
Strategic environmental management and green space network development for sustainable green growth in the Eastern Economic Corridor: A case study of Chon Buri Province

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Abstract The findings in 2006- 2024 that is decreased in agricultural land from 65.23% to 53.74%, urban areas are increased from 13.06% to 23.65%. The result is decreased in forest areas from 14.31% to 11.34% and increased in vacant lands from 4.35% to 7.61%. These trends showed a shift in land use from agriculture to urban and industrial sectors. Analysis of green spaces from satellite data year 2026 revealed that green spaces in Chon Buri are 76.68% of the province's total area, with agricultural land accounting for the largest proportion (55.97%), followed by forest and tree areas (18.54%), mostly evergreen and mixed forests, with only small amounts of mangrove forests, the smallest area is found to be water bodies (1.61%) and golf courses (0.56%), respectively. However, there is a continuous downward trend in green space due to urban expansion and construction. District-level analysis is categorized the green spaces to three groups as districts with large agricultural areas is Phanat Nikhom, Ko Chan, Nong Yai, Ban Bueng, and Bo Thong, districts with high forest areas is Sattahip and Koh Si Chang, which have protected forest areas and topography unsuitable for agriculture or urbanization, and districts with dense urban areas and construction is Mueang Chon Buri and Si Racha, which are rapid expanded the industrial estates, ports, and residential areas. Results indicated that differences in green space distribution are related to topography and development levels, rapid industrial and urban expansion in Thailand's Eastern Economic Corridor. Coastal areas of industrial structures is tended to lose green space more than inland and islands. Changes in green space is affected energy exchange and ecosystems, causing urban heat island effects in cities. The hydrological changes are increased drought risks and water demand in urban and rural areas. Green space management to balance economic development with environmental conservation is needed.

Keywords: Geo-informatics, Eastern economic corridor, Strategic Environmental management plan, Green growth

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Introduction

Since the inception of the Eastern Seaboard Development Plan (ESDP) in 1981, Chon Buri Province has been central to Thailand's industrial development, as a major industrial and logistical hub. Development along the eastern coast has resulted in urban expansion, economic and industrial growth, as well as continuous population and building growth. In particular, the government's Eastern Economic Corridor (EEC) policy in 2018 is considered a target zone, which designates it as a world-class economic zone encompassing Rayong, Chon Buri, and Chachoengsao provinces, and aims to support industrial investment, generate income, and create jobs. Led by Laem Chabang Port—one of Southeast Asia's most strategic deepwater ports—and extensive industrial estates, Chon Buri has evolved into a multifunctional economic hub spanning industry, commerce, agriculture, and tourism (EECO, 2024).

While this development has positive economic impacts, it has also had significant negative effects on the environment and the quality of life. The shift from agricultural and green spaces to densely populated urban and industrial areas has created an urban heat island effect and has led to the degradation of natural resources. For example, studies show a continuous increase in average surface temperatures in the eastern region, with Chon Buri and Rayong provinces recording the highest averages, thereby increasing the vulnerability of ecosystems and environmental quality.

This situation reflects the crisis of declining green spaces in Thailand, both in quantity and quality. Past green space management has lacked integration among government agencies, the private sector, and the public. This has led to inadequate and inconsistent green space maintenance. Therefore, establishing policies and measures for green space management that are aligned with the principles of sustainable development is crucial. The concepts of green growth and eco-town development are key approaches to mitigate the impacts of climate change and strike a balance among the economy, society, and the environment.

The research finding is focused on analyzing land use and the distribution of green spaces in the Eastern Economic Corridor, particularly Chon Buri province, to study the link between green space development and climate change, and to develop guidelines for sustainable green space management. Ultimately, this study aimed to contribute to a master plan for a green space network and a green growth strategy in the EEC.

Materials and methods

This research investigation was employed a mixed-methods approach, integrating qualitative and quantitative techniques with Geographic Information Systems (GIS) to study land use dynamics and the distribution of green spaces in Chon Buri Province, Thailand. It is presented spatial data, land-use classification, and statistical analysis of land-use changes over time. The research design was combined a satellite remote sensing, GIS spatial analysis, systematic field surveys, and statistical processes. The analysis was focused on industrial and urban areas. Quantitative data are derived from high-resolution satellite imagery and datasets from relevant agencies, while qualitative data were collected from policy and strategic reviews, GPS field surveys, and policy analysis. Statistical validation was used to confirm the reliability of land use classifications and the significance of changes.

Geospatial data sources

The research finding was conducted in Chon Buri Province, Thailand, one of the three key provinces in the EEC. The study period covered from 2006 to 2026 (20 years) to collect long-term data on land use change and ecosystems.

Primary quantitative data on green areas were collected through field surveys in Chon Buri Province, including the recording of geographic coordinates using a global positioning device (GPS).

Secondary data included both descriptive statistics and quantitative information on (1) land use, urban planning, and population in the Eastern Economic Corridor from the Office of Public Works and Town & Country Planning, Ministry of Interior, Land Development Department, National Statistical Office, and Provincial Offices; (2) climate information, including temperature, humidity, and wind data from the Meteorological Department and other agencies; and (3) other information related to this study, including physical characteristics, socioeconomic and industrial reports, statistical datasets, and infrastructure development obtained from relevant documents and previous studies.

Spatial data were sourced from secondary records, including topographic and land-use maps. To analyze land-use dynamics and map green spaces, 2006, 2017, and 2024 data from the Land Development Department were integrated with high-resolution Sentinel-2 imagery (from 2006, 2019, and 2026) at a 10 m spatial resolution. By utilizing the visible, near-infrared, and shortwave-infrared bands, comprehensive provincial coverage was achieved, and vegetation indices were computed (Figure 1). These datasets were further supplemented by Land

Development Department databases and high-resolution Google Earth imagery. Image processing was conducted via standard remote sensing software, employing supervised classification alongside manual verification against ancillary data, such as topographic maps, forest reserve boundaries, and field surveys.

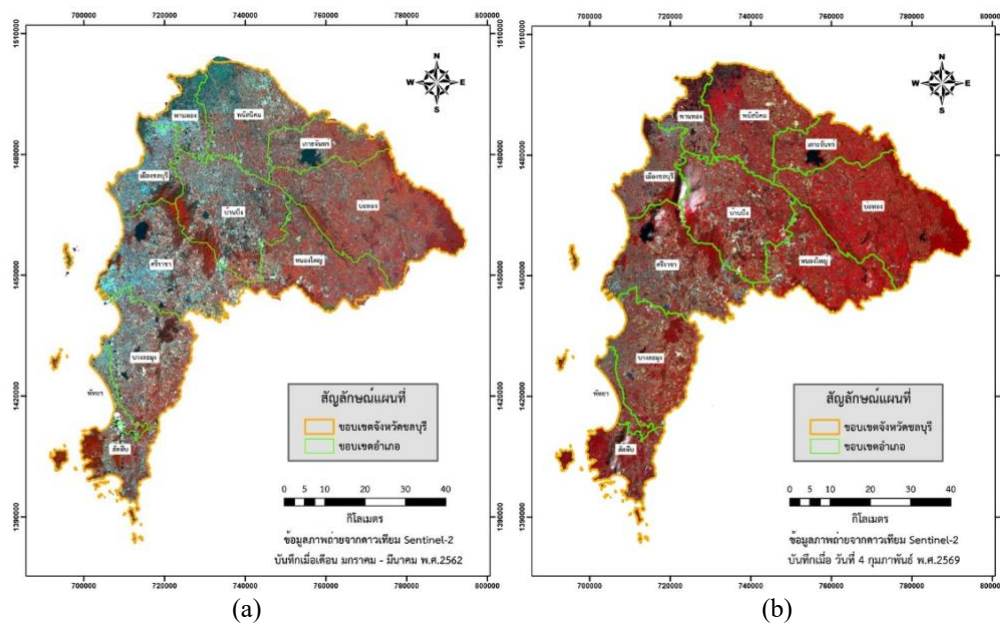


Figure 1. Satellite imagery. (a) Sentinel-2 (January-March, 2019); (b) Sentinel-2 (February 4, 2026)

Analytical framework

Quantitative data were analyzed using GIS-based spatial statistics and descriptive statistics, and land-use and green-space analysis. For example, land-use change detection was performed through supervised classification with GIS software. Comparisons were made across three time points (2006, 2019, 2026). The analyzed data were rechecked with a field survey and ground truthing.

Qualitative data from policy documents and socio-economic reports were analyzed using a TOWS framework, helped to identify strategic opportunities and risks within the province's environmental management system.

It led to develop a strategic environmental management plan. The integration of analytical data provided a comprehensive understanding of the dynamics of green spaces in Chon Buri province, linking spatial patterns of green space loss to the area's economic, social, and environmental challenges.

Results

Land use change analysis, 2006–2024

Chon Buri Province has been experiencing rapid urban and industrial expansion, particularly from 2017 to 2024. The analysis showed a correlation between these changes and the development of the Eastern Economic Corridor (EEC). The primary impact is pertaining to the continued loss of agricultural land and forests, threatening food security, ecosystems, and long-term environmental stability. This trend is found to be an evident in a comparative analysis of land use and land cover (LULC) in Chon Buri Province in 2006, 2017, and 2024, utilizing satellite imagery and data from the Land Development Department. (Table 1).

Table 1. Land Use/Land Cover Change in Chon Buri Province in 2006, 2017, and 2024

<i>Land Cover Type</i>	<i>2006 Area (Rai)</i>	<i>2006 (%)</i>	<i>2017 Area (Rai)</i>	<i>2017 (%)</i>	<i>2024 Area (Rai)</i>	<i>2024 (%)</i>
Agriculture	1,778,716	65.23	1,615,067	59.23	1,465,573.00	53.74
Forest	390,252	14.31	346,254	12.7	309,273.00	11.34
Water Bodies	83,137	3.05	151,450	5.55	99,825.00	3.66
Urban/Built-up	356,055	13.06	482,527	17.7	644,886.00	23.65
Vacant Land	118,714	4.35	131,577	4.83	207,318.00	7.61
Total	2,726,875	100	2,726,875	100	2,726,875.00	100

Source: Analysis of satellite imagery data from the Land Development Department.

The analysis revealed significant changes in the land use types, covering a total area of 4,363.00 square kilometers or 2,726,875 rai in Chon Buri Province (Figure 2). Agricultural land showed a continuous downward trend throughout the study period, decreasing from 65.23 percent of the total area in 2006 to 53.74 percent in 2024, representing a net decrease of 313,143 rai (501.03 square kilometers) or 17.61 percent over 18 years. Similarly, forest area decreased from 14.31 percent to 11.34 percent, representing a total decrease of 80,979 rai (129.57 square kilometers) or 20.75 percent. Conversely, urban/built-up areas showed the most significant expansion, increasing from 13.06 percent in 2006 to 23.65 percent in 2024, representing an increase of 81.12 percent within 18 years.

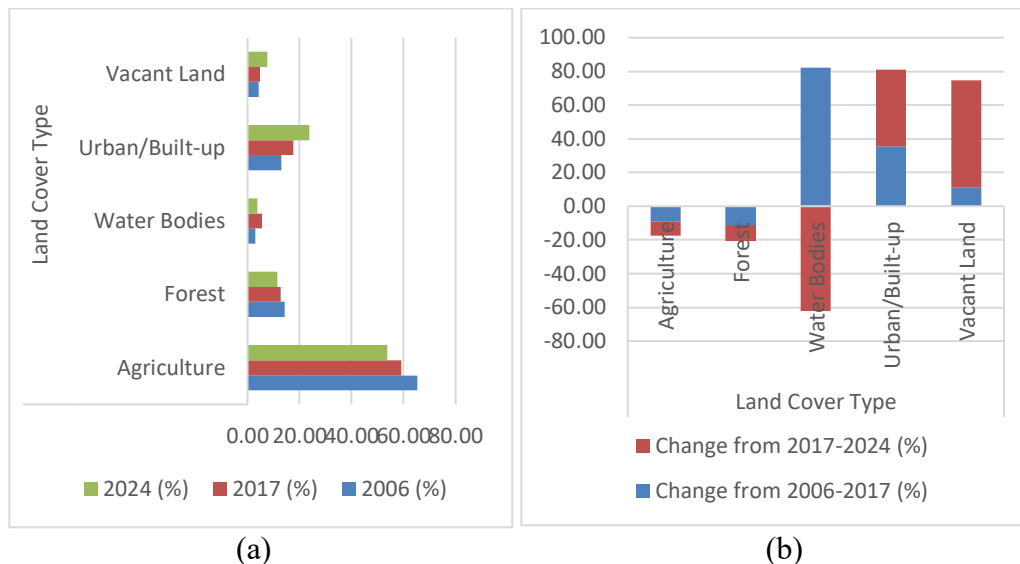


Figure 2. Land Use/Land Cover Change in Chon Buri Province during the years 2006, 2017, and 2024: (a) Percentage of land use/land cover in Chon Buri Province in 2006, 2017, and 2024; (b) Percentage of land use/land cover change in Chon Buri Province from 2006 to 2024

This expansion accelerated significantly between 2017 and 2024, with urban/built-up areas increasing by 162,359 rai (259.77 square kilometers), or 45.60 percent, in just seven years. This aligns with the timeframe of the EEC's development policies promoting investment in industry and infrastructure in Chon Buri and neighboring provinces. Vacant land also increased, from 118,714 rai (189.94 square kilometers) to 207,318 rai (331.71 square kilometers), a 74.64 percent increase within 18 years, which may reflect land held for future development. Regarding water areas. Although there has been a net increase of 20.07 percent over the past 18 years, there has been a significant decrease of 62.10 percent between 2017 and 2024, possibly resulting from land reclamation to accommodate commercial and industrial development.

Land use and distribution of green space in Chon Buri Province

A study of the distribution of green spaces in Chon Buri Province, as shown in Figure 3, revealed that the province's green spaces consist of three main types: agricultural land, forest and perennial trees, and water bodies. The details are as follows:

Chon Buri Province, the most agriculturally green area, including rice paddies and grasslands, accounted for the largest proportion, at 2,441.89 square

kilometers, representing 55.97 percent of the total area, distributed throughout the province. This was followed by forest and perennial tree areas, totaling 808.84 square kilometers, representing 18.54 percent. These areas consist mainly of evergreen and mixed forests, with only a small proportion of mangrove forests. Most of these areas are distributed across the coastal lowlands of Phanat Nikhom, Phan Thong, Mueang Chon Buri, and Bang Lamung districts. Forest and perennial plant areas are distributed in the following districts: Bo Thong, Ban Bueng, Si Racha, and Sattahip.

Additionally, water bodies covered 70.39 square kilometers (1.61%), while golf courses cover 24.59 square kilometers (0.56%). Furthermore, non-green areas, including urban and vacant land, total 1,017.29 square kilometers (23.32%). These areas are concentrated in some districts, specifically in Phanat Nikhom, Phan Thong, Mueang Chon Buri, and Bang Lamung, which have high concentrations of urban and industrial development.

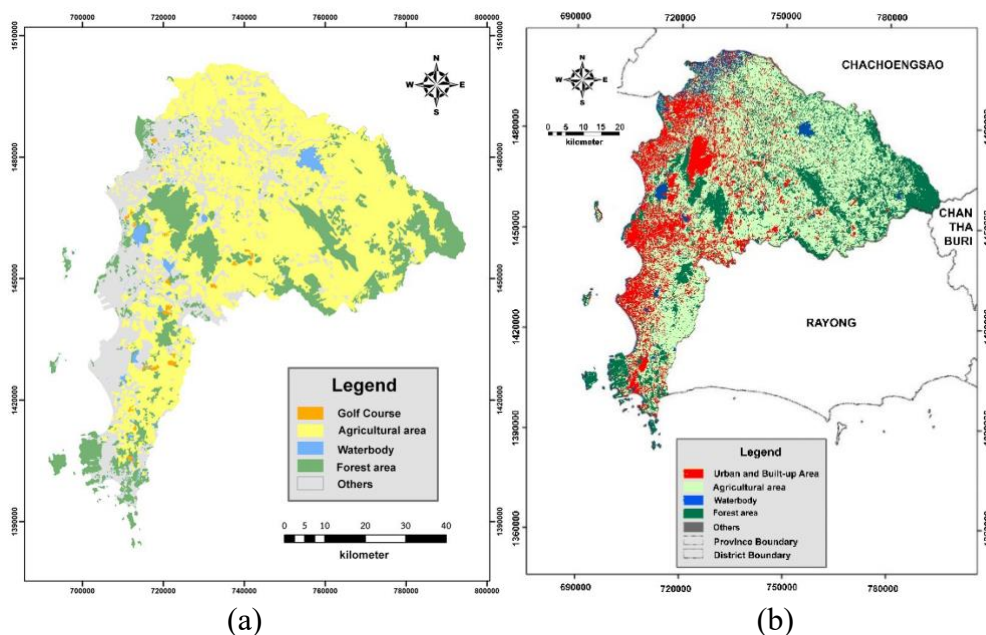


Figure 3. Land use in Chon Buri in 2026: (a) Land use classification according to green space typology; (b) Land use classification according to the Land Development Department

District-level green space analysis

Satellite imagery analysis of the distribution of green areas in Chon Buri province by district, as shown in Figures 4 and 5, revealed significant differences in land-use patterns. These districts were classified into three main groups:

districts with a primary agricultural component, districts with a high proportion of forest area, and districts dominated by urban and built-up areas.

The first group is comprised the districts with a predominant agricultural component, including Phanat Nikhom (75.71%), Koh Chan (73.99%), Nong Yai (72.39%), Ban Bueng (69.50%), Bo Thong (65.15%), Phan Thong (56.12%), and Bang Lamung (50.93%). These districts are maintained significant agricultural activity; Bo Thong, in particular, exhibited a high proportion of forest and perennial cover (30.22%) alongside its agricultural land.

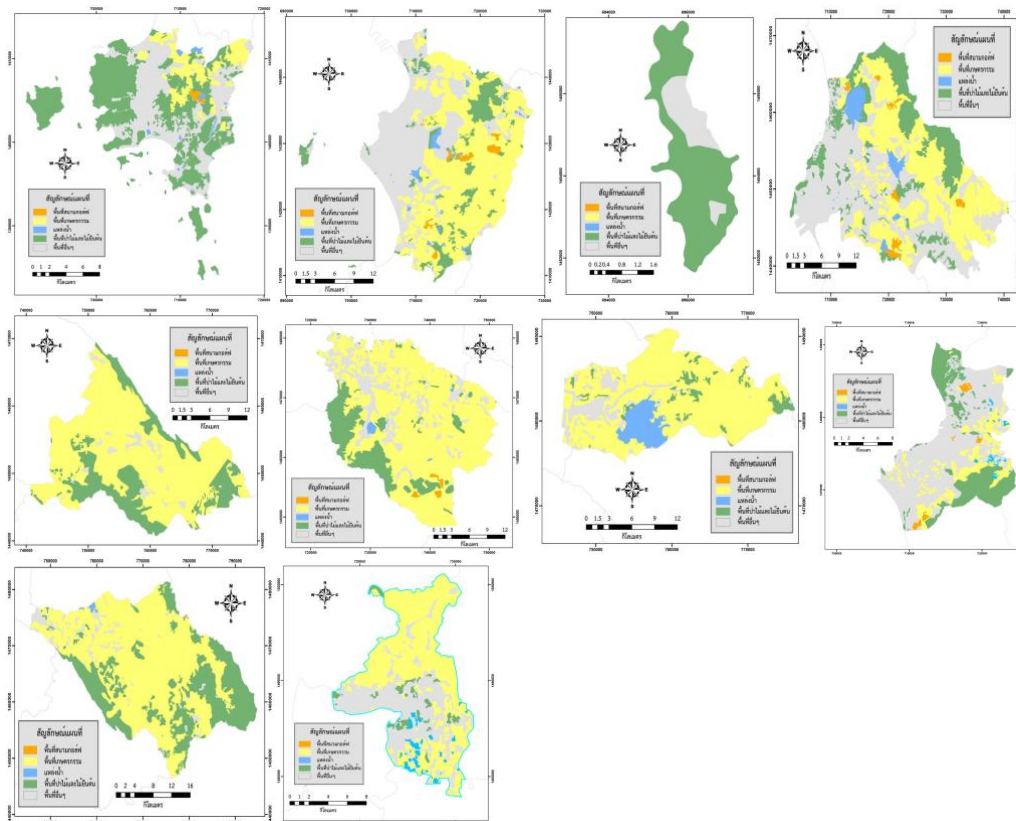


Figure 4. Distribution of green areas in 11 districts classified by land use types

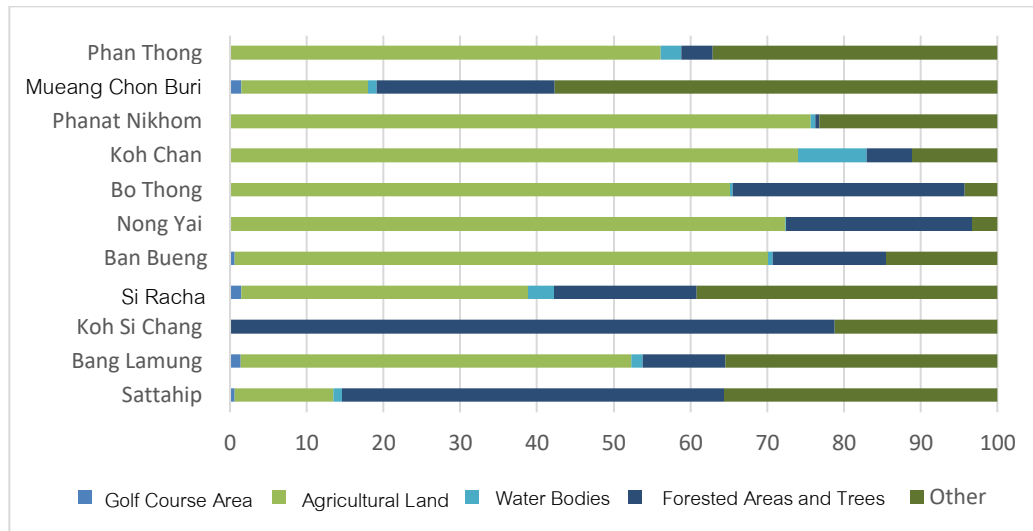


Figure 5. Proportion of green space distribution by district

The second group is comprised the districts with a high proportion of forest cover, specifically Sattahip and Koh Si Chang. Sattahip district has the largest proportion of forest and perennial trees (49.71%), which is attributed to key protected areas such as the Khao Chi-on Wildlife Sanctuary and portions of the Bang Lamung National Forest Reserve. Meanwhile, Koh Si Chang features the province's highest forest proportion at 78.79 percent, as the steep island topography renders most of the terrain unsuitable for agriculture or urban development.

The third group is comprised the districts dominated by urban/built-up areas. Mueang Chon Buri exhibits a high proportion of urban and vacant land at 57.70 percent. Similarly, Si Racha's urban area (39.15%) is slightly higher than that of agricultural land (37.37%), reflecting the expansion of industrial estates, commercial ports, and residential zones, mainly concentrated around Laem Chabang Port. Furthermore, although the largest proportion of Phan Thong's area is agricultural land (56.12%), its urban and vacant land has reached 37.07%, illustrating the significant pressure urban expansion places on agricultural areas.

District-level analysis revealed that the differences in green space distribution across Chon Buri province are closely linked to industrial and tourism development. Coastal districts with dense industrial infrastructure exhibit a significant decline in green areas, whereas inland and island districts retain a higher proportion of natural landscapes. These findings are highlighted the urgent need for context-specific green space management plans to mitigate further loss in areas facing intensified development pressure.

Forest resource trends in Chon Buri Province

An analysis of Chon Buri province's forest resources between 2004 and 2024 revealed clear timelines of changes, as shown in Figure 6. The province's forest area showed the changes which divided into three periods: 1) from 2004 to 2009, the forest area remained relatively stable, ranging from 480 to 483 square kilometers (approximately 11.02–11.06% of the province); 2) from 2010 to 2013, there was an increasing trend, peaking at 561.50 square kilometers (12.46%) in 2013; and 3) from 2014 onwards, the forest area has continuously decreased, in 2017, the forest area decreased to 486.24 square kilometers (11.14%), and recovered only slightly to 494.84 square kilometers (11.34%) in 2024.

In 2015, terrestrial forests covered 541.50 square kilometers, while mangrove forests accounted for 7.28 square kilometers. Based on cabinet resolutions dated December 15, 1987, and August 22, 2000, the designated mangrove forest area in the province totaled 41,313 rai. Currently, these areas are under the management of the Department of Marine and Coastal Resources, Ministry of Natural Resources and Environment, with significant areas located in Mueang Chon Buri district, particularly in Khlong Tamru subdistrict.

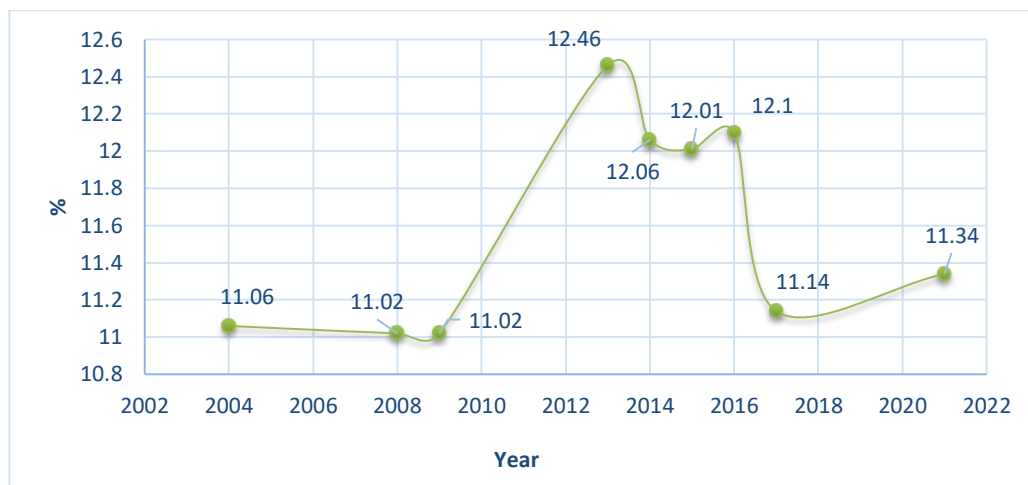


Figure 6. Forest Resource Area in Chon Buri Province, 2004–2021

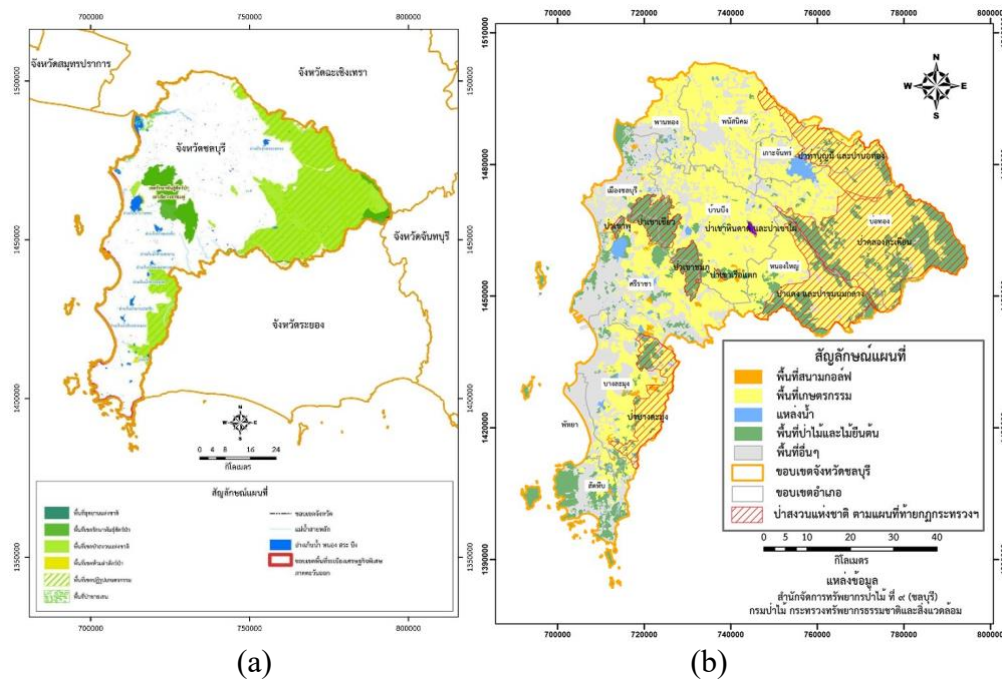


Figure 7. Forest areas in Chon Buri Province: (a) all classified forest areas; (b) forest areas classified according to national reserved forest boundaries, overlapping with various existing green space types

For forest areas are covered under the authority of various government agencies (Figure 7a), a consistent pattern of change was observed. Specifically, the 186297.92 rai managed by the Department of National Parks, Wildlife, and Plant Conservation maintained the highest quality of forest cover, with 87.70 percent of the area remaining intact, whereas forest cover within areas managed by the Agricultural Land Reform Office (ALRO) dropped to 16.51 percent, with the majority, 516,942.50 rai (80.31%), being converted for agricultural purposes. Similarly, lands under the Department of Lands retain only 3.91% forest cover, the lowest among all agencies, with most of the area transformed into urban/barren land (42.50%) and agricultural plots (46.61%). Beyond these figures, Chon Buri hosts significant terrestrial and mangrove ecosystems, including nine National Forest Reserves. These reserves, established by ministerial regulations, encompassed approximately 1,416.80 square kilometers (885,505.76 rai). Pa Khlong Takian is the largest reserve (388,286.74 rai), followed by Pa Daeng-Pa Chumneum Klang and Pa Tha Bun Mee-Bo Thong.

The best-preserved forest reserves are Pa Khao Chomphu, with 96.63% of its forest area remaining, and Pa Khao Khiao, with 94.50% remaining as shown in Figure 7b. Both are mountainous areas and located within wildlife sanctuaries,

the urgent need for effective conservation and restoration measures, integrated with land use planning, economic growth, and long-term green conservation.

Management guidelines for the Eastern Special Economic Zone with a green growth strategy

The TOWS Matrix analysis of Chon Buri Province within the EEC framework (Table 2), integrated with findings from the studies on land-use change in the context of green spaces, revealed key challenges and limitations in achieving sustainable development.

In terms of strengths, Chon Buri Province within the EEC has strategic advantaged due to its location as a regional industrial, commercial, and tourism hub. These areas have comprehensive transportation infrastructure, including Laem Chabang Port, railway networks, and highways. At the same time, environmental protection laws have been established in Bang Lamung and Sattahip. Furthermore, there are measures and approaches to significantly increase environmental awareness among residents.

However, land-use analysis reveals an 81.12 percent increased in urban/built-up areas over the past 18 years, while forest areas have decreased by 20.75 percent. This evidence indicated that existing environmental laws and public awareness are insufficient to effectively mitigate the loss of green spaces.

In terms of weaknesses, uncontrolled urban and industrial expansion, along with urban planning that was not in line with the EEC's development context, aligns with studies showing the decline of green spaces in several national forest reserves, particularly the Pa Tha Bun Mee-Bo Thong and Pa Daeng-Pa Chumnum Klang, with only 9.99 percent and 30 percent of forest areas remaining, respectively. Furthermore, the inadequate water management problems identified in the TOWS analysis are directly linked to decline in upstream forest areas, as forests act as natural reservoirs and filter systems. The reduction of forests therefore is directly exacerbated the water shortage problems in the region.

Regarding opportunities, the EEC policy and smart city trends are opened up opportunities to concretely integrate 'green growth' strategies into area development, especially through digital technologies for monitoring green spaces and natural resources. At the same time, the increasing demand for organic products and ecotourism are created economic incentives for conservation. However, climate change, manifested as drought risks in Phanat Nikhom and Phan Thong, as well as urban flooding due to reduce permeable surface areas, have remained a structural risk requiring a holistic solution.

Table 2. TOWS Matrix for developing a strategy for managing environmentally-friendly and sustainable ecosystem growth in the Eastern Economic Corridor

TOWS Matrix	S - Location/Site - Serving as a production base - Well-equipped with public utilities - A major agricultural and farming area - Well-equipped with medical and educational facilities - Environmental protection and pollution control laws in place - The public is attentive and aware of environmental issues and their health.	W - Incomplete urban planning for land use in the province is not comprehensive and does not align with area development. - Uncontrolled urban growth and industrial expansion, as well as the transition from an agricultural to an urban and industrial society. - Environmental and occupational health management problems arising from production processes. - Degradation of natural resources and environmental pollution. - Limitations in pollution management in the area. - Inefficient water management and insufficient water supply. - Changes in land use. - Construction of infrastructure and buildings obstructs natural water flow, causing flooding in some areas, especially in residential areas. - Labor shortage. - Lack of connectivity to tourist attractions.
O - The government has a policy to promote investment in the EEC. - Tourism and sports are promoted. - There is a diverse transportation and logistics system. - It is an important source of agricultural products. - Rapid technological advancements are underway. - Chon Buri province is one of the pilot areas for Smart City development. - The population structure is changing towards an aging society. - The trend of health consciousness and a growing appreciation for nature is also a factor.	SO - Establish a green space network to enhance transportation infrastructure. - Promote integrated organic/sufficiency farming, sustainable agriculture, and the new theory of agriculture.	WO - Promote and develop green spaces; conserve, restore, and maintain natural resources and the environment sustainably; plan appropriate and sustainable land use in green areas. - Strengthen and develop tourist attractions; develop and promote traditional and cultural activities for conservation, tourism, and marketing; create added value for tourism products and services to enhance competitiveness.
T - Technological advancements are progressing at a rapid pace in various aspects. - The population structure is changing towards an aging society. - Changing social values. - Measures that promote foreign investment more than Thai investment. - Non-tariff barriers. - Climate change.	ST - Environmentally friendly growth management. - A network of green spaces ready to adapt to climate change.	WT - Promote community participation in the development of green spaces. - Develop management practices to support the concept and formulate policies for sustainable development in natural resource management, environmental management, green spaces, and ecosystems.

Based on the TOWS matrix analysis (Table 2), this study is proposed an environmentally friendly growth strategy for Chon Buri and the broader EEC region. This strategy is anchored in the Green Growth concept, which integrates social and environmental considerations into every stage of economic development. The corresponding strategic framework is detailed in Table 3.

Table 3. Strategic framework for green growth in Chon Buri Province and the EEC

Key Action	Strategic Focus
I. Resource Conservation & Land Management	
Strategy 1: Restoration and Sustainable Land Use	
• Forest Reserve Protection: Enforce strict boundaries for the 9 national forest reserves (885,505 rai total); halt further encroachment in the 5 most degraded reserves. • Minimum Green Space Standard: Set and legally enforce 9 sq. m./capita urban green space per WHO guidelines. • Land-Use Integration: Align One Map parcel data with the EEC Master Plan to eliminate conflicting designations across 7 responsible agencies.	Core Problem: A 20.75% reduction in forest cover (2006–2024); the Pa Tha Bun Mee–Bo Thong reserve retains only 9.99% of the original forest area. Target Zones: Degraded reserves in Bo Thong, Nong Yai, and Phanat Nikhom districts where forest loss exceeds 60%. Outcome: Stabilize provincial forest cover at $\geq 11.34\%$ and reverse the downward trend by 2030.
Strategy 2: Technological Integration in Management	
• GIS & One Map Platform: Deploy a unified cross-agency GIS dashboard linking RFD, Land Department, and related datasets for real-time land-status monitoring. • Remote-Sensing Alerts: Implement automated change-detection (NDVI/EVI anomaly alerts) for all forest reserve boundaries with <30-day response protocols. • Digital Reporting: Standardize environmental data formats across all Chon Buri districts to enable province aggregation and benchmarking.	Core Problem: Seven related agencies have independent management capabilities, despite having overlapping responsibilities for managing forest areas, resulting in inconsistent boundaries and a lack of a joint monitoring system. Critical Gap: Local governments lack the necessary personnel, equipment, and access to information to effectively enforce environmental laws. Outcome: A single authoritative land-cover dataset and a reliable land-use dataset that is updated every two years, reducing law enforcement response times from months to weeks.
II. Sustainable Economic Sectors	
Strategy 3: Integrated Organic & New Theory Agriculture	
• Transition to Agroforestry: Replace monoculture farming in degraded forest reserve areas with integrated agroforestry systems to restore ecosystem function while preserving farmers' livelihoods. • Organic Certification: Provide subsidized organic-certification support (GAP, Organic Thailand) for farm households in agricultural areas, e.g., Bo Thong and Nong Yai.	Core Problem: Agricultural land in forest reserves has expanded to 516,943 rai (80.3% of the ALRO area), and heavy chemical use is degrading soil and water quality. Opportunity: Chon Buri's agro-tourism brands (e.g., durian, mangosteen, tropical fruits, etc.) can generate premium revenue that offsets the cost of change. Outcome: Reduce the amount of agricultural chemicals that flow into water sources and increase the area of certified organic farmland by 20% by 2030.
Strategy 4: Value-Added Ecotourism	
• Conservation-Tourism Linkage: Develop nature-based tourism products (birdwatching, mangrove kayaking, forest trail networks) in Koh Si Chang, Sattahip, and Khao Khiao as revenue streams for conservation. • Cultural-Heritage Routes: Connect coastal cultural sites with inland forest areas via a 'Heritage & Greenway Loop' linking Pattaya, Si Racha, and Bo Thong.	Opportunity: Ko Sichang (78.79% forest cover) and Sattahip (49.71% forest cover) represent high-value natural assets currently under-monetized for conservation purposes. Risk: Without revenue-sharing mechanisms, communities in areas with <1% forest have no economic incentive to protect remaining green space. Outcome: Establish 3 new nature-based tourism destinations by 2030.

Key Action	Strategic Focus
• Community Benefit Mechanism: Establish a Tourism Revenue Sharing scheme (5% of park entry fees) directed to local conservation funds.	
III. Infrastructure & Connectivity	
Strategy 5: Green Transportation Networks	
• Ecological Corridors: Design vegetated buffer zones (≥50m width) along all new EEC road and rail corridors to connect fragmented forest patches and reduce wildlife-traffic collisions. • Urban Greenways: Develop shaded pedestrian and cycling paths (≥3m canopy coverage) linked to mass transit stations in Si Racha, Laem Chabang, and Pattaya. • Riparian Greenways: Restore and protect 10m riparian buffer strips along streams and canals as linear green infrastructure for biodiversity and stormwater management.	Core Problem: EEC transport infrastructure (high-speed rail, motorways) fragments remaining forest patches and cuts ecological connectivity between forest blocks. Urban Need: Si Racha and Mueang Chon Buri districts have the lowest per-capita urban green space among all 11 districts, despite high population density. Outcome: Establish ≥200 km of green corridor network; achieve 9 sq.m/capita of urban green space in the 3 priority urban districts by 2030.
IV. Climate Resilience & Holistic Growth	
Strategy 6: Sector-Wide Environmentally Friendly Growth	
• Eco-Industrial Town Standards: Apply Eco-Industrial Town (EIT) criteria -including a minimum 15% green cover per estate to industrial estates in Chon Buri during renewal of operating licenses. • Sustainable Urban Development: Mandate green-building standards (LEED equivalent) for all new commercial and residential developments over 200 sq. m. in the EEC. • Green Agricultural Zones: Designate buffer zones around Bang Phra and Khlong Luang Reservoirs as ‘Water Catchment Agricultural Areas’ with prohibited chemical-intensive cropping.	Core Problem: Rapid industrialization has generated persistent pollution (air, water, and hazardous waste) with inadequate monitoring, particularly in Laem Chabang Industrial Estate-adjacent areas. Systemic Gap: No binding green-space standard currently applies to industrial estates or new urban developments in Chon Buri. Outcome: Industrial estates certified at EIT Level 3 or above by 2030; GHG emissions from the industrial sector are reduced by 20% from the 2024 baseline.
Strategy 7: Climate Change Adaptation Network	
• Urban Cooling Network: Plant trees in the 3 most heat-stressed urban districts (Mueang, Si Racha, and Bang Lamung) using species selected for high evapotranspiration rates and local resilience. • ‘Monkey Check’ Bioretention Areas: Construct bioretention basins (total capacity ≥ 5 million CBM) in the flood-prone urban centers (Pattaya (Bang Lamung), Si Racha, Mueang, Phan Thong, and Phanat Nikhom). • Drought Risk Mapping: Update EVI-based drought vulnerability maps annually and use them to prioritize reforestation in the 196.96 sq. km. A high-drought-risk zone is concentrated in Phanat Nikhom and Phan Thong.	Climate Data: 289,456 rai in Chon Buri faces a high drought risk; 761 sq.km. faces moderate drought risk (EVI analysis, 2011–2015 baseline). Urban Heat: Pattaya and Si Racha show rapidly declining vegetated surfaces, intensifying the Urban Heat Island effect; cooling solutions are urgently needed. Flood Risk: Six major urban centers face flash flood recurrence due to impermeable surfaces replacing natural infiltration zones. Outcome: Reduce flood inundation frequency by 40% in the target cities by 2030.
V. Social Inclusion	
Strategy 8: Public-Private-Community Participation	
• Community Forest Stewardship: Establish Community Forest Agreements (CFA) in 20 sub-districts adjacent to national forest reserves, granting communities defined management rights in exchange for measurable conservation outcomes. • Private Sector Green CSR: Create a voluntary framework for industrial estate operators to commit to specific green-space and biodiversity targets with annual public disclosure. • Green Education & Awareness: Integrate Forest ecosystem and urban green space curricula into all primary and secondary schools in the 3 most urbanized districts.	Governance Gap: Strong community conservation networks exist (particularly in Sattahip and Koh Si Chang) but lack formal legal standing and resource support. Private Sector Opportunity: Industrial estates and major EEC investors represent untapped CSR capacity for large-scale green investment. Outcome: 20 active Community Forest Agreements and 80% of target schools with a green curriculum by 2030.

The research team therefore analyzed and prepared a zone classification map for development with reference to the city plan in the Eastern Special Economic Area. Set by the Eastern Special Development Zone Policy Committee Office (EECO) (2024), as shown in Figure 9.

The map classifying zones for green area development (Figure 9) and the integrated strategy (Table 3) are served as a roadmap to transform the EEC from a high-density industrial zone into an environmentally resilient and sustainable economic region. The formulation of green growth strategies is indicated that the sustainable development of the EEC area can only be achieved when economic goals are seriously integrated with the conservation of natural resources, especially halting the loss of pristine forest reserves and restoring green spaces in high-density urban areas. Furthermore, adapting industrial development models to align with the carrying capacity of the local ecosystem would be a crucial foundation for enhancing the competitiveness and environmental stability of Chon Buri province and the EEC area in the long term.

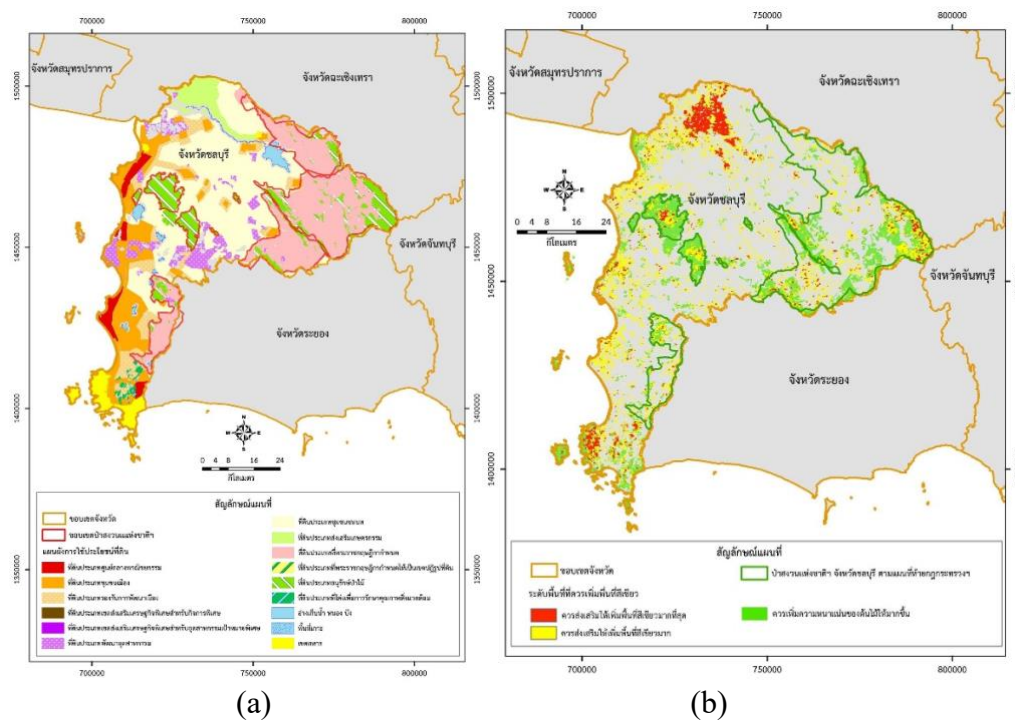


Figure 9. (a) Land use classification and forest area in Chon Buri Province; (b) spatial classification map for green area development

Discussion

Dynamics of land use change and green space in the EEC context

This study is reflected the strained relationship between economic growth and environmental conservation. The observed land-use change in Chon Buri Province between 2006 and 2024, with an 81.12 percent expansion of urban areas and built structures coupled with a 20.75 percent reduction in forest area, is the cumulative impact of development priorities that place economic benefits over environmental concerns. This pattern mirrors the past trajectory of the ESDP since the 1980s, where the neglect of environmental planning during early industrial development led to a long-term deterioration in the quality of life of local communities in the EEC. Although the EEC is aimed to be a world-class economic zone, this deterioration appears to be accelerating at a faster rate and on a larger scale.

These results are consistent with research on urbanization, particularly a global analysis by Seto *et al.* (2012), which showed that regions undergoing intensive economic development, especially in developing Asian countries, experience high rates of natural land loss. This aligns with data from studies showing that the most extensive urbanization in Chon Buri province occurred between 2017 and 2024, coinciding with the official announcement and initial implementation of the EEC policy. This temporal consistency clearly suggests that investment incentives were driven by policy rather than natural population growth alone. Therefore, a key observation is that government policy played a significant role as a major catalyst for land-use change. Frenkel and Ashkenazi (2008) also found that special economic zones often trigger rapid and widespread landscape changes within short timeframes, a pattern that is evident in this case.

These findings are raised crucial questions about the extent to which the EEC's spatial planning framework has adequately anticipated or attempted to mitigate such outcomes. To avoid repeating the environmental impacts of the previous key regional development plan, the ESDP, a green growth strategy should be implemented for development within the EEC.

However, the relationship between economic zone development and environmental quality is not definitive. Lin and Wang (2014) argued that special economic zones, when implemented within an integrated planning framework, have the potential to be the platforms for green growth and the emergence of environmentally friendly urban models. Evidence from studies in Chon Buri province is suggested to be a potential which is not fully realized. The key question is not economic development that should continue, but the

environmental planning should be considered as a fundamental factor rather than an afterthought.

The deforestation data presented in this research warrants special attention. The fact that many national forest reserves in Chon Buri province are left with less than 20 percent of their originally designated area, below the minimum 25 percent threshold specified by the IUCN (2016) as necessary for maintaining biodiversity and basic ecosystem functions, demonstrates that degradation in some parts of the province has already exceeded an ecologically significant threshold. The three most severely affected conservation areas, e.g. Pa Tha Bun Mee-Bo Thong (9.99% remaining), Pa Bang Lamung (20.79% remaining), and Pa Daeng–Pa Chumnum Klang (30.31% remaining), share the common characteristic of all being under land reform processes within designated degraded economic forest zones.

The correlation between land allocation policies and deforestation is consistent with the findings of Lambin *et al.* (2001) that agricultural expansion driven by policy incentives is one of the main mechanisms of tropical deforestation. This research is suggested that the degradation of these protected areas is not a coincidental occurrence but rather stems from the internal structures of the region's land management framework.

Taken together, these findings pointed to a governance gap linking economic and environmental policies within the EEC context. The World Health Organization (2016) emphasized that urban expansion, coupled with a lack of green spaces and environmental risk management, exposes urban populations to health hazards, including air and noise pollution, while simultaneously reducing access to nature. As Chon Buri's urban footprint continues to expand, the cumulative decline of forest reserves and green spaces could lead to measurable declines in environmental quality and public health outcomes, particularly in low-income and least adaptable communities. Effective management is required not only stronger environmental protections within the EEC framework but also a fundamental re-evaluation of how ecosystem sustainability is weighted in regional development planning.

Green growth strategy and green space networks in the EEC context

The green growth strategy derived from the TOWS analysis for the EEC context is based on the accepted theoretical framework of the Organization for Economic Cooperation and Development (OECD): "Green growth is about fostering economic growth and development while ensuring that the natural assets continue to provide the resources and environmental services on which our well-being relies. To do this, it must catalyze investment and innovation, which

will underpin sustained growth and give rise to new economic opportunities” (OECD, 2010; Kim *et al.*, 2014). This forms the conceptual foundation for this study. The core of implementing this framework in Chon Buri province lies in establishing a green infrastructure network, as defined by Benedict and McMahon (2012). Green infrastructure comprises a strategically planned network of natural and semi-natural areas to preserve the value and function of ecosystems while providing essential benefits to the human population.

A crucial dimension of the proposed strategy involves ecological connectivity. Strategies 5 and 7 emphasize creating networks linking relatively intact forest reserves, particularly Khao Khiao and forest clusters in Sattahip, with urban green spaces throughout the province. This approach aligns with Forman’s (1995) concept of ecological corridors, which are vital for maintaining gene flow and species movement across scattered landscapes. Beyond biodiversity, it enhances ecosystem resilience to climate change (Heller and Zavaleta, 2009). In the context of the EEC, with major roads and a high-speed rail network crisscrossing the province, designing green pathways along transportation corridors is a practical and multifaceted strategy. Instead of viewing infrastructure solely as an economic driver, this approach reconstitutes infrastructure as a framework that connects ecosystems while simultaneously advancing conservation, climate adaptation, and livelihood goals.

Green space management impacts water management dimensions within green growth strategies that emphasize the systemic importance of forest restoration. Brauman *et al.* (2007) showed that restoring forest areas in watersheds can increase groundwater recharge by 20 percent to 40 percent. This research is directly and urgently relevant to Chon Buri province, as Chon Buri and the Eastern region differ from other areas in Thailand. The Eastern region lacks long, major river systems; most rivers are short. Therefore, the region relies heavily on reservoirs as its primary freshwater source. This structural vulnerability makes forest restoration in Bo Thong and Nong Yai districts, the main watersheds supporting the province’s major reservoir network, a strategic necessity rather than just an ecological issue. The degradation of these upstream forests, as revealed by the land-use analysis in this study, reflects the potential impacts of biodiversity loss, threatening long-term water security across the province and disrupting industrial and urban systems of the EEC that depend on water from these areas.

These findings indicated that the ecological and economic dimensions of the EEC development are far more intertwined than current planning frameworks acknowledge. Issues such as green infrastructure, ecological corridors, and watershed forest restoration are fundamental conditions for the sustainable operation of the special economic zone itself. Integrating these elements into the

EEC's spatial planning and investment framework is not a constraint on development, but a prerequisite for long-term sustainability.

Therefore, developing a master plan for green space networks and clearly defining zoning areas are a crucial to enable Chon Buri and the EEC adaptation to climate change and transition toward a balanced and sustainable economic zone. However, implementing these strategies requires fundamental adjustments to how ecological sustainability is prioritized within regional development framework. This is required an integrated GIS-based governance among forest management agencies, enforceable green space standards for industrial estates, and meaningful community participation in forest conservation.

Future research finding should track the implementation of green space transformation initiatives and strategies to assess the effectiveness of law enforcement and monitor changes in urban green space per capita in Chon Buri province. This information can be used as an indicator of progress toward equitable and sustainable development.

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Conflicts of interest

The authors declare no conflicts of interest.

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