Structure, Diversity and Dynamics of Natural-Anthropogenic Landscapes of Phu Yen Province

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Abstract: The natural-anthropogenic landscape is a form of a modern landscape, formed on the common foundation of the geocomplex in which human activities become a basic factor participating in the creation and development of the landscape. Analysing the diversity and structure of the natural-antropogenic landscape is the basis for the planning of economic development, especially the agro-forestry economy as well as the conservation of biodiversity. Phu Yen Province is a coastal province of central Vietnam, but the western area is mostly hilly, bringing a high division of natural conditions, along with the typical economic development activities associated with indigenous culture. It is a territory with a high differentiation of natural and anthropogenic conditions, which is the foundation for the formation of a system of natural-anthropogenic landscapes with high diversity, including 1 system, 1 subsystem, 3 classes, 5 subclasses, 9 types and 132 kinds of landscape. Based on the results of the field survey and analyzed structure of the outstanding landscape types for Phu Yen Province, including natural forests, plantation forests, annual agricultural crops and perennial industrial plants. Biodiversity is expressed in the natural forest landscape type group distributed in the Hinh River - Deo Ca area, with the division of species according to different high belt structures. The annual agricultural crops are distributed largely across the river valleys and Tuy An plain, Tuy Hoa city. The group of plantation forests landscape is distributed on the form of low mountainous terrain, Son Hoa basalt plateau, Hinh River. The perennial industrial plants are distributed largely in western Phu Yen Province, with popular crops being *Litsea glutinosa, Hevea brasiliensis*, and *Piper nigrum*. Analysing the characteristics and structures of landscape types allows us to assess the suitability of the landscape for natural and socioeconomic conditions, which is the foundation for the orientation of agro-forestry economic development and biodiversity conservation for Phu Yen Province.

Keywords: Natural-anthropogenic landscape, Diversity, Seasonal dynamics, Components, Phu Yen

From the realistic requirements, the consequences of human impacts must be fully and vividly reflected in natural territorial complexes, which have promoted landscape science to a new development step, which is the birth of anthropogenic landscape science. The object of anthropogenic landscape science is anthropogenic landscape (AL) or natural-anthropogenic landscape (NAL). AL is a modern landscape formed on the common ground of geocomplex in which human activities become the basic factors participating in the creation, transformation and succession of landscape (Nguyen Dang Hoi 2007). AL are natural landscapes that have been affected, altered or built by technical methods (Nguyen Dang Hoi, Ngo Trung Dung et al 2021). Structure, diversity and dynamics are basic attributes of landscape in general and AL in particular (Dang Hung Cuong et al 2020). Research and analysis of landscape structural features allow the determination of the characteristics and roles of each landscape component, each landscape unit, and the interaction of its constituent components, especially anthropogenic components and factors (Nguyen Dang Hoi and Tishkov 2021). Based on the structure and dynamics of the landscape, it is possible to

forecast changes, self-adjusting or under external factors of the landscape in the future (Nguyen Dang Hoi 2007). Humans are an important component of NAL when there are always direct and indirect impacts on landscapes, changing their composition and structure (Chase 2016, Nguyen Dang Hoi et al 2016, Nguyen Dang Hoi and Ngo Trung Dung 2017, Nguyen Dang Hoi et al 2019). To date, research on AL or NAL has been applied in many countries of the world, from Russia to Europe, America, Asia, and in the fields of conservation, territorial planning and economic development (Schreg 2019, Vasconcelos, Ventincinque 2021). The application of GIS in the establishment of thematic forms of maps has a long history of development, which is mentioned in many studies in many different countries (Kumar et al 2021, Sreedevi and Karthikeyan 2021, Venkatachalapathy, Kumar et al 2021). For the establishment of NAL mapping, GIS software with algorithms helps to increase accuracy, shorten time, and ensure data information for the resulting map.

In Vietnam, research on AL and NAL has been carried out for more than 20 years. However, the first phase of the research mainly focuses on discussing viewpoints, researching objects or some theoretical classification systems

of AL (Nguyen Dang Hoi et al. 2019). From the establishment of principles and the classification system of NAL, the study focuses on clarifying the characteristics and roles of natural and anthropogenic components and factors forming NAL, their diversity and dynamics in Phu Yen Province, a coastal province in the south-central coastal region of Vietnam.

MATERIAL AND METHODS

Studied area: Phu Yen is located in the East of Truong Son range, in the geographical coordinate frame from 12°42'36" to 13°41'28" north latitude; from 108°40'40" to 109°27'47" east longitude. The province has 9 administrative units at the district level and 110 administrative units at the commune level (People's Committee of Phu Yen province 2019). The natural area of the province is 5,060 km^2. It borders Binh Dinh Province to the north, Khanh Hoa Province to the south, Gia Lai and Dak Lak Provinces to the west, and the East Sea to the east with a coastline of 189 km (Fig. 1). The territory of Phu Yen Province is located in the fault between the Kon Tum uplift and the Lam Dong zone. The geological structure includes formation factors such as sedimentary, metamorphic and eruptive sediments that range in age from Proterozoic to Kanozoic. Phu Yen's topography is quite complex, including hills, mountains, plains, plateaus, and valleys interspersed with each other. The mountainous terrain forms extending from the Cu Mong pass in the north to the Ca pass in the south

Fig. 1. Location of Phu Yen Province

of the province. Phu Yen Province has a tropical monsoon climate influenced by the oceanic climate. The year is divided into 2 distinct seasons: the dry season lasts from January to August, and the rainy season lasts from September to December. The annual average temperature ranges from 23-27°C, and the weather is warm and stable. The average annual rainfall ranges from 1,600-2,100 mm, increasing gradually from valleys and coastal plains to high mountain. The hydrological network is thick and relatively evenly distributed throughout the province. There are four main river systems: the Ba River, Ban Thach River, Ky Lo River and Tam Giang River.

Phu Yen Province has 11 soil groups (sand soil, saline soil, alkaline soil, alluvial soil, gray and infertile soil, black soil, red–yellow soil, yellow humus in mountains, valley soil, inert eroded soil with gravel rocks and other soils) with 27 soil types. The most common and large area is red–yellow soil on shale and metamorphic rock (37.9%) and gley-formed alluvial soil (23%). The vegetation cover of the Phu Yen is characterised by three main forest types: evergreen broad-leaved closed forest, sparse deciduous forest and plantation forest. Within Phu Yen Province, typical human activities are resource exploitation for the development of agriculture - forestry - fishery, industry, urban areas and tourism.

Component mapping system: The article is made on the basis of the database made by the authors themselves within the framework of the project E.1.2, task 2: "Features and changes of NAL of Phu Yen Province" implemented by the Institute of Tropical Ecology, Vietnam-Rusian Tropical Center, including proportional component maps at scale of 1/100000: Geological map, geomorphological map, soil map, vegetation map of Phu Yen Province (Fig. 2).

NAL map: To create the landscape map of Phu Yen Province, the component maps were superimposed using Arcgis software based on the Intersect algorithm (Fig. 2). The Intersect tool calculates the geometric intersection of any number of feature layers. The feature, or part of the features, for all input information is written to the output feature class. When multiple classes or feature classes are specified in the list of input features, the order of the entries in the list does not affect the output feature type, but the spatial reference of the entry on the same dialog box tool (first entry in the script) of the list used during processing and set to output (ESRI 2021).

Taxonomic systems and classification criteria for the landscape: In accordance with the type viewpoint, a taxonomic system comprising six ranges (Nguyen Dang Hoi et al. 2016), namely, System → Subsystem → Class → Subclass → Type → Kind, was chosen. Using these six ranges, a landscape map of the studied area was built at a scale of 1/100.000 (Table 1).

Differentiation and diversity of the NAL: The differentiation in nature and human activities has formed the system of NAL in Phu Yen Province with a high diversity of low-level taxa. Accordingly, the territory includes 1 system, 1 subsystem, 3 classes, 5 subclasses, 9 types and 132 kinds of landscapes (Fig. 3).

Field survey: To assess the current status and check the areas as well as assess the dynamics of NAL in Phu Yen Province, field surveys were conducted in April 2020 and January 2021 (Fig. 4), identifying and visually describing the current status of component-forming typical landscape kinds. Conducted interviews with local people and rangers to determine the timelines of changes in afro-forestry landscapes in the area, determining the dynamics of each specific landscape kind in the studied area on the basis of spatial differentiation and landscape diversity.

In April 2020, the survey focused on the Song High protected forest area, assessing the current status, defining the contours of tropical forest landscapes and interviewing local rangers about the timelines for structural change and local forestry policies. In January 2021, a survey along the main national and provincial roads of the Phu Yen was conducted to check the borders of landscapes, determine the crop structure, and interview local people and forest rangers to collect information on structural changes in agricultural crops and forestry. This is an important source of data to determines the dynamics of NAL in Phu Yen Province. The identification of plant and vine species was carried out on the basis of synthetic studies of morphological signs and documents of Pham Hong Ho (1999), Takhtajan A. L. (1987).

Diversity and dynamics of NAL: On the basis of the resulting map, the research team analysed the differentiation
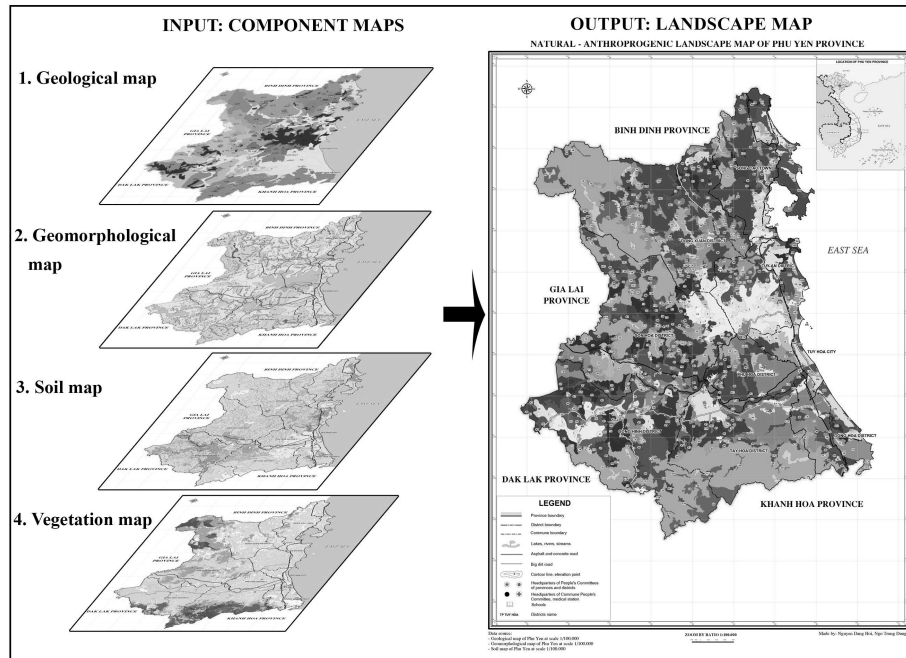

Fig. 2. The process of overlaying component maps to create a landscape map

Table 1. Taxonomic ranges and classification criteria for the landscape of Phu Yen Province

Taxonomic range	Classification criteria
System of landscape	Decisive role of the atmospheric circulation regime in the process of climate formation in the belt area.
Subsystem of landscape	Decisive role of the regime of atmospheric circulation in the process of climate formation and ecological region of the flora
Class of landscape	Relief configuration, which determines the homogeneity of two large processes, namely, erosion and concentration, in the real cycle
Subclass of landscape	Peculiarity of the formation of large relief forms manifests the property of nonzone on the basis of the combination of relief and typical geomorphological processes
Type of landscape	Quantitative peculiarity of bio climate and anthropogenic activities, which determines the formation of vegetation groups (except for the type of reservoir)
Kind of landscape	Differentiation of vegetations on different types of soils (except for the kind of reservoir)

Due to the homogeneity of landscape systemand subsystem levels, the legend of the landscape map does not show these two taxonomic ranges

Landscape type note:
- Tropical monsoon climate on Highland, average annual air temperature 22oC;
- Total annual rainfall fluctuate 1500 — 2800 mm, slightly lacking in humidity;
- The rainy season lasts 8-9 months, from January to August, the dry in short 3-4 months, from September to December

LANDSCAPE SYSTEM	LANDSCAPE SUB-SYSTEM	LANDSCAPE TYPE	LANDSCAPE KIND	Natural-anthropogenic Vegetation			Anthropogenic Vegetation					Inland waters
				Evergreen tropical closed forest	Bamboo forest	Grassland, shrub	Plantation forest	Perennial industrial plants	Annual agricultural crops	Wet Rice	Vegetation in resident	
Mountain	Medium Mountain	Abrasion planar surface on basalt	X-cr-h (*)	1		2	3	4	5	6		
			Fd-c-hu						7			
			X-h			8	9		10			
			X-hu-nh				11		12			
			X-tm-hu					13	14			
			Pc-a						15			
			C						16			
			E				17		18			
			All of Soils									19
	Low mountain and hill	Abrasion planar surface on different bedrock	X-cr-h				20					
			Fd-c-hu				21					
			X-h	22		23	24		25			
			X-hu-nh			26			28			
			X-tm-hu				27					
			A	29								
		Gravititional slope on different bedrock	X-cr-h	30		31	32		33	34		
			Fd-c-hu				35		36	37		
			X-h	38		39	40	41	42	43		
			X-hu-nh	44		45	46		47			
			X-tm-hu	48		49	50	51	52	53		
			Pc-a				54		55	56		
			C				57					
			E				58		59			
			A	60			61					
			M							62		
			All of Soils									63
Plain - Valley	Plain	River floodplain	X-cr-h						64			
			Fd-c-hu						65	66		
			X-h			67	68		69	70		
			X-hu-nh						71			
			X-tm-hu	72			73		74	75		
			Pc-a				76		77	78		
			C						79			
			E						80			
			M			81			82	83		
			All of Soils									84
		River/marine/marsh deposition surface	Fd-c-hu						85			
			Pc-a							86		
			C				87		88			
			M						89	90		
			All of Soils									91
		Mixed plain with relict hill and rock	X-cr-h						92			
			Fd-c-hu						93			
			X-h			94	95					
			C						96			
			E			98	97					
		Aeolian sand, and dune	X-cr-h						99			
			C			100	101			102		
			M					103	104	105		
			All of Soils									106
	Valley	Deposition-erosion valley bed	X-cr-h						107			
			Fd-c-hu						108	109		
			X-h	110		111	112		113	114		
			X-hu-nh				115		116			
			X-tm-hu	117		118	119		120	121		
			Pc-a				122		123	124		
			C						125	126		
			E	127					128			
			M						129	130		
			All of Soils									131
Inland waters												132

(*): X-cr-h: Hapli-Chromi Acrisols; Fd-c-hu: Humi-Acric Ferralsols; X-h: Haplic Acrisols; X-hu-nh: Alumi-Humic Acrisols; X-tm-hu: Humi-EndoLeptic Acrisols; Pc-a: Dystri-Arenic Fluvisols; C:Arenosols; E: Dystri-Lithic Leptosols; A: Chromi-Humic Alisols; M: Molli salic fluvisols

Fig. 3. Legend of the NAL map of Phu Yen Province at a scale of 1/100000

and diversity of NAL in Phu Yen Province according to the classification and followed the principle from high to low levels and paid attention to the differentiation of kinds or group of landscape kind in each landscape class and subclass. The dynamics of NAL were determined based on the seasonal dynamics of the components and factors that formed NAL. Analysis of landscape seasonality was based on natural fluctuations and human activities, especially related to types of territorial use.

RESULTS AND DISCUSSION

Diversity and dynamics of NAL: The territory of Phu Yen Province has 3 landscape classes, including mountains, plains and valleys, and inland water (Table 2).

Mountain landscape class: Consists of 2 subclasses: medium mountains, low mountains and hills. In the subclass of medium mountains, there are 2 types: K1 (natural - anthropogenic vegetation on the leveled surface, eroded and developed on basalt) and K2 (planted vegetation on the leveled surface, eroded and developed on basalt). The subclass of low mountains and hills has 2 types: K3 (natural - anthropogenic vegetation growing on the leveled and eroded surface and gravity slopes) and K4 (planted vegetation on the leveled surface and gravity slopes).

Landscape type K1 includes 3 landscape kinds, numbered 1, 2 and 8. The total area was 1,006.27 ha, with vegetation cover mainly natural forest, grassland and shrub growing on soil types X-cr-h and Fd-c-hu. Landscape type K2 includes 16 landscape kinds, numbered 3÷7 and 9÷19, with a total area of 42,460.39 ha. The dominant group is the group of landscape kinds of annual agricultural crops growing on different soil types, with 8 landscape kinds. Landscape type K3 includes 13 landscape kinds, with a total area of 161,176.55 ha, in which there are similarities in the number of landscape kinds in the natural forest and shrub-grassland groups (numbered 7 and 8, respectively). Landscape type K4 includes 31 landscape kinds, with a total area of 165,826.95

ha. Landscape kinds of plantation forests and annual agricultural crops dominate, number 13 and 9, respectively.

Landscape class of plain and valley: Consists of 2 landscape subclasses: plain and valley. In the plain landscape subclass, there are 2 types: K5 (natural - anthropogenic vegetation on the plain surface accumulating river, river - sea and swamps, formed by sea winds and coastal plains interspersed with the rocks shore and hills); K6 (planted vegetation on the surface of the plain accumulates river, river - sea and swamps, formed by sea winds and coastal plains interspersed with the rock shore and hills). The valley landscape subclass has 2 landscape types: K7 (natural - anthropogenic vegetation growing on the bottom of valley with erosion and accumulation) and K8 (planted vegetation growing on the bottom of the valley with erosion and accumulation).

Landscape type K5 includes 6 kinds with a total area of 1,385.16 ha. Vegetation cover is mainly grassland and shrub growing on soils C and E. Landscape type K6 includes 57 kinds and has the highest level of landscape diversity, with a total area of 74,650.26 ha. The group of annual agricultural crops grew on different soil types, with 17 kinds. Next is the group of wet rice with 9 kinds and the group of plantation forests with 7 kinds. Landscape type K7 includes 5 kinds with a total area of 4,428.85 ha, in which there are similarities in the number of kinds of natural forest and shrub-grassland (numbered 2 and 3, respectively). Landscape type K8 includes 25 kinds, with a total area of 29,040.39 ha. The group of annual agricultural crops dominates has 9 kinds, and the group of wet rice has 6 kinds.

Landscape class of inland water: This is a special landscape class, not according to classification criteria such as terrestrial landscapes. This class is not differentiated but only has 1 subclass, 1 type (K9) and 1 kind number 132, with an area of 25,989.17 ha. This class includes inland water bodies such as natural lakes, man-made lakes, and lagoons. Landscape class plays an important role in supplying water

Table 2. Differentiation and diversity of NAL of Phu Yen Province

NAL class	NAL subclass	NAL type	NAL kind	Area (ha)
Mountain	Medium mountains	K1	1, 2, 8	1,006.27
		K2	3÷7, 9÷19	42,460.39
	Low mountains and hill	K3	22, 23, 26, 29, 30, 31, 38, 39, 44, 45, 48, 49, 60	161,176.55
		K4	20, 21, 24, 25, 27, 28, 32÷37, 40÷43, 46, 47, 61÷63	165,862.95
Plain and valley	Plain	K5	67, 72, 81, 94, 97, 100	1,385.16
		K6	64÷66, 68÷71, 73÷80, 82÷93, 95, 96, 98, 99, 101÷106	74,650.26
	Valley	K7	110, 111, 117, 118, 127	4,428.85
		K8	107÷109, 112÷116, 119÷126, 128÷131	29,040.39
Inland water	Inland water	K9	132	25,989.17

for agricultural landscapes, forestry, and the development of coastal aquaculture. Some reservoir landscapes can be mentioned: Song Hinh hydropower reservoir, reservoir capacity 357 million m³; Ba Ha River hydropower reservoir, capacity 395 million m³; Dong Tron irrigation reservoir (Tuy An District) with a capacity of 19.5 million m³; Phu Xuan irrigation reservoir (Dong Xuan District) with a capacity of 11 million m³.

Structural characteristics of typical landscape groups in Phu Yen Province: Phu Yen Province has a high level of differentiation, creating a diversity of taxa, especially types and kinds of landscape. In the landscape groups of the Phu Yen, natural forests, plantation forests, annual agricultural crops and perennial industrial plants are typical.

Landscape group of natural forests on low mountains and hills: Currently, in Phu Yen Province, natural forest landscapes are concentrated in the southern and western areas of the province, such as the Deo Ca - Hon Vong Phu mountain range, including Song Hinh protected forest (Fig. 4a, c, d, e), Deo Ca protected forest (Figure 4b) and Nature Reserve Krong Trai. Research results at Song Hinh protection forest show that the natural forest landscape is composed of shale, granite and basalt.

Vegetation consists of 4 floors. The first floor is 30-40 m high, formed by the following species: *Dipterocarpus turbinatus*, *D. hasseltii*, *D. retusus*, *Hopea odorata*, *Shorea cochinchinensis*, *Tarrietia javaniva*, *Pometia pinnata*, *Canarium album*, *Garcinia ferrea*, and *Endospermum sinensis*. The second floor is 18-24 m high. Species that form forest vegetation include *Balacata baccata*, *Cinnamomum iners*, *Schima wallichii*, *Swintonia floribunda*, *Dillenia blanchardii*, and *Lagerstroemia macrocarpa*. The 3rd floor is 8-12 m high. The main species recorded are as follows: *Arenga pinnata*, *Flacourtia jangomas*, *Stenomurus perobtusus*, *Helicia longeteticate,* and *Livistona saribus*. The 4th floor is 1.5-5 m high and is formed from species of the families Euphorbiaceae, Palmae, Apocynaceae, Rubiaceae, Melastomataceae, and Simaroubaceae. The herbaceous floor is quite developed but unevenly distributed in the landscape, depending on the microterrain structure. Species of the families Araceae, Primulaceae, Pandanaceae, Melastomataceae, and Poaceae have been recorded.

Forest landscapes in the plain valley: This group is widely distributed in Phu Yen Province and has been strongly affected by humans. In areas that still retain the natural structure, such as in the Krong Trai Natural Reserve, Song Sinh protection forest, landscapes develop on many different types of soil, but mainly sandy soil mixed with light flesh derived from river, basalt soil, and soil on schist. The vegetation has a structure of 3-4 floors. The first floor is 30-35

Fig. 4. Natural forestland scape of Phu Yen Province: Landscape of medium mountain forest (a, b); tree structure (c); bark root (d); profile of forest soil (e)
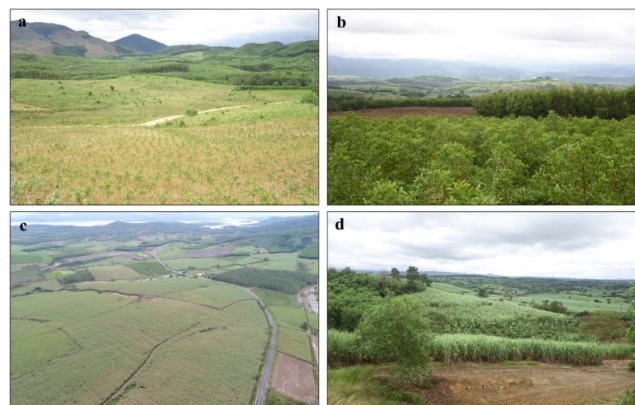

Fig. 5. Plantation forest and agricultural landscapes of Phu Yen Province: plantation forest landscape (*Acacia auriculiformis*) on plain and valley (a, b); sugarcane landscapes (c, d)
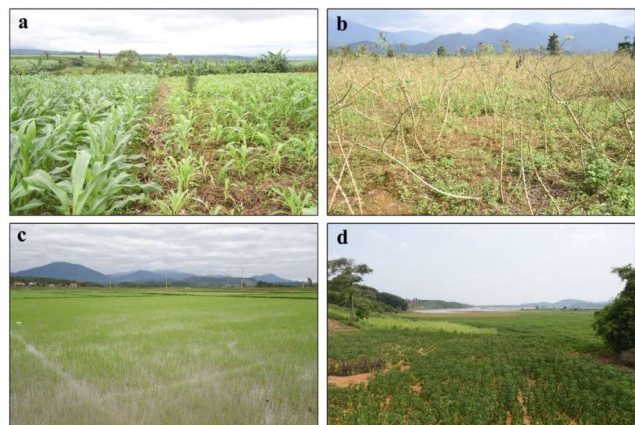

Fig. 6. Agricultural landscapes: corn and cassava (a, b, d); wet rice (c)

m high, with representatives such as *Dipterocarpus turbinatus*, *Shorea cochinchinensis*, *Herritiera javanica, and Endospermum sinensis*. The second floor is 15-20 m high, with representatives such as *Mangifera dongnaiense*, *Litsea monopetala*, *Cinnamomum* sp., *Cratoxylum cochinchinensis*, *Parkia sumatrana*, *Pometia pinnata, Diospyros buxifolia*, and *Metadina trichotoma*. The 3rd floor is 6-10 m high and has a diverse structure. Representative species belong to the families Rosaceae, Euphorbiaceae, Phyllanthaceae, Rubiaceae, Lamiaceae, Palmae, and Melastomataceae. The 4th floor is 1-4 m high and has a diverse structure, with representatives of the families Rubiaceae, Apocynaceae, Violaceae, Palmae, Melastomataceae, Rutaceea, and Zinginberaceae.

Landscape group of plantation forests: Commonly distributed, especially in the landscape subclass of low mountain - hill. The main plantation forests are *Acacia auriculaeformis* (Earleaf acacia), *Hopea ordorata*, *Dipterocarpus alatus*, and *Michelia mediocris*. The area of the Earleaf acacia forest landscape dominates absolutely in all subclasses in Phu Yen. Depending on the age of the plant, the height of the cover varies but usually does not exceed 15 m. The landscape of plantations with Earleaf acacia usually has a density of 2400 - 2500 trees/ha. Single-species plantation forest (Figure 5a,b). The tree has good vitality, increasing biomass evenly over the years from the first year to harvest (6th or 7th year).

Landscape group of annual agricultural crops: Widely distributed, from plains, valleys to medium mountains. Landscape develops on almost all types of soil at slopes below 25°, common below 15°. The most popular agricultural crops are wet rice (2 crops/year), cassava, corn (Fig. 6a), sweet potato, peanuts, beans, and sugarcane. In addition to wet rice (Fig. 6c), cassava and sugarcane are the dominant crops (Fig. 5c,d and Figure 6b,d). The composition of species in each landscape unit is quite simple and is usually planted with pure species. Sugarcane is planted in rows 1 m apart. Productivity and product quality depend on the farming conditions of the people. In mountainous areas, yields are often low due to a lack of people's care.

Landscape group of perennial industrial plants (including fruit trees): Widely distributed, but the size of each unit is usually small. The main plants grown in the landscape are *Litsea glutinosa, Hevea brasiliensis*, and *Piper nigrum*. In addition to landscpes of industrial plants, there are landscpes of fruit trees. These are landscapes with high economic value, but the area is small and undeveloped in Phu Yen Province.

Dynamics and transformation of NAL of Phu Yen Province: The dynamics of the landscape are reversible

changes that do not lead to a radical structural shift. State changes are reversible, provided that changes in the parameters of the external environment do not exceed some critical value. The seasonal changes in the elements constituting the landscape must include the parameters of climate, hydrology, phenology of vegetation and the seasonal change of agricultural landscapes. The seasonality of the landscape of the study area is reflected in the air temperature regime, rainfall and processes occurring in the landscape. Seasonal rhythms are represented by the dry season lasting from January to August and the rainy season from September to December. The temperature range between the two seasons is 6-7°C. Rainfall is mainly concentrated in the rainy season, with 85% of the total annual rainfall. The flow of water in the landscape of water bodies also varies with the seasons, and the flood season is approximately 1 month slower than the rainy season. In the dry season, many landscapes of water bodies are dry, even exposing the bottom. At that time, the aquatic fauna and flora in the landscape no longer exist but instead are vegetation with the predominance of herbaceous species. Some landscapes of large water bodies do not run out of water, but in shallow zones, they are also "bottomed out" at the end of the dry season, losing the properties of water mass in the landscape, instead of annual agricultural crops such as the shallow water zone of Song Hinh hydropower reservoir, Ba Ha River hydropower reservoir, Dong Tron irrigation reservoir and Phu Xuan irrigation reservoir. In the rainy season, the landscape returns to the maintained state of the aquatic landscape with the characteristics of water mass and aquatic fauna and flora.

Landscape groups of agricultural crops are widely distributed throughout the province but are mostly concentrated in the lowlands of river basins. Vegetation changes seasonally. For example, with the landscape of sugarcane or cassava in districts of Song Hinh and Son Hoa, in the rainy season, the vegetation thrives, but in the dry season, the crops are harvested to create a bare land surface, changing the climate and soil parameters, especially illumination, temperature of the air and soil in the landscapes.

The landscapes of wet rice are distributed in the coastal areas of Tuy An, Dong Hoa, Tay Hoa dictricts and Tuy Hoa city. These are mainly two-crop rice fields, creating seasonality in the structure of the surface covers, unlike the landscapes of sugarcane or cassava. In these landscapes, the rhythm of the vegetation within 3-5 months creates 2 cycles each year. Meanwhile, in the rice landscapes in the western mountains, many areas are single-crop rice, and after fallow, create a dynamic cycle of vegetation in a year, consistent with other landscape factors. Thus, in agricultural

landscapes of wet rice or crops with rotation of 2 or more crops in a year, the rhythm of the plant cover is out of phase with the climatic and hydrological conditions, creating the complexity of the NAL of Phu Yen Province. For forest landscapes, seasonal dynamics clearly show the harmony of forming components and factors. There, the elements of the climate and hydrological components determine the seasonal rhythms of vegetation and forest soil. The phenomenon of budding, young leaves, flowering, fruiting, deciduous and decomposing of falling plant layers on the ground, climatic and hydrological conditions of forestland comply with the seasonal laws of the local climate. When studying the seasonal dynamics of forest landscapes in Song Hinh protected forest, the results show that the deciduous period of trees is concentrated in January and February. After the period of old leaves fall, new leaves develop in 2-3 weeks. During the months of March and April, the trees under the canopy are partially deciduous, and some species are completely deciduous. On the surface of the soil, dry leaves and twigs of different sizes were observed. The falling plant layer only has traces of bones of some leaves from the previous year, which shows that the ability to decompose fallen leaves of plants in the landscape subclass of low mountains and hills completely takes place according to the annual cycle under the influence of seasons of soil animals and forest fungi.

CONCLUSIONS

Phu Yen Province is a territory with a high differentiation of components and elements that make up the NAL. On the basis of taxonomic range and classification criteria, a landscape map of Phu Yen Province was established at the scale of 1/100000. Accordingly, the landscape of the Phu Yen includes 1 system, 1 subsystem, 3 classes, 5 subclasses, 9 types and 132 kinds of landscapes. The highest diversity belongs to the landscape class of plain and valley with 2 subclasses, 4 types and 68 kinds. The mountain landscape class has a high degree of differentiation of the low mountain and hill subclasses, with 2 types and 44 kinds, respectively. The subclass of medium mountains has low diversity, with 2 types and 19 kinds. Landscape groups of plantation forests and annual agricultural crops dominate in terms of area and high diversity, consistent with the differentiation of natural and anthropogenic factors in the territory. The landscape of Phu Yen Province has a complex structure, especially its internal structure. In addition to the natural forest landscapes whose structure is quite consistent with the formation rules of natural components, in many groups of NLA, especially agricultural landscapes, plantation forest landscapes have many elements in their structure that

are built by human activity. The seasonal dynamics of Phu Yen's NAL are clearly reflected in the seasonal rhythms of the natural elements of the climate, hydrological and forest vegetation components and the seasonality of anthropogenic activities, especially the seasonality of agricultural landscapes, in which the rhythm of the plant cover is out of phase with the climatic and hydrological conditions, creating the complexity of the NAL of Phu Yen Province. For natural forest landscapes, seasonal dynamics represent the suitability of landscape components and elements occurring in seasons as well as the transition period from winter to summer or from summer to winter. Meanwhile, agricultural landscapes, especially landscapes of annual crops, and landscape dynamics are strongly influenced and dominated by people in mountainous areas, plateaus or plains and valleys. This is a feature that should be noted in the process of landscape design and selection of plants suitable to the technical conditions of cultivation of each area and each district in the whole Phu Yen Province.

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