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Research article

Dynamics of Land use and Land cover in the Belitung Island, Indonesia

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ABSTRACT

Belitung Island, situated in the Southeast Asian tin belt, experiences substantial transformations in land use and land cover (LULC) driven by mining activities, impacting both local economic growth and the ecosystem. This study aims to elucidate the dynamic LULC changes on Belitung Island and evaluate deforestation trends. LULC data spanning from 1990 to 2020 were acquired from The Indonesian Ministry of Environment and Forestry (KLHK), employing supervised classification of satellite imageries. The dataset demonstrated an overall accuracy ranging from 0.79 to 0.92 and was reclassified into six types based on the Intergovernmental Panel on Climate Change or IPCC's classes, encompassing forest, cropland, grassland, other land, settlements, and wetlands. Our research unveiled a notable reduction of over 25 % in forest cover within the past 30 years. Notably, 2020 exhibited instances of reforestation, which subsequently transformed into cropland (0.57 %), grassland (0.32 %), and other lands (0.39 %). Belitung Island grapples with challenges related to sustainable development, environmental conservation, and food security. Forest Landscape Restoration (FLR) emerges as a potential strategy to address some of the socioeconomic and ecological issues.

1. Introduction

Belitung Island, situated in the world's tin belt in Indonesia, has been a hub for tin mining activities dating back to the eighteenth century, predominantly overseen by a Dutch company [1,2]. Despite serving as a primary source of income for the island's residents, tin mining has significantly impacted the island's geography and ecosystem. The resultant land degradation has led to biodiversity loss, diminishing the functionality and services of the forest ecosystem [3]. Deforestation, encompassing the conversion of forests into cropland, grassland, mining complexes, or built-up areas [4,5], is driven by various factors such as logging, commercial agriculture, infrastructure development, urban expansion, and mining [6,7].

The imperative to conserve the ecosystem in Belitung Island is undeniable for achieving sustainable development. Globally

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recognized as part of the savanna corridor in Sundaland between Sumatra and Borneo [8], the island plays a crucial role in connecting similar open vegetation types north and south of the equator. This corridor acts as a barrier to the dispersal of rainforest-dependent species. Additionally, small islands, such as Belitung, offer a unique opportunity to influence discussions on Strategic Environmental Assessment (SEA) in favor of sustainability due to their distinctive natural and human characteristics [9] Notably, the United Nations Educational, Scientific, and Cultural Organization (UNESCO) has acknowledged the significance of Belitung Island's resources, leading to the establishment of "Belitong UNESCO Global Geopark" [10]. This initiative focuses on the value of geological processes, landscapes, high biodiversity, heath forest ecosystems, and traditional knowledge.

According to studies on the Sundaland savanna corridor, the heath forest ecosystem 'Kerangas' is likely the primary ecosystem in Belitung, covering a significant portion of the island [11]. Sundaland heath forest, characterized by diverse soils but typically found on thin soils capping sandstone plateaus, podzolized siliceous sands, and acidic soil, exhibits a unique vegetation composition [12–14]. However, the heath forest's ground, derived from quartz sand soil, signifies high fragility in response to disturbance [15]. The degradation of the heath forest results in a barren ecosystem resembling 'Padang' vegetation, posing challenges in the restoration of ex-tin-mined land [16].

In recent decades, Belitung Island has witnessed significant changes in Land Use and Land Cover (LULC) due to escalating anthropogenic activities [17]. Urbanization acceleration has led to ecological destruction, including a decrease in ecological carrying capacity [18,19], widespread water and soil loss [19–21], and consequential desertification and biodiversity loss. Given these circumstances, our study aims to identify the latest LULC in Belitung Island, laying the groundwork for a strategic plan for Forest Landscape Restoration (FLR) [22,23]. The identified LULC changes include the emergence of production forests, agricultural land, and scrub [24].

Research related to LULC is commonly conducted as part of environmental change monitoring and policymaker evaluation efforts. For instance, studies on LULC in the Brazilian Caatinga Dry Tropical Forest from 2016 to 2020, utilizing remote sensing, highlighted 2018 as the year with the highest deforestation percentage [25]. Similarly, a study by Yomo et al. [26] in Agoènyivé Plateau, Togo, using four scenarios for predictions for 2030 and 2050, revealed increased built-up land and decreased vegetation. Another study by Leta et al. [27] examining LULC in the Nashe watershed (Ethiopia) in various years and predictions for the future identified significant forest-to-agricultural land conversion.

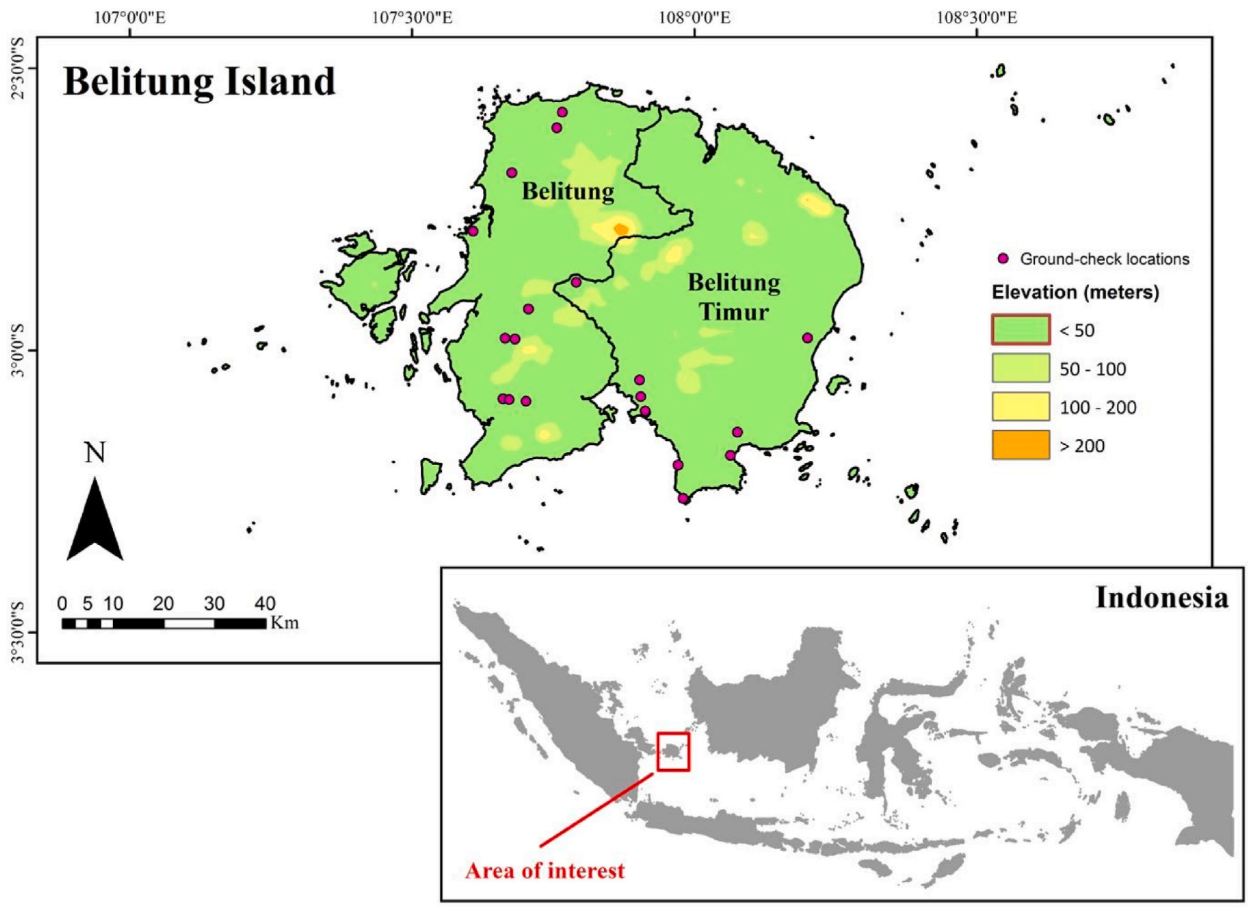

Fig. 1. Map of the study area.

The analysis of LULC changes is pivotal for program design, management, and monitoring at local, regional, and national levels [28]. This information contributes to a better understanding of LULC issues and assists in formulating policies and development planning. The data on Belitung Island's changing LULC provided by this study is valuable for environmental monitoring and government development initiatives, particularly before and after the regional autonomy regulation. The findings not only inform environmental conservation efforts but also establish a foundation for designing resilient and sustainable development plans. Therefore, this study aims to analyze LULC changes in Belitung Island from 1990 to 2020 and evaluate the deforestation trends to guide Forest Landscape Restoration (FLR) efforts.

2. Materials and methods

2.1. Study area

The study area encompasses Belitung Island, situated in the Bangka-Belitung Province of Indonesia, spanning from 107°31.5′ E to 108°18′ E longitude and 2°31.5′ S to 3°6.5′ S latitude (Fig. 1). Belitung Island, with a total area of approximately 4800 km^2, is divided into two regencies: Belitung Regency (2294 km^2) and Belitung Timur Regency (2509 km^2). It is surrounded by the Karimata Strait and

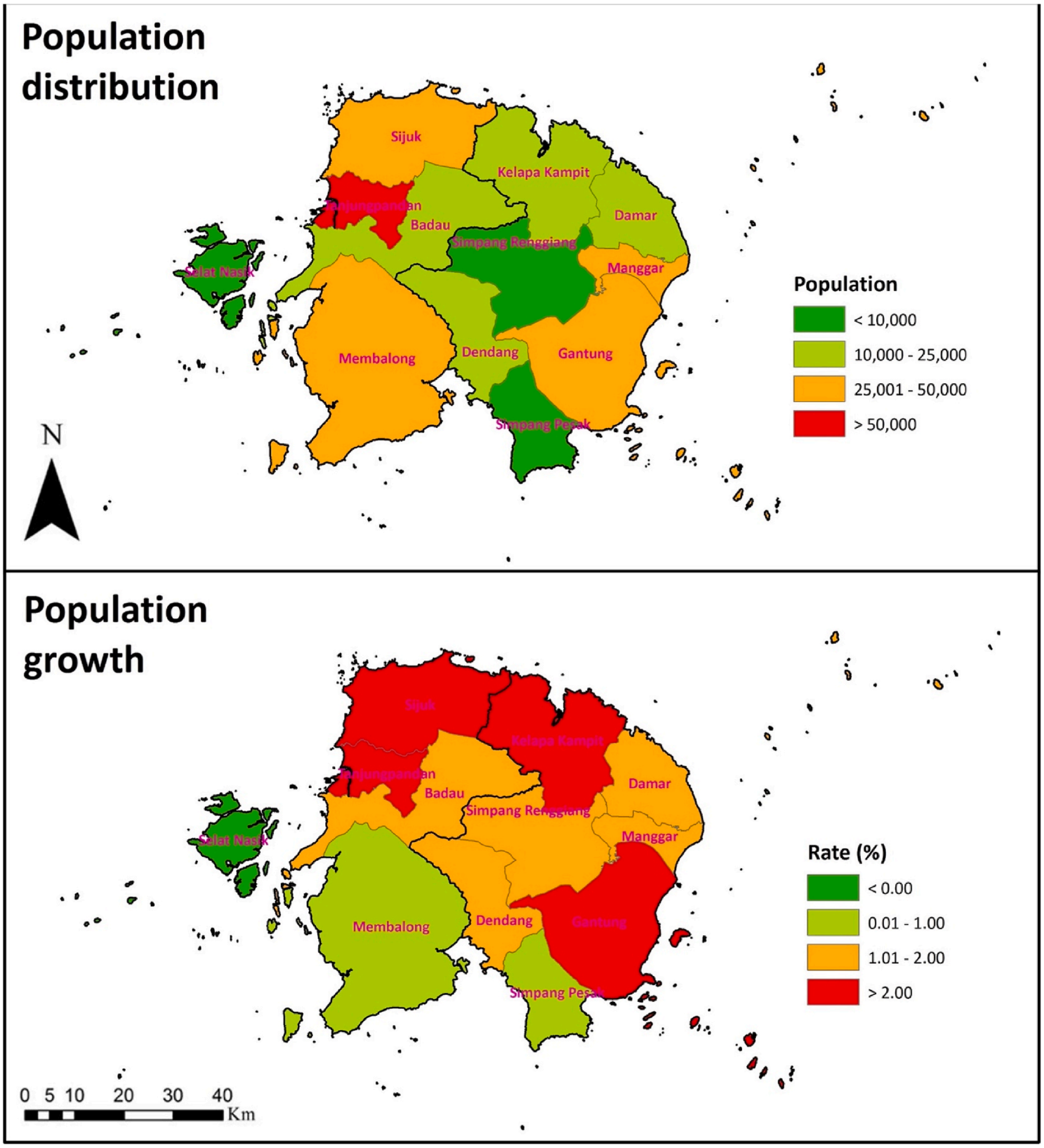

Fig. 2. Map of the distribution of population and population growth in belitung and belitung timur, based on data from the Indonesian statistical agency (2020).

Borneo Island to the east, Gaspar Strait and Bangka Island to the west, the Java Sea to the south, and the South China Sea to the north.

The geological composition of Belitung Island is predominantly characterized by quartz and sand, alluvial rocks, and granite rocks [29]. Quartz and sand cover approximately 56.98 % of the island's total area, distributed evenly throughout the sub-district. The island's topography features plateaus, valleys, and a small percentage of mountains and hills. The local topography consists mainly of lowland, with elevations ranging from 0 m to 500 m above sea level (masl), and the highest peak, Gunung Tajam (500 masl), is located in the northeast part of the island [30]. The central part of the island exhibits a hilly area with undulating to hilly topography, while the coastal areas have a relatively flat surface [31]. Belitung experiences a tropical and wet climate, with a mean annual precipitation of approximately 2966 mm from 2015 to 2020 and a mean annual temperature of 26.86 °C. The island's vegetation is predominantly dryland forest and savanna, featuring species such as *Tristaniopsis obovata*, *Callophyllum lanigerum*, *Schima walichii*, and *Syzygium lepidocarpa*. The endemic animal species on the island include *Cephalopachus bancanus saltator* [32].

Belitung Island was split into two regencies (Belitung Regency and East Belitung Regency) in 2003 as part of a regional expansion initiative aimed at accelerating development in the area. The newly formed autonomous region functions as a distinct entity, encompassing geographical, political, economic, social, and cultural aspects. This restructuring is expected to have notable impacts on Land Use and Land Cover (LULC) dynamics, aligning with the regional spatial plans outlined for each regency. Fig. 2 displays the distribution of population and population growth in Belitung and Belitung Timur.

2.2. Data collection and analysis

The existing Land Use and Land Cover (LULC) maps were obtained from the Indonesian Ministry of Environment and Forestry (KLHK), and the administrative boundary map from the Geospatial Information Agency (BIG) served as our study baseline. The LULC datasets encompass maps from 1990 to 2020, derived from satellite imagery interpretation [33,34]. The overall accuracy of each LULC map ranges from 79 to 92 %. These data cover four periods: 1990 (Landsat Multispectral Scanner - MSS), 2000 (Landsat-5 TM and Landsat-7 ETM+), 2011 (Landsat-5 TM, Landsat-7 ETM+, MODIS), and 2020 (Landsat-5 TM, Landsat-7 ETM+, Landsat-8 OLI, MODIS, SPOT) for analysis (see Table 1). Reclassification of LULC data was necessary to simplify the information. This research utilized secondary data (the national dataset of LULC) from the Indonesian Ministry of Forestry and Environment (KLHK), generated through supervised analysis with the maximum likelihood algorithm [35]. The different satellites were used for image mosaics to obtain cloud-free imagery, employing the nearest-neighbor image mosaic method to improve semantic relationships between nearby regions [36].

For Belitung Island, there are 21 types of LULC, reclassified into the IPCC's classes (6 types). "Gain and loss analysis" was employed to discern LULC changes, verified by ground-check with 20 points and an overall accuracy of 0.70. In other parameters such as kappa accuracy, contingency coefficient, and phi, the data showed values of 0.57, 0.91, and 0.67, respectively (see Table 2). These parameters align with the criteria set by Basu and Das [37] as well as and Plourde and Congalton [38], demonstrating statistical significance at a 95 % confidence level. Therefore, this data is deemed valid for assessing landscape changes in Belitung during the specified period.

There are 21 out of 23 LULC classes identified in Belitung Island according to KLHK (see Fig. 3). Meanwhile, the IPCC classification, obtained by reclassifying LULC into 6 classes [39–41], was based on Forest Reference Emission Level [42]. The dynamics of LULC were identified by overlaying maps from the periods 1990, 2000, 2011, and 2020 to determine the area of land change for each use. Additionally, an analysis of the level of land change from forest to other uses was conducted. Based on the pattern of land change, the annual rate of forest degradation was calculated. The post-classification change detection technique in GIS enabled quantitative analysis of the geographical and temporal dynamics of LULC changes. To analyze the difference in LULC between 1990 and 2020, *t*-test analyses were performed, with data processing carried out using QGIS software and Microsoft Excel.

Table 1
Dataset information.

Dataset	Year	Season	Resolution	Source
Landsat MSS	1990	Dry season (April 01, 1990–September 30, 1990)	60 m	Earth Explorer USGS
Landsat-5 TM	2000, 2011, 2020	Dry season (April 01, 2000–September 30, 2000, April 01, 2011–September 30, 2011, March 01, 2020–October 31, 2020*)	30 m	Earth Explorer USGS
Landsat-7 ETM+	2000, 2011, 2020	Dry season (April 01, 2000–September 30, 2000, April 01, 2011–September 30, 2011, March 01, 2020–October 31, 2020*)	30 m	Earth Explorer USGS
Landsat-8 OLI	2020	Dry season (March 01, 2020–October 31, 2020*)	15 m	Earth Explorer USGS
SPOT	2020	Dry season (March 01, 2020–October 31, 2020*)	1.5 m–6 m	European Space Agency
MODIS	2011	Dry season (April 01, 2011–September 30, 2011)	250 m	NOAA

Note: The acquisition time in the date range is due to the use of mosaic images to minimize cloud cover. *Climate change triggers seasonal variations, where the dry season lasts longer than the wet season in Indonesia [77].

Table 2
Parameter and accuracy value for LULC data used in the study.

Parameter	Value
Overall accuracy (claimed by KLHK)	0.79–0.92
Overall accuracy (ground-check)	0.70
Overall kappa (ground-check)	0.57
Phi (ground-check)	0.91
Contingency coefficient (ground-check)	0.67

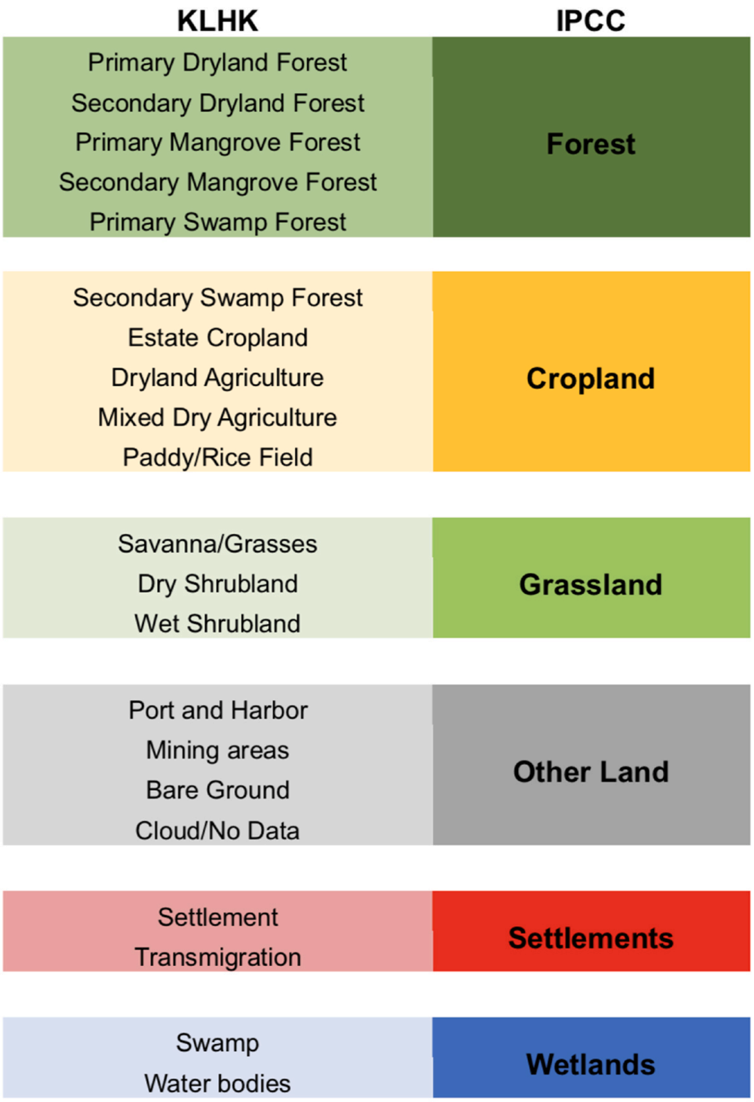

Fig. 3. LULC Classes in Belitung Island based on reclassification from KLHK to IPCC.

3. Results

The forested areas in Belitung Island experienced a decline from 1450.92 km^2 (29.79 %) in 1990 to 1285.59 km^2 (26.40 %) in 2000, further decreasing to 1100.63 km^2 (22.60 %) in 2011, and reaching 837.42 km^2 (17.20 %) in 2020. In contrast, the cropland in the study area expanded from 872.01 km^2 (17.90 %) in 1990 to 1841.19 km^2 (37.80 %) in 2000, continuing to 1898.23 km^2 (38.97 %) in 2011, and culminating in 2311.81 km^2 (47.47 %) in 2020. The most significant change occurred in 2000, with cropland witnessing the highest increase from 872.01 km^2 in 1990 to 1841.19 km^2 in 2000. Moreover, grassland experienced a notable decline of approximately 923.97 km^2 from 1990 to 2000 (see Fig. 4). Over thirty years, wetlands and settlements saw slight increases. However, diverse land categories, including port and harbor areas, mining sites, bare ground, and cloud cover, underwent dynamic changes from 1990 to 2020, as illustrated in Fig. 5. The percentage and total changed area for each LULC class are presented in Fig. 5. Belitung Island exhibited a highly dynamic LULC, with cropland experiencing the most significant change, showing an increase of approximately 29.54 % over a 30-year period. The graph indicates that 17.88 % of grassland in 1990 was converted to cropland in 2000. From 2011 to 2020, 4.25 % of forests changed to cropland. Concurrently, 5.60 % of other lands also transformed into cropland. Minor percentages of cropland in 2011 were converted to forest, grassland, other land, settlements, and wetlands in 2020.

The primary dryland forest constituted a small portion of Belitung Island's forest types and was lost entirely in 2020. The secondary dryland forest witnessed a substantial decline over thirty years, experiencing the greatest loss compared to other forest types, decreasing from 1190.96 km^2 in 1990 to 607.68 km^2 in 2020. Some newly categorized areas, such as estate cropland, settlements, dryland shrubland, and mining sites in 2020, were originally mapped as secondary dryland forests in 1990. Furthermore, the primary mangrove forest was lost in 2020, with a total loss area of about 33.32 km^2. Conversely, the secondary mangrove forest slightly increased from 2019 to 2020, gaining 33.45 km^2.

The most extensive non-forest LULC is dry shrubland, losing approximately 839 km^2 over thirty years, followed by bare ground, which lost about 231.26 km^2 (refer to Table 3). Meanwhile, the most significant increase in non-forest area is estate cropland, showing a gain of more than 50 % over the last ten years. Our results also indicate that the pure dry agriculture area increased by 59 km^2 from 2011 to 2020. The mixed dry agriculture area notably increased by about 605.47 km^2 from 1990 to 2000. Interestingly, LULC changes from 2000 to 2011 remained relatively stable, except for the transmigration area, which increased from 0 km^2 to 24.17 km^2, and the secondary dryland forest, which decreased by 185.76 km^2. LULC changes in Belitung have transformed the island's landscape into a more urbanized and warmer environment [43]. However, these changes did not show statistical significance when referring to the *t*-test. Statistical analysis indicates that changes over the past 30 years were not significant, with a t-value of 0.03 and a p-value of 0.998, respectively (at a 95 % confidence level).

Declining in forest area appears linear to increasing croplands and settlements, without being accompanied by conservation efforts, heath forest as Belitung's icon is continuing threatened. This situation indicates that the natural landscape tends to change and be

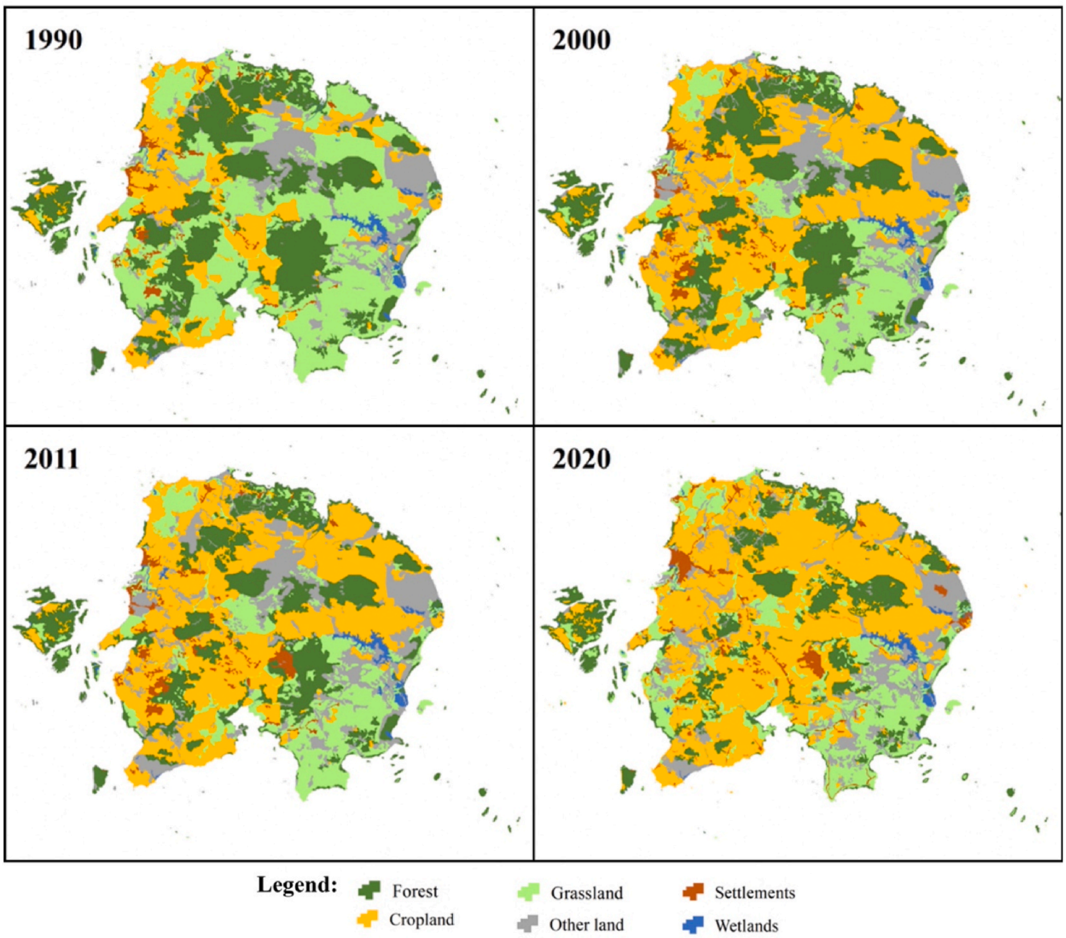

Fig. 4. LULC changes in Belitung Island for the years 1990, 2000, 2011, and 2020.

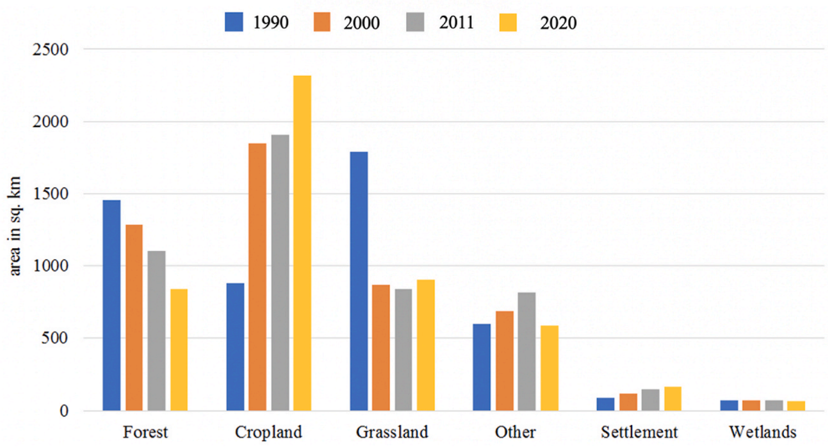

Fig. 5. The area of LULC changed.

Table 3
Area distribution in km^2 of each LULC class in Belitung Island.

LULC	1990	2000	2011	2020	1990–2020
Primary Dryland Forest	1.14	1.14	1.14	0.00	−1.14
Secondary Dryland Forest	1190.96	1028.31	843.55	607.68	−583.28
Primary Mangrove Forest	72.03	72.03	66.83	38.71	−33.32
Secondary Mangrove Forest	121.40	121.40	126.40	154.85	33.45
Primary Swamp Forest	5.45	0.45	0.45	0.00	−5.45
Secondary Swamp Forest	64.93	62.25	62.25	36.17	−28.75
Mining areas	317.23	313.84	407.61	561.19	243.96
Estate Cropland	134.66	482.11	536.55	1268.20	1133.54
Pure Dry Agriculture	26.84	43.09	43.09	102.17	75.33
Mixed Dry Agriculture	710.51	1315.98	1318.59	941.44	230.92
Swamp	60.93	60.93	60.85	53.07	−7.87
Savanna and Grasses	63.74	96.51	96.11	54.00	−9.75
Paddy/Rice Field	5.84	5.84	5.84	6.43	0.59
Dry Shrubland	1457.86	531.91	517.02	617.92	−839.93
Wet Shrubland	268.41	237.62	228.81	230.94	−37.48
Bare Ground	249.25	340.79	376.02	18.00	−231.26
Port and Harbor	0.70	0.70	0.70	1.72	1.02
Settlement Areas	88.18	120.16	120.16	137.93	49.75
Transmigration Areas	0.00	0.00	24.17	24.17	24.17
Water bodies	10.92	10.92	10.92	13.29	2.37
Cloud/No Data	30.27	30.27	29.21	8.38	−21.89

replaced by cultural landscapes to support human life, thus disrupting carrying capacity and ecosystem stability [44]. Belitung Island has been designated as a geopark in Indonesia, it should respond wisely regarding LULC changes and the government needs to conserve heath forests as "heritages" [45,46].

4. Discussion

4.1. LULC and development

The escalation of land conversion into cropland is driven by the burgeoning population, leading to a heightened demand for Land Use and Land Cover (LULC). Additionally, Belitung, being a micro island, predominantly engages its local populace in mining and fishing. The Belitung government, open to transmigration since 2005, has seen an influx of people, primarily farmers from Java Island. A substantial increase in transmigration areas is evident in 2011 (Table 3). The expansion of urban development, rural housing, industrial parks, and transportation infrastructure constitutes the primary factors propelling construction land expansion. Urbanization, notably in two districts on Belitung Island, has different characteristics. The growth of settlements in Belitung Timur exhibits a "concentrated" pattern in Manggar City and another in the northeastern region, with Manggar being an urban area, while the northeastern region resembles a fishing village with a rural style. In contrast, Belitung Regency demonstrates a relatively dispersed settlement growth pattern along the main roads. The p-value and t-value are not significant, mainly because changes in each class tend to vary in area, for instance, the dynamic nature of forest and cropland every 10 years, while other classes exhibit relatively smaller changes. Despite being statistically insignificant, analyzing the dynamics of LULC changes is imperative as they are intricately linked to spatial planning policies, disaster mitigation strategies, and environmental carrying capacity [47–49].

Previously, Belitung Island was administratively divided into two formal regions, with development centered in the west. Following regional autonomy (2000-present), Belitung Island now comprises two formal regions, named Belitung (west) and Belitung Timur (east). While settlement growth is more prominent in the west, Manggar City plays a pivotal role as a new pole of development and a primary driver of LULC changes. In Belitung, the rising settlements contribute to a fragmented landscape, posing a significant challenge to environmental management. The existence of fragmented new settlements poses a threat to the landscape, impacting spatial planning and potentially triggering uncontrolled land conversion. Growth centers, such as cities, can trigger urban sprawl [50]. In Java, the term "fragmented rice fields by settlements" has emerged due to urban development, ultimately diminishing the ecological function of paddy fields as productive agricultural land [51]. The addition of settlements often leads to the conversion of other land functions, such as from forests to plantations, then to rice fields, followed by pastures and settlements [52]. According to da Cunha et al. [53], the preservation of riparian vegetation failed to effectively protect watercourses. This underscores the critical need to implement optimal management practices within agricultural production areas, particularly in regions with extensive slopes or gradients exceeding 2 %.

The rate of development is anticipated to rise in developing regions, resulting in the loss of agriculture, posing a threat to sustainability and livelihoods [54]. Human activities, such as deforestation, significantly influence changes in LULC [55]. Many companies have committed to preventing forest loss in their supply chains by purchasing only "sustainable" certified items [56]. Regarding change patterns, Belitung identifies the rapid development of urbanization as critically important. Land policies should be formulated and implemented in tandem with the socioeconomic and environmental growth of the region. The deforestation process is primarily driven by cropland expansion, a major global driver of deforestation [57,58]. Over the past 30 years, grassland in Belitung Island has undergone various conversion patterns. In the period 1990–2000, 17.9 % and 2.8 % of grassland and forest, respectively, changed into cropland (Fig. 3). The dominant agricultural commodities adaptable to Belitung Island's conditions are palm oil and white pepper. In the last fifteen years, rubber plantations have also been established on Belitung Island. Particularly, bare ground decreased significantly from 376.02 km^2 in 2011 to 18.00 km^2 in 2020, mainly located in the Belitung Timur regency.

In Belitung Regency, settlement development can be initiated as planned; however, numerous forest lands have undergone a change in function, particularly transforming into cropland. The presence of protected forest and production forest areas is still maintained outside the main island. Conversely, in Belitung Timur, settlement development progresses at a slower pace compared to Belitung Regency, focusing only on a few points. Several forest lands in Belitung Timur deviate from the development plan. This discrepancy arises from the dominant presence of grasslands in the land cover of Belitung Timur, especially in the southeastern part. The prevalence of grassland signifies an abandoned landscape with the potential to transition into critical land [34,44]. An additional effort is necessary to restore it to a forest, aligning with the local government's plan.

4.2. LULC changes threaten biodiversity

Transforming extensive areas of natural ecosystems, such as forests or grasslands, into agricultural lands results in the devastation and fragmentation of habitats, leading to the displacement and extinction of indigenous flora and fauna. In the 1980s, a study on the effects of agricultural expansion and intensification on vertebrate and invertebrate diversity in the Pampas of Argentina found that birds and carnivores were more strongly affected than rodents and insects [59]. This disturbance in ecological equilibrium disrupts the intricate interplay of species within these environments. Natural ecosystems rely on intricate ecological processes such as pollination, seed dispersal, and nutrient cycling [60,61]. The replacement of natural habitats with large-scale agricultural estates disrupts or even terminates these processes. For example, the loss of pollinators due to habitat destruction can lead to reduced crop yields and negatively affect the reproduction of wild plant species [62].

Understanding the connections between people and their environment requires knowledge of the interconnections between Land Use and Land Cover (LULC) and biodiversity. On one hand, changes in LULC and land management are major forces behind changes in biodiversity at the global, national, and local levels [63]. Grasslands on Belitung Island form a unique savanna ecosystem with high conservation value. The unique savanna ecosystem in Belitung is called padang, where there are some protected plants such as *Nepenthes* spp., and *Combretocarpus rotundatus*. The dominant ground cover species founds are *Fimbristylis* sp., *Eriocaulon* sp., *Panicum* sp., *Drosera burmanii*, and *Rhynchospora aurea*. As for the predominant small trees, they include *Leptospermum flavescens*, *Malaleuca leucadendron*, and *Tristaniopsis obovate* [64]. Some species existed in padang also used as medicinal plants for local people [65]. Therefore, the reduced area of grassland will have an impact on the loss of biodiversity and its ecological function.

Additionally, deforestation can cut off the home range of wild animals, often leading to conflicts between wild animals and humans. Mapping spatiotemporal LULC changes allows for a better understanding of environmental trends and factors, as well as the identification of more sustainable land management techniques. In Fig. 4, grassland was significantly converted to cropland in 2000. Converting native grassland to cropland has been shown to affect soil microbial processes [66,67] and water quality and availability in previous studies. Therefore, a better understanding of LULC changes would be extremely useful in guiding policy and decision-making actions, particularly to avoid further ecosystem service loss [68]. Belitung Island is an exotic area with endemic biodiversity, such as heath forests and protected animals, in accordance with Indonesian environmental regulations (Regional Regulation of Bangka Belitung Islands Province No. 2 of 2023). Changes in LULC are characteristic of a landscape transformation that has an impact through fragmentation and loss of corridors for biodiversity [69–72]. In particular, tin mining activities severely degrade soil conditions and diminish plant diversity on Belitung Island [73].

In other situations, agricultural land is diminishing while the remaining areas are being used more intensively [74,75]. Although (active or spontaneous) natural development on abandoned agricultural sites mitigates some of the detrimental effects of intensification on biodiversity, the overall trend appears to be unfavorable [76–79]. Prioritizing conservation is crucial to balancing agricultural production with conservation goals by identifying hotspots of probable future conflicts. Cropland expansion and intensification are the primary options for increasing agricultural productivity in response to the growing demand for biomass. However, they are also significant drivers of biodiversity loss [80].

5. Conclusion

Understanding Land Use and Land Cover (LULC) dynamics in Belitung Island over the last three decades is essential for observing changes resulting from forest conversion into anthropogenic lands. Forests have decreased by over 25 % in 30 years, transforming into cropland (0.57 %), grassland (0.32 %), and other lands (0.39 %). The large-scale establishment of agricultural land poses a threat to biodiversity and ecosystem function. Additionally, future hazard mitigation measures are required. We suggest enforcing regulations on land use and mining to protect Belitung Island's landscape, using zoning laws, protected areas, and permits. It is also necessary to advocate for sustainable mining methods, such as reforestation and eco-friendly technologies, to minimize environmental damage. Diversifying the economy through eco-tourism, agriculture, and renewable energy is proposed to lessen dependence on mining and create new opportunities. Additionally, allocating resources for conservation efforts and involving the community in land management decisions are emphasized to safeguard habitats and empower locals for sustainable practices.

This study serves as an initial exploration that can inspire further research on landscape changes in Belitung. Our study provides a crucial baseline dataset for environmental assessments of Belitung Island. With the anticipated increase in climate change and human activities, the island will face more significant challenges in regional sustainable development, ecology, and food security. This study demonstrates that the LULC dataset from the KLHK remains suitable for development activities, policy formulation, and further research, provided it is complemented by field surveys to ensure accuracy. However, our research had limitations because only used data from the KLHK, also there were no very high-resolution imageries that came drones and commercial satellites.

Ethical statement

Not applicable.

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Data availability statement

The datasets are available through a request to the corresponding author.

CRediT authorship contribution statement

Dina Oktavia: Writing – review & editing, Project administration, Data curation, Conceptualization. **Santi Dwi Pratiwi:** Writing – review & editing, Project administration, Conceptualization. **Nadia Nuraniya Kamaludin:** Writing – review & editing, Methodology, Conceptualization. **Millary Agung Widiawaty:** Writing – review & editing, Methodology, Investigation. **Moh. Dede:** Writing – review & editing, Visualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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