemaron, and Anturan Village sit next to each other. Kalibubuk sees a medium rate of land conversion amidst this area due to the high and intense tourism activity. On the contrary, Kampung Singaraja, Alasangker, and Kelurahan Kampung Bugis become the least converted built-up areas with only this non-built-up area being converted. The percentage of land use change can be seen in a graph in Fig. 4.

Fig. 4. Percentage comparison of non-built-up and built-up conversion for each village.

For the kappa index calculation, we used 15 areas for each non-built-up and built-up land use. The calculation found 3 errors in interpreting the land use, which is 3 non-built-up areas that are built-up areas. Thus, the value for the kappa index is 0.8 (the standard is 0.8 and above) with the OCA of 90% which means the classification is good and corresponds with the real land use condition. Kappa calculation and the observation result can be observed in Table 2 below.

Table 2. Kappa Value Calculation

<table>
<thead>
<tr>
<th>Classes</th>
<th>Observation</th>
<th>Total</th>
<th>Producer Accuracy</th>
<th>Omission Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Built up</td>
<td>15</td>
<td>15</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Non-Built up</td>
<td>3</td>
<td>12</td>
<td>80</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>User accuracy</td>
<td>83.33</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Omission Error</td>
<td>16.67</td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 2 also shows the number for UA and PA for each category. For the built up, the PA reach 100% and for the non-built up is 80%. The built up UA is 83% and the non-built up reach 100%. It is due to the ability of
the discrimination of the built-up area in the image classification since the built up shows a more contrast pattern.

### 3.2 Tourism Facilities and Built-up Changes

In 2017, the majority of this area remained devoid of tourism facilities. However, over the course of time, significant and noteworthy changes have become apparent. Lands within this region, formerly dedicated to agriculture, natural forests, settlements, and other uses, have transformed into tourism facilities. These changes within the area appear to be broadly distributed, with denser transformations occurring in the northern, southern, and southeastern sectors. The illustration can be seen in Fig. 5 below.

![Fig. 5. (a) Paddy field in Buleleng District, (b) built environment (c) illustration of land cover from agricultural area to settlement](image)

In 2017, this region was enveloped by a non-built-up area; however, it has now evolved into a primary tourism destination with a multitude of resorts, hotels, and recreational amenities. The red-shaded areas on the map symbolize the alterations related to tourism facilities, such as entertainment venues and tourist destinations. Meanwhile, in the western section of the region, similar changes are observable, although not as concentrated as in other areas. The yellow dots and stars on the map indicate the locations of constructed sites that attract tourists. The yellow dots represent restaurant locations, which are widely distributed mainly in the northern and western portions, while the stars indicate hotel locations, also dispersed primarily in the western part and some in the northern areas.

The transformation of land into tourism facilities signifies the Buleleng District's shift towards emphasizing the tourism industry, extending beyond just the coastal areas and extending into the hillier regions. This map also reflects significant shifts in land use within the Buleleng District, increasingly focusing on the tourism sector as illustrated in Fig. 6.

![Fig. 6. Map of tourism facilities spatial distribution overlaid with land conversion](image)

### 3.3 Sustainable Tourism Sector Development and Land Governance in Buleleng District

#### 3.3.1 Non-Built-Up Conversion Impact on Tourism

The land use or land cover change could be significant considering the impact and the entailing effect it induces. From the result, this research agrees with researches from Fahyudi, et al. [27] that shows there are land use changes in the peri-urban area of Singaraja City. In this manner the non-built-up to built-up needs to be addressed more because the change would be more drastic. Research from Damayanti et al. [28] and Oktavianingrum et al. [29] pointed out that the non-built-up to built-up land cover change altered the surface temperature. Intensifying and denser built-up structures increase heat reflectance hence affecting the air temperature. In the tourism sector, increasing temperature will directly relate to the visitors’ comfort while they enjoy the attraction. Research in the Iberian Peninsula agreed that tourists have their preference for urban thermal and maintaining the temperature becomes a key factor in delivering tourism service [30,31]. We need to underline the results from those research that, although visitors may refer to a ‘slightly hot’ temperature, the humidity as a factor in a tropical climate where Buleleng District is situated needs to be taken into account.

Moreover, with many old buildings and historical and cultural sites, a built-up area needs to be managed. As a strategy for managing the temperature, as the land conversion from non-built-up to built-up is happening and, in some cases, increasing, a green open space with tree covers or shading is required. Green belts, green corridors, and recreational parks can battle scorching heat and provide another benefit by protecting tourists while strolling around and visiting some cultural sites [32].

The most significant type of non-built-up area converted is the agricultural type. Buleleng District was once covered with a vast area of paddy fields as an integral part of Balinese. Paddy fields provide sufficient rice as the primary staple for the
Balinese and the tourists who visit Buleleng. In some cases, this paddy field also could be utilized to be a tourist attraction. However, the conversion of agricultural land has a meaningful implication for the adat or culture of Buleleng residents. It could weaken cultural cohesion which is crucial in managing the negative impact of tourism. These concerns were raised in papers from Srilaksmi et al. [33] and Mariadi & Surata [34]. It is important to mainstream adat institution which is embodied in the form of awig-awig from the Balinese. That way, not only food security for the residents who are not directly related to tourism but also to the cultural institutions that are rooted in the paddy field.

3.3.2 Sustainable Tourism and Land Management

As an economic sector and a core business, tourism necessitates competition to attract the number of visitors. To enhance competitiveness tourism facilities are continuously built and improved to provide comfortability to tourists. From a business perspective, the new infrastructures and facilities are also important to increase tourism values and prices. It could be observed, that Buleleng District, at Lovina Beach, and Buleleng Harbor as the main attractions. Investors and entrepreneurs compete to enhance the tourism facilities and it is illustrated in Fig. 4 where tourism facilities were aggregated at Lovina Beach. As an implication, there would be land cover changes and negative impacts on the ecosystem and the community, especially in a strong adat community like the Balinese.

Tourism management, however, has shifted from competitiveness to sustainability [35] and reshaped tourism into sustainable tourism management. UNWTO [14] addresses land issues in the context of sustainable tourism management encompassing social inclusion in land access and climate change related to the carbon stock.

Conversion of the non-built-up area to the built-up area may give a direct hit to the capacity of land to store carbon in the form of biomass. Cutting down trees for land clearing erases their ability to absorb and store carbon. Therefore, it is important to retain the green area and control the conversion of the non-built-up area.

Implementation of sustainable tourism management to mitigate land conversion and the negative impact it causes requires a strong political commitment and cooperation among stakeholders. For the Buleleng District case, adat-based management will be fruitful since its residents still hold a strong belief in the adat. Enhancing values and philosophy like Tri Hita Karana [36] for spatial planning and sad kerti could be an initial strategy to strengthen a community-based tourism and conservation effort for land conversion management. Regarding the role of Tri Hita Karana, our argumentation shows similarity with a research from Wesnawa [37] that examined the change in settlement environment in Singaraja City.

4 Conclusion

This study has shown that Buleleng District has an imbalance in land conversion, indicating that non-built-up areas including green areas and agriculture are converted to built-up areas with the largest village experiencing it is Banyuasri Village. As one of the main tourism destinations, land conversion yields negative impacts on the visitor’s comfort, food security, and agricultural sectors. Sustainable tourism management should be implemented to enhance adat-based institutions in managing land conversion. A legal-formal base will be crucial to be provided i.e., through regional policy.

Nevertheless, this study still provides a wide perspective, only studying land conversion descriptively at two kinds of land cover. It is important to conduct a more detailed explanation of the correlation or even causation of the tourism sector to land conversion as well as exploring land conversion in another type of land cover as the base for forecasting or predicting land cover conversion in the future. Using Sentinel-2 as a modality in monitoring land conversion is also fruitful considering its resolution and ability to provide a good picture and land cover discrimination.

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