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Research Article

Quantifying Biodiversity in the Absence of Taxonomic Data: A Study of Thailand's Economic Development Zones

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Abstract

The biodiversity status measures the ecological capacity of a given area. However, biodiversity assessments in developing countries are limited by the absence of taxonomic data on plants and animals. By developing methods to evaluate biodiversity via alternative data, it is now possible to quantify the ecological carrying capacity in areas where taxonomic data are lacking. The relationship between forest ecosystem health and biodiversity values can be used to estimate biodiversity values by considering the proportions of different land use types that are associated with forest ecosystem abundance. The biodiversity value of the area can be assessed by adding the abundance values of forest ecosystems for each land use in the study area, resulting in computed biodiversity values. The accuracy can be confirmed by comparison with the Shannon–Wiener index values obtained in the research areas. The calculated biodiversity values in the study area, namely, Chonburi, Rayong, and Chachoengsao provinces in Thailand, were 2.08, 1.29, and 2.33, respectively. These values are close to the areas' average Shannon–Wiener index values. As a result, it is possible to conclude that the method has the potential to be applied as a substitute for biodiversity assessment in regions where taxonomic data on plants and animals are insufficient to guide future appropriate development.

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Introduction

Carrying capacity assessment is an ecological tool used to evaluate the sustainability of human activities in areas of different sizes while considering the capacity of natural resources and the environment, ensuring that negative impacts are not severe [1]. Economic development zones have undergone significant infrastructure development and transformed land cover. Consequently, there has been an increase in built-up structures, accompanied by a loss of natural areas. This shift toward denser urbanization may result in the formation of heat islands [2–3] and thermal discomfort. Furthermore, the existence of built-up land cover directly affects the efficiency of rainfall drainage, resulting in an increased risk of flooding in urban areas [4]. Urban heat islands and built-up land cover significantly affect biodiversity by altering natural habitats and microclimatic conditions. Rising temperatures can disrupt local ecosystems by stressing native plants and animal species, reducing habitat suitability, and accelerating the spread of invasive species that thrive in warmer environments [5]. Built-up land cover also contributes to habitat fragmentation and loss, diminishing green space and natural vegetation. This limits the availability of food, shelter, and breeding grounds for many species, thereby decreasing species richness and ecosystem resilience [6]. The cumulative effect of these changes has led to a decline in biodiversity, particularly in densely developed zones. Therefore, it is imperative to evaluate the carrying capacity of ecosystems in economic zones to achieve a harmonious equilibrium between promoting economic development and safeguarding environmental health, thereby increasing the quality of life for local people.

The carrying capacity of an ecosystem is an evaluation of the status of biodiversity that focuses on the rate of species extinction per unit of time [7–8] and requires continually collected taxonomic data in the area. Nevertheless, in many regions, the data necessary for assessing biodiversity are unavailable. As a result, efforts have been made to evaluate biodiversity via additional related data. For example, Newbold et al. [9] studied the consequences of biodiversity loss both locally and globally via land-use change components. They reported that there was an average 10.7% decline in species abundance worldwide. Hooper et al. [10] reported a significant relationship between biodiversity and ecological functions and services at the local level. In addition, the biodiversity habitat index (BHI) principle is used to assess the level of habitat degradation experienced by flora and wildlife and spatial fragmentation. The technique calculates the proportional change in overall biodiversity values that persist within a specific geographic region because of habitat degradation [11]. A significant association exists between land use change and habitat loss in these areas. Furthermore, natural areas are highly associated with increasing local biodiversity. However, the correlation with human land use is inversely proportional [9]. The worst-case scenario revealed a 76.5% difference in overall species richness between natural and human-affected areas, indicating that places with high human land use activities had considerable influence.

Land use as a habitat for biodiversity components can be divided into five distinct categories: (1) primary vegetation comprising native trees (forests) and regenerating forest areas classified as secondary vegetation. (2) Plantation; 3) cropland; (4) pasture; and (5) urban area. Land use classification demonstrates the variety in biological diversity in an area, which is determined by the density and number of trees in the presence of living species at a certain location. Therefore, in line with the principles of the biodiversity habitat index, the change in the number of species and the area covered by trees should be taken into consideration when measuring the capacity to support biodiversity. Unfortunately, there are still problems with many habitat databases for plant and animal species, especially in developing countries.

The Eastern Special Economic Development Zone, commonly known as the Eastern Economic Corridor (EEC) of Thailand, has undergone changes in land use and land cover to allow development projects such as industrial parks, airports, deep-sea ports, and electric trains. These changes stress natural regions. However, there is currently a shortage of thorough taxonomic data on plant and animal species in the area. As a result, establishing criteria for evaluating ecological potential is critical to achieving a harmonic and sustainable development approach. These principles help guarantee that development is carried out in an environmentally responsible way that allows for ecosystem maintenance and restoration. This study aims to develop an approach to evaluate biological diversity in Thailand's EEC. A method was developed to estimate biodiversity values in areas where taxonomic data are insufficient by using land use types and forest ecosystem abundance as proxies. This approach was chosen because of the practical limitations in conducting comprehensive taxonomic surveys across many developing regions. Although indices such as the BHI and other taxonomic-based metrics are widely employed in biodiversity assessments, they require detailed species-level data, which are often unavailable or incomplete in the study areas. Consequently, these indices were not applicable to this research. Instead, the proposed method integrates land use classification with forest ecosystem health to compute a biodiversity value (BDV), which is subsequently validated against the Shannon–Wiener index. This approach offers a practical alternative for biodiversity assessment in data-scarce regions and supports evidence-based decision-making in environmental planning.

Methodology

This section outlines the ecological concepts and practical methods used to assess biodiversity in the EEC. It integrates land use classification, biodiversity indices, and ecosystem functions with the calculation and validation of BDV, offering a comprehensive approach for evaluating ecosystem carrying capacity, as illustrated in Figure 1.

1) Definitions of ecosystems and biodiversity

An "ecosystem" is a geographical area where numerous plants, animals, and other organisms share the same physical environment, climate, and landscape [12–13]. On the other hand, "biological diversity" refers to the wide range of distinctions present in life on Earth, such as genetic and species variation, as well as differences in ecosystem structure and function. Thailand's Office of Natural Resources and Environmental Policy and Planning defines "biological diversity" as the existence of numerous living organisms and diverse species in various ecosystems around the world or, more simply, the abundance of different types, species, and ecosystems on Earth.

2) Biodiversity index

A biodiversity index is a quantitative measure of the number of different species in a community (area). Richness, evenness, and dominance are three features of this statistical model of biodiversity. The biodiversity index focuses on the number of species, genera, families, or roles and functions of plants and animals. There are various methods for estimating biodiversity indicators.

Kitikidou et al. [14] compiled 17 different methods. Nonetheless, Wilson and Gownaris [15] reported that Simpson's index and the Shannon–Wiener and evenness indices are the most commonly used methods for evaluating biodiversity.

Simpson's index calculates the probability of two randomly picked species being identical. Values near 1 imply limited biodiversity, whereas values near 0 indicate high biodiversity.

The Shannon–Wiener Index incorporates uncertainty into the richness and evenness of species in a community. A community with low diversity is more likely to categorize randomly picked species appropriately. The probability of successfully categorizing randomly picked species decreases in a highly diverse community. The value is calculated from zero to the maximum value.

The evenness index is derived from the population densities of all species present in a specific habitat. The values range from 0 to 1, with values closer to 1 indicating a higher level of species evenness. In contrast, numbers close to 0 indicate the level of dominance displayed by a particular species.

To measure the biodiversity of a region accurately via these approaches, comprehensive biological data of the area are needed. Frequently, the necessary information is lacking in specific regions that require investigation [15]. This causes the species indicator scores to be unrealistic. Wittawachutik et al. [16] offered biodiversity scores on the basis of the value of ecological services obtained from the forest ecosystem. Under the assumption that an area has a high level of biodiversity, the forest ecosystem in that area is also very healthy. There are three critical components of the forest ecosystem to consider: structure, function, and services. Four aspects define forest ecosystem structure: (1) external variable factors, such as weather beyond human control; (2) internal constant factors, such as topography and soil type; (3) interconnected factors, such as ground cover quantity and quality; and (4) wildlife-promoting factors.

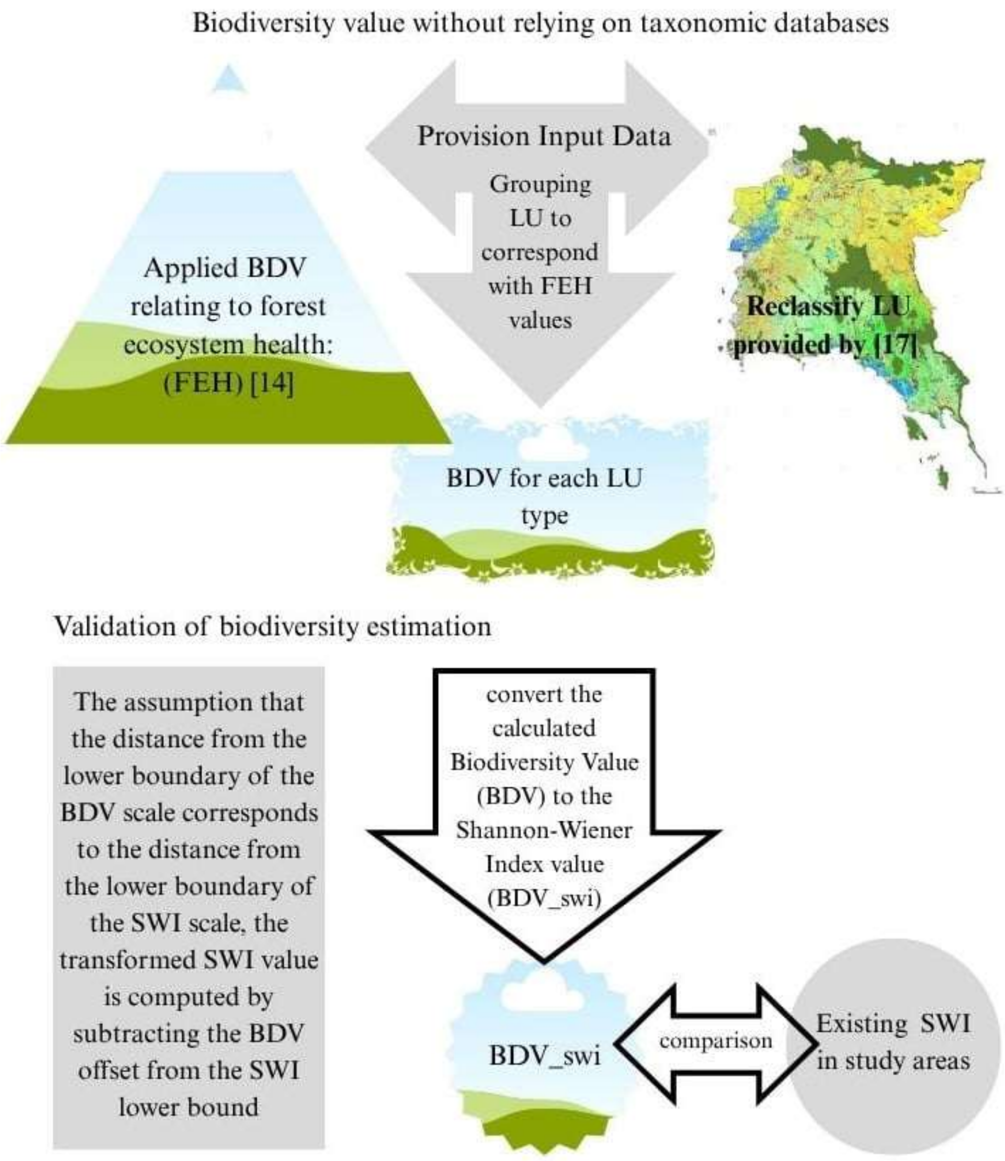

Figure 1 Research approach.

The structure of a forest ecosystem encompasses both its physical components and the dynamic processes that sustain it. These include not only the spatial arrangement of vegetation and abiotic factors but also the functional roles that maintain ecological balance. Among these processes, two key processes—water circulation and energy–nutrient cycling—are essential for supporting biodiversity and ecosystem services. With respect to the roles and responsibilities within forest ecosystems, two primary ecological functions are emphasized: (1) Forests play a vital role in regulating the hydrological cycle. Rainfall is intercepted by the tree canopy, which slows its descent and allows more water to infiltrate the soil. This process reduces surface runoff, supports groundwater recharge, and contributes to stream formation. Additionally, evapotranspiration from vegetation returns moisture to the atmosphere, influencing local and regional climate patterns [17]. (2) Energy–nutrient circulation systems, inherent to forest ecosystems, facilitate the transformation and movement of energy and nutrients. Through photosynthesis, trees absorb sunlight, carbon dioxide, water, and soil nutrients to produce biomass. This biomass supports herbivores and decomposers, which in turn nourish higher trophic levels. Decomposition returns nutrients to the soil, maintaining fertility and enabling continuous plant growth. These cycles are essential for sustaining biodiversity and ecosystem productivity [17]. The last section discusses ecosystem services, including direct services involving wood products and forest products and indirect services such as carbon dioxide gas absorption, controlling the system for absorbing rainwater and draining runoff to streams, controlling soil erosion, alleviating weather severity, being a natural learning source, and being a place to relax.

The SCS-SN approach, developed by the United States Soil Conservation Service (SCS) and adapted by Thailand's Soil Network (SN), is a framework used to evaluate the impacts of land use on ecological health. It integrates soil characteristics, vegetation cover, and land management practices to assess ecosystem functionality. This method is particularly useful in regions where direct taxonomic data are unavailable, as it provides a proxy for estimating biodiversity via land use and forest ecosystem indicators. Wittawatchutikulul et al. [18] examined the combined influence of land use characteristics on the overall health of vegetation across different areas. This study enables the determination of the BDV for each land use type, as presented in Table 1. Forested regions have the highest score, whereas urban areas have the lowest score [16, 19].

3) Study area

The EEC includes Chachoengsao, Chonburi, and Rayong provinces along the eastern coast of Thailand (Figure 2). These areas include both industrial zones and adjacent forested regions. The EEC contributes approximately 14% of the nation's economic value, with its industrial mass product being the most significant. Both the population size and population density are increasing. This selection allows for a comprehensive assessment of biodiversity across varying land use types influenced by economic development.

Table 1 Biodiversity score (BDV) for each category of land use [16]

Classification of land use based on indicators	The overall state of the area	Biodiversity value (BDV)
Evergreen forest	Complete	55
	Incomplete	28
Deciduous forest	Complete	45
	Incomplete	23
Edible forest	Deep soil	51
	Shallow soil	25
Mixed crop farm	Deep soil	42
	Shallow soil	22
Fruit orchard	Deep soil	32
	Shallow soil	17
Field planting area	Deep soil	16
	Shallow soil	14
Abandoned farm	-	18
Vacant area	-	13
City	-	0

Remark: * The BDV is derived as an average land use dataset.

4) Biodiversity data and configurations

Biodiversity assessment in the EEC relies on land use data provided by the Land Development Department (LDD) [21]. This dataset was reclassified into biodiversity value categories on the basis of ecosystem health indicators, as shown in Table 2, which displays nine distinct land use types.

On the basis of the biodiversity score assigned to each land use category (Table 1) and the corresponding land use data for the study area, the BDV for each study area can be calculated via Eq.1.

$$\sum_{i=1}^{m} \frac{Li \times BDVi}{N} \quad \text{(Eq.1)}$$

Where;

- Σ = Score of the BDV level of the ecosystem
- M = The number of land use types
- i = The type of Land Use
- L = Area of land use (km^2)
- BDV = Biodiversity value
- N = The area of the study area (km^2)

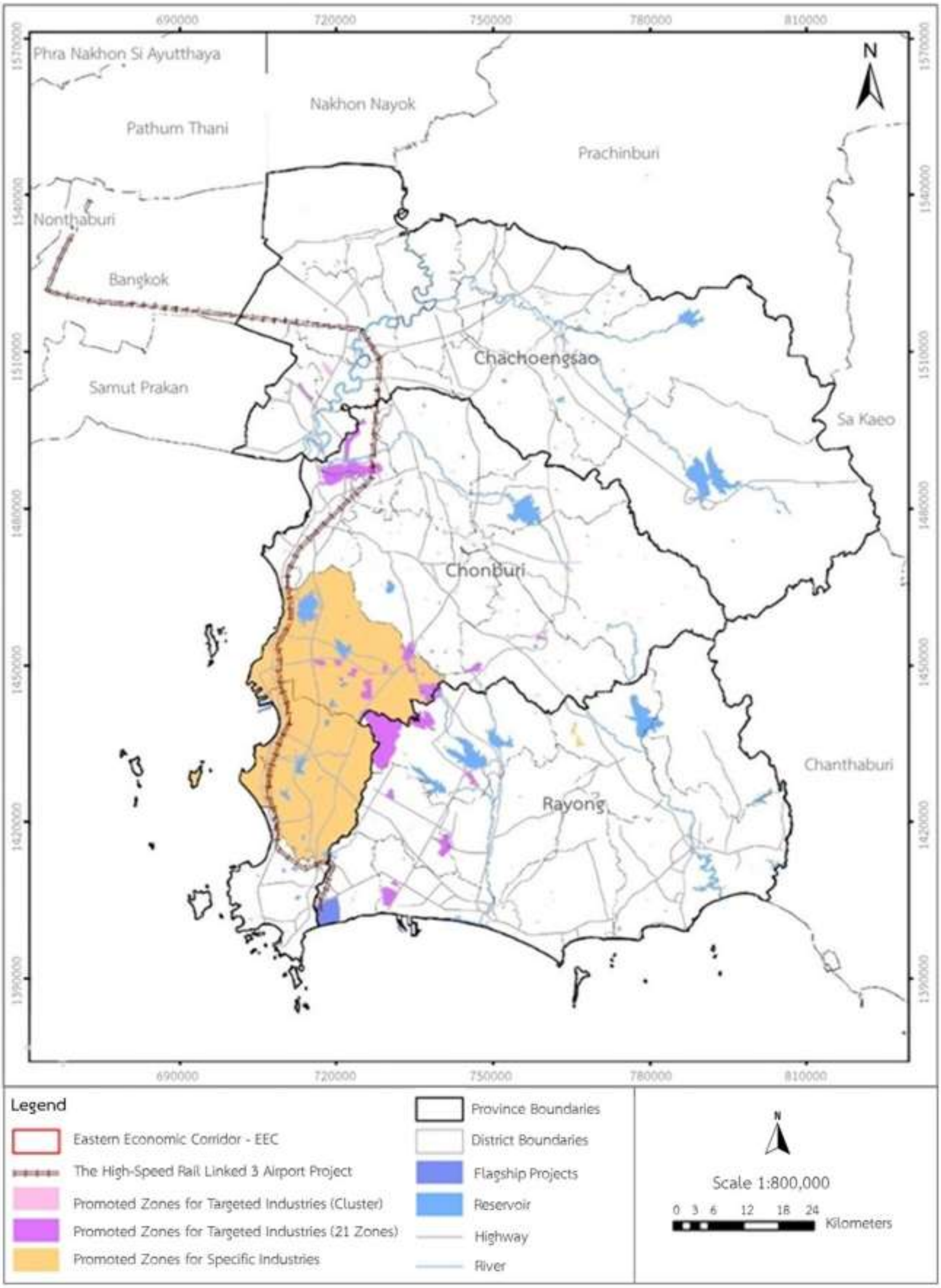

Figure 2 Eastern Economic Corridor (EEC), Thailand [20].

Table 2 Land use types in the study area w

Classification of land use based on indicators	Land use categorized by Land Development Department (LDD)	The overall state of the area (according to indications)
Evergreen forest	Complete evergreen forest	Complete
	Restore evergreen forest	Incomplete
Deciduous forest	Complete deciduous forest	Complete
	Restore deciduous forest	Incomplete
Edible forest	Vegetation, herbs, etc.	Deep soil
		Shallow soil
Mixed crop farm	Integrated agriculture, mixed farming etc.	Deep soil
		Shallow soil
Fruit orchard	Durian, mango, rambutan etc.	Deep soil
		Shallow soil
Field planting area	Corn, sugarcane, cassava etc.	Deep soil
		Shallow soil
Abandoned farm	Abandoned farm	-
Vacant area	Open land, pasture meadow	-
City	Downtown, commercial area, village, Factory, industrial estate etc.	-

Remark: Area sizes for each land use type are derived from the Land Development Department dataset [21] and are presented in square kilometers.
Source: Adapted from Land Development Department [21]

BDV is a crucial determinant for assessing the level of biodiversity in an ecosystem, considering various land uses (Table 1). Land uses with BDVs less than 14 are prone to cause substantial sediment and water loss. It symbolizes the disruption of the ecosystem's operational processes. Hence, it is categorized as "critical" with respect to ecosystems. Scores between 14 and 42 indicate that the system is "vulnerable" in the sense that it can cease to provide ecosystem services if it is compromised from the outside. Ecosystems or land uses with a diversity score exceeding 42 may be classified as such if they continue to support the regular operation of the ecosystem's functions [16].

5) Examination of the accuracy of the calculated results from the specified methods

Validation of biodiversity estimation methods is a critical step in confirming the reliability of the proposed BDV approach. This section introduces a comparative framework that aligns BDV values—derived from land use data—with the Shannon–Wiener index (SWI), a widely recognized metric for biodiversity assessment. Through this comparison, the accuracy and practical relevance of the BDV method are evaluated, particularly in contexts where comprehensive taxonomic data are unavailable.

Eq.2 is used to convert the calculated BDV into an equivalent Shannon–Wiener index value (BDV_swi). This conversion is essential for validating BDV results in regions lacking sufficient taxonomic data. The SWI typically ranges from 1.5–3.5 in normal ecosystems [22], with higher values indicating greater biodiversity. In contrast, BDV values range from 14–42, where values below 14 are considered critical, and values between 14 and 42 are deemed vulnerable. To enable comparison, a linear transformation is applied to map BDV values proportionally onto the SWI scale. The slope of this transformation is calculated as slope = ((3.5-1.5))/((42-14)). Under the assumption that the distance from the lower boundary of the BDV scale (14) corresponds to the distance from the lower boundary of the SWI scale (1.5), the transformed SWI value is computed via the formula shown in Eq.2.

$$\mathrm{BDVswi} = \frac{1.5-(14-\mathrm{BDVi})\times(3.5-1.5)}{(42-14)} \qquad \text{(Eq.2)}$$

This equation allows BDV values to be interpreted on the same scale as the SWI, facilitating their validation and comparison with existing biodiversity studies.

Results

The principle states that geographic areas with high levels of biodiversity are directly correlated with the abundance of forest ecosystems. An analysis of the land use data from the Eastern Special Development Zone revealed that 8.14% of the territory consisted of undisturbed forest regions. When the areas were divided by province (Chachoengsao, Chonburi, and Rayong), 14.97%, 11.11%, and 2.76% of the forest area, respectively, were in good condition. The forest area fraction in good condition indicates the disparity in the level of biodiversity within the region. The calculation findings indicated that the biodiversity level of the ecosystem in the Eastern Special Development Zone was 17.79, as shown in Table 3. It may be inferred that this ecosystem falls into the vulnerable category due to its low biodiversity. Consequently, an ecosystem is at risk of losing its role as a provider of ecosystem services when exposed to external effects.

The examination of each province can be summarized according to its biodiversity level as follows. The ecological biodiversity level in Chachoengsao Province is 25.67, whereas the level in Chonburi Province is 22.21. These values indicate that the biodiversity levels are higher than the total biodiversity level of the special economic development region. The ecosystems of both provinces are classified as vulnerable on the basis of their BDV scores. These values fall within the 14–42 range, which indicates that ecosystems that are still functional but susceptible to losing their ecological services when subjected to external pressures. The area requires rules for the preservation and restoration of its ecosystems to establish stable sustainable ecosystem services. Rayong Province has an ecosystem biodiversity level rating of 11.17, which is lower than the whole area's biodiversity level. It is classified as a group of land users that cause a great deal of loss of soil and water, indicating a decline in ecosystem function. It is categorized as critical because its biodiversity value exceeds the area's carrying capacity. Immediate action is required to implement measures aimed at restoring ecology in conjunction with economic development projects.

We consider comparing the data between the calculated biodiversity values and the proportion of forest areas that are in good condition. This shows a linear relationship where a high proportion of intact forest area indicates high biodiversity values. The details are shown in Figure 3.

Following their conversion to the Shannon–Wiener index, the calculated BDVj were validated and compared to the actual values obtained in the surrounding areas. According to Table 3, the computed BDVswi values for the provinces of Chachoengsao, Chonburi, and Rayong were 2.33, 2.08, and 1.29, respectively. These values are close to the Shannon–Wiener index of neighboring ecosystems. As shown in Figure 4 and Table 4, the data from the studies of biodiversity, estuary ecosystems, and botanical gardens in Rayong had values in the range of 0.1–2.4, whereas the data from the studies of biodiversity and beach ecosystems in Chonburi Province had values in the range of 1.0–2.6. The values are in the SWI, which is similar to that of nearby ecosystems. Thus, the accurate method of estimating biodiversity in areas lacking taxonomic data involves evaluating BDV values through land use types. This method can then be taken into consideration when making decisions about area development to ensure that economic development does not have an unsustainable impact on the ecosystem of the area.

Table 3 Biodiversity value of EEC in Thailand

Types of land use	BDV for LU types	BDV Score (Area: km^2)			
		EEC	CC	CB	RY
Evergreen forest					
-Complete	55	48,496 (881.8)	37,453 (681)	4,296.5 (78.1)	6,746.8 (122.7)
-Incomplete	28	309.6 (11.1)	309.6 (11.1)	1.4 (0.05)	428.2 (15.3)
Deciduous forest					
-Complete	45	26,205 (582.3)	3,362.6 (74.7)	17,305 (384.5)	5,535 (123.1)
-Incomplete	23	1,519.1 (66)	116.9 (5.1)	902.4 (39.2)	499.8 (21.7)
Edible forest					
-Deep soil	51	3,876.4 (76)	2,308.9 (45.3)	1,134.2 (22.2)	433.8 (8.5)
-Shallow soil	25	1,249.7 (50)	1,01.70 (41.3)	203.0 (8.1)	15 (0.6)
Mixed crop					
-Deep soil	42	151,885 (3,616)	46,605 (1,110)	39,625 (943.4)	65,655 (1,563)
-Shallow soil	22	27,106 (1,232)	14,911 (677.78)	5,277.5 (239.9)	6,917.4 (314.4)
Orchard					
-Deep soil	32	13,056 (408)	1,052.8 (32.9)	4,156.3 (129.9)	7,846.6 (245.2)
-Shallow soil	17	1,134 (66.7)	292 (17.2)	367.5 (21.6)	474.5 (27.9)
Field plant					
-Deep soil	16	45,420 (2,839)	22,183 (1,386)	18,096 (1,131)	5,140.1 (321.3)
-Shallow soil	14	6,199.7 (442.8)	4,837.6 (345.5)	1,080 (77.1)	282.6 (20.2)
Abandoned farm	18	4,110.2 (228.3)	1,930.9 (107.3)	1,485 (82.5)	694.3 (38.6)
Vacant area	13	5,972.9 (459.4)	949.9 (73.07)	2,961.4 (227.8)	2,061.2 (158.6)
City	0	0 (2,007)	0 (422.2)	0 (1,012)	0 (575.8)
Total		336,541 (18,914)	137,346 (5,351)	96,891 (4,363)	102,733 (9,200)
BDV		17.79	25.67	22.21	11.17
BDV_{swi}		1.77	2.33	2.08	1.29

Remark: EEC = Eastern Economic Corridor, CC = Chacheangsao, CB = Cholburi, RY = Rayong
BDV acquired from Equation 1; BDV_{swi} acquired from Eq.2.
Source: adapted from Land Development Department [21]

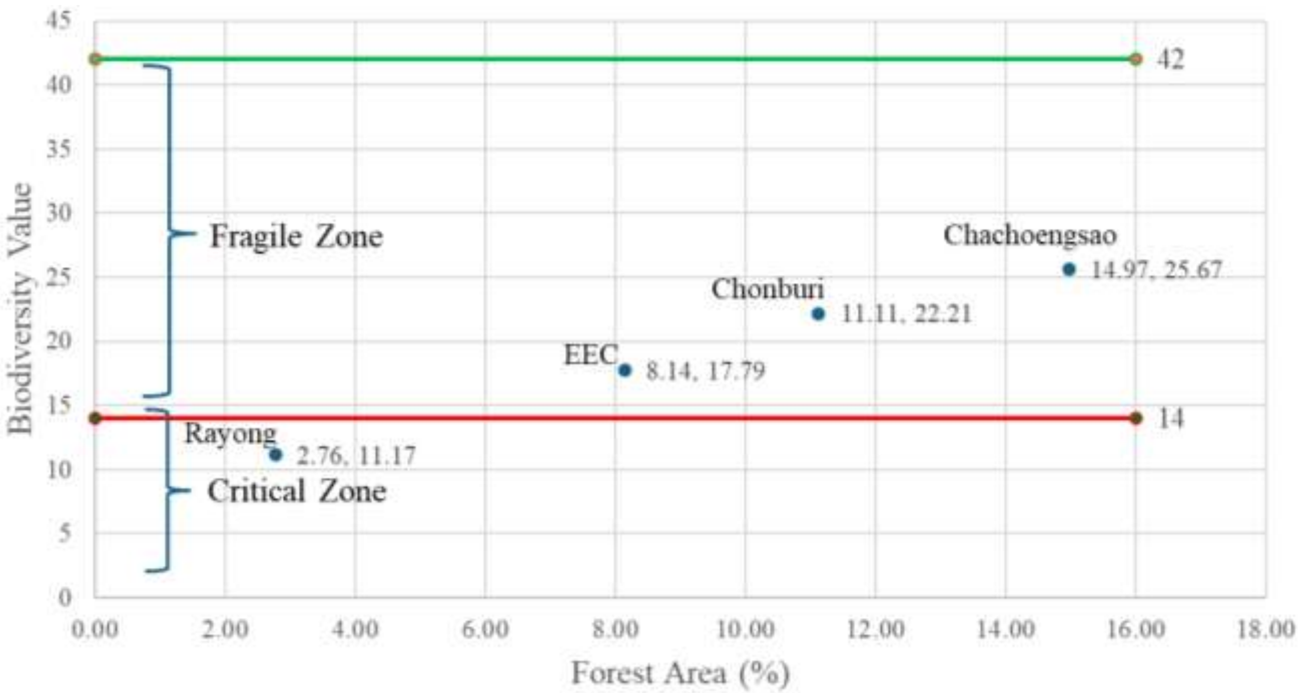

Figure 3 A comparison of the percentage of complete forest and biodiversity levels.

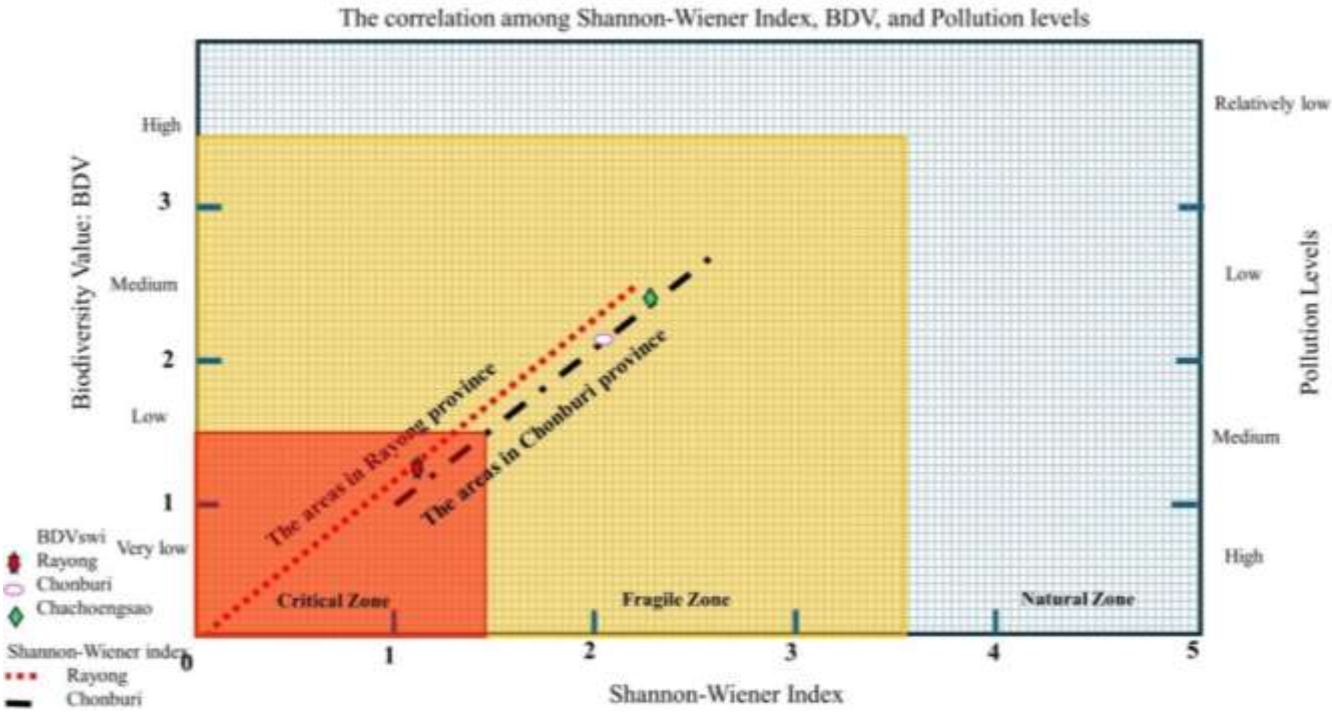

Figure 4 Comparison between the Shannon–Wiener index and the calculated BDV_{swi}.

Table 4 Comparison between the Shannon–Wiener index and the calculated BDV_{swi}

Area	Shannon–Wiener index	Data source	BDV_{swi}
General ecosystem	1.5–3.5	[22]	
Chonburi			
Bang Saen beach	1.0–2.6	[23]	2.08
Worn Napa beach	1.2–1.9	[24]	
Rayong			
Rayong botanic garden	0.08–0.18	[25]	1.29
Seagrass source, Klang district	0.188–1.042	[26]	
Prasae estuary	0.57–2.40	[27]	
Chachoengsao			
No data was found for evaluating the Shannon–Wiener Index in the area.			2.33

The relationship between biodiversity and pollution levels illustrated in Figure 3 is further supported by comparative data presented by Albueajee et al. [28], which categorizes pollution levels on the basis of the SWI. According to this framework:

- SWI values between 3.0–4.5 indicate high biodiversity and light pollution.
- SWI values between 2.0–3.0 reflect moderate biodiversity and light pollution.
- SWI values between 1.0–2.0 correspond to low biodiversity and moderate pollution.
- SWI values between 0.0–1.0 suggest very low biodiversity and heavy pollution.

This classification aligns with the findings in the study area. For example, Rayong Province, with a BDVswi of 1.29, falls within the range associated with moderate to heavy pollution. In contrast, Chachoengsao and Chonburi, with BDVswi values of 2.33 and 2.08, respectively, correspond to light to moderate pollution levels. These correlations reinforce the ecological interpretation that reduced biodiversity is frequently associated with increased pollution, particularly in regions undergoing rapid industrial development.

Discussion and conclusions

Evaluating biodiversity is crucial for making land development decisions, resulting in alternatives that achieve a balance between economic growth and environmental preservation. However, performing such an assessment necessitates enough taxonomic data in the area and adhering to commonly accepted methodologies for determining biodiversity values. The availability of taxonomic data remains restricted, particularly in developing countries. Hence, it is imperative to devise techniques for evaluating biodiversity with other correlated data. In addition, ensuring the efficacy of formulating a comprehensive area development plan that strikes a harmonious equilibrium between economic and environmental considerations is crucial. This study applies the relationship between forest ecosystem health and biodiversity values to estimate biodiversity values on the basis of the proportions of land use categories that are associated with the richness of forest ecosystems. The results were verified by comparing them with the data. The Shannon–Wiener index can be used to search in the research region.

The calculation revealed biodiversity values of 25.67, 22.21, and 11.17 for the provinces of Chachoengsao, Chonburi, and Rayong, respectively. When the estimated values are compared with the SWI, the similarity values are 2.33, 2.08, and 1.29, respectively. These values were converted to SWI equivalents (BDV_swi), which are consistent with the observed biodiversity levels in nearby ecosystems. The results confirm that the proposed method is sufficiently accurate for assessing biodiversity in data-scarce regions. However, the validation was based on limited availability index data, which were available for only three areas. As such, the method's applicability to other regions or countries should be approached with caution, particularly where ecological, climatic, or land use characteristics differ significantly. Future research should aim to validate and calibrate the model across a broader range of ecological contexts to increase its robustness and transferability. Despite these limitations, this study provides a foundational framework that can be adapted and refined for application in other data-scarce regions, offering a practical alternative for biodiversity assessment where traditional taxonomic surveys are not feasible.

Furthermore, when the results of this study were compared with the established benchmarks for biodiversity and pollution levels, as assessed by Albueajee et al. [28], a Shannon–Wiener index value between 2 and 3 indicated a moderate level of biodiversity, whereas a value between 1 and 2 indicated a low level. The biodiversity values in Chachoengsao and Chonburi Provinces may be moderate, whereas in Rayong Province, the value is poor. The pollution level in Chachoengsao and Chonburi Provinces is classified as low; however, Rayong Province has a moderate level of pollution. It aligns closely with the environmental conditions that were present in a specific region during the previous period. Moreover, land use in Rayong Province has undergone significant and quick changes because it has been designated a key location for industrial growth under the Eastern Special Economic Zone Development Plan. Consequently, natural areas experience a higher rate of loss than other areas because of changes in land use. Simultaneously, the higher thresholds of pollution sources in this region increase the likelihood of a larger quantity of pollutants being emitted into the atmosphere.

The interpretation of biodiversity levels in this study is consistent with global findings. For example, Newbold et al. [9] reported an average 10.7% decline in species abundance due to land use changes, emphasizing the vulnerability of ecosystems undergoing rapid development. Similarly, Hooper et al. [10] demonstrated that biodiversity loss significantly impairs ecosystem services, particularly in areas with intensive human activity. These findings align with the observed trends in Rayong Province, where industrial expansion has led to reduced biodiversity and elevated pollution levels.

Moreover, data concerning biodiversity levels are crucial for making informed decisions when undertaking different projects. This will result in alterations to land use, particularly within the forest environment. This is because key determinants of biodiversity [29] include the following: (1) Alterations in the use of land and sea have the most detrimental effect on the natural environment instead of directly exploiting animal resources, plants and other organisms that surpass their carrying capacity due to activities such as deforestation, overhunting, and overfishing, which surpass the available resources; (2) Escalating climate change, resulting in extensive effects on biodiversity across many regions, particularly concerning the diminishing significance of ecosystem services; (3) Environmental contamination and the emergence of nonnative species; (4) Growth in population size and the economy results in a rise in the need for energy and other resources; and (5) incentives that promote the growth of economic activity, which fail to acknowledge the significance of ecosystem services. Hence, it is imperative to formulate a comprehensive strategy for the preservation and rehabilitation of ecosystems to ensure the optimal level of biodiversity. This will help strike a harmonious equilibrium between land use for construction purposes and the preservation of natural areas, thereby fostering sustainable economic and environmental development.

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