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TRANSFORMATION AND ECOLOGICAL SUCCESSION OF NATURAL – ANTHROPOGENIC LANDSCAPES IN KONKAKINH – KONCHURANG CONSERVATION TERRITORY, VIETNAM

Nguyen Dang Hoi[1], Ngo Trung Dung[1], Dang Hung Cuong[1,2], Kolesnikov S.I.[2], Tishkov A.A.[3]

[1]Vietnam – Russian Federation Tropical Center, Nguyen Van Huyen Str., Ha Noi, Vietnam
e-mail: danghoi110@gmail.com
[2]Southern Federal University, Russian Federation, Rostov-on-Don, Russian Federation
[3]Institute of Geography RAS, Moscow, Russian Federation

Study about characteristics of diversity, change and ecological succession of landscapes is an important content in determining territorial division, especially in the monsoon tropics such as the Central Highlands of Vietnam, where the strong division of non-zonal rule. Konkakinh – Konchurang conservation territory is a special geographic site located in the north eastern part of Gia Lai province, which is noticeable for a profound division of components, natural and human factors. The humid tropical climate of this area is simultaneously influenced by the climate of the Central Highlands and the Central Coast. Both the diversified natural conditions and the strong impact of residents have contributed to the creation of the typical natural-anthropogenic landscape system in this studied area. Natural – anthropogenic landscapes are quite differentiated from one system, one subsystem, three classes, five subclasses, 13 types and 87 kinds. The diversity in the landscape structure is evident in the elevation law through subclasses. Landscape diversity is reflected through not only the number of landscapes, but also the frequency of any certain landscape in the studied territory. During the research period from 2005 to 2017, significant changes in landscape of this studied area, in both quantitative and qualitative manners, were observed. During approximately 13 years, the landscape of this area has greatly changed. In 2005, there was a total of 94 kinds of landscape, with the domination of the group of evergreen broadleaf tropical forest types with shrubs, grasslands, industrial crops and annual crops dominate. The comparison between these two periods shows that there are 43 landscape kinds completely disappeared and 33 new landscape kinds formed. The remaining landscapes have fluctuations in area. In this studied area, the formation of typical landscape succession chains reflects living activities of local human. The evergreen broadleaf forest landscape under mankind impact has resulted in a dramatic change. The succession chains change over different short periods of time, leading to the creation of new landscapes.

Keywords: Conservational territory, diversity, landscape changes, human impacts, Konkakinh – Konchurang.

Introduction

In the process of formation and movement, the landscapes undergo different stages of development. They are transformed, creating their succession sequence. Landscape succession characterizes the interaction of components and elements. As a mirror reflecting the landscape, vegetation is seen as the first sign and the most important component to decide the change and succession, especially the forest landscape (Alejandro et al., 1997; Nguyen et al., 2011; Nguyen et al., 2017).

The study of landscape succession is mentioned later than the vegetation succession. In the literature of foreign authors, "*succession*" was first used in the study of vegetation (Pielke, 1999; Nguyen et al., 2013; Nguyen et al., 2018; Nelson et al., 2018; John et al. 1997), then used in ecological research, the motion of ecosystems (Soumana, 2013; Triskov, 2012). Therefore, the current reality when scientists talk about succession, is to talk about ecological succession and landscape transformation, in Russian Federationn language, that is: "*Экологическая сукцессия*" and "*Динамика ландшафта*" (Bulatov, 1996; Gusev, 2012; Triskov, 2012). This also means that many scientists acknowledge the process of succession in landscape is the ecological succession, taking place with the sequential development of the central element – the biological element.

With the thinking the landscape is an individual or type, the ecological succession of landscape, according to us, is a very "standard" concept and a reality is existing in nature whether it is a natural succession or anthropogenic succession. When studying the characteristics of succession of plants of zonal ecosystems, from the pioneering stage to the climax state, Triskov, 2012 recorded vegetation covers 2 to 6 stages.

In the territory of Vietnam, most of landscapes has passed two long periods of succession chains: the primitive ecological succession and the secondary ecological succession (Nguyen et al., 2018). Due to the demand for resource exploitation and territorial use, the human impacts have been strongly increasing in scale and intensity, which made the process of landscape formation and development on specific territories change gradually, even differ from their inherent natural laws (Nguyen et al., 2019). Human impacts often influence the changes and the succession of landscape in general and ecological succession in particular (Pham et al., 1997; Nguyen et al., 2003, Nguyen et al., 2017).

This research examines characteristics of structure and differentiation of the natural – anthropogenic; clarifying diversity in classes of landscape. Especially, analyzing characteristics, causes of change and ecological succession of natural – anthropogenic landscapes in Konkakinh (Kon Ka Kinh) – Konchurang (Kon Chư Răng) conservation territory in period of more than half a century.

Material and research methods

Studied area. Konkakinh – Konchurang conservation territory is in the area of K'Bang district, northern part of Mang Yang district and a small part of Dak Doa district, located in the Central Highland of Vietnam (Fig. 1). It is the starting area of the river system containing four rivers: Ba, Se San, Srepok and Con. In the manner of administrative geography, this territory is divided by the East Truong Son route, nearby the National Highway 19 in the south, adjacent to Highway 24 in the north and the vast forest of Kon Plong, Kontum province, forming a valuable natural ecosystems under preservation in the central of Truong Son forest.

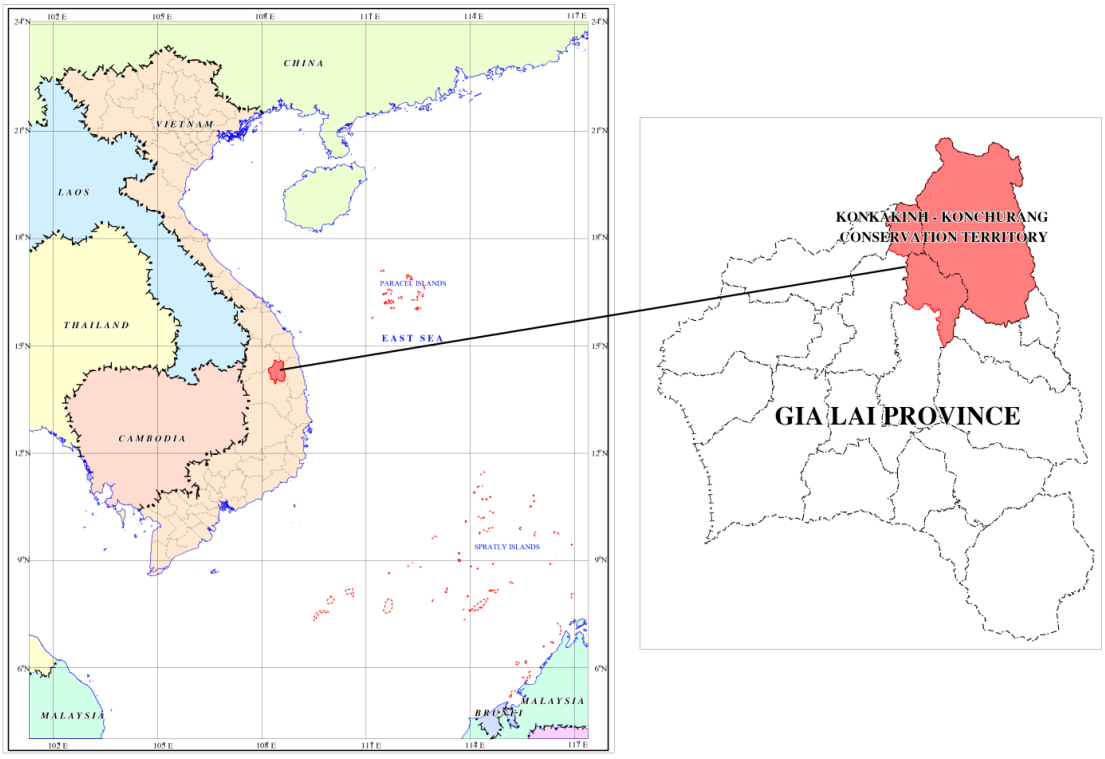


Fig. 1. Location of the studied area

The studied area consists of various geological formations and petrographic compositions with 21 different geological complexes. Basaltic and granite bedrocks distribute widely, creating characteristic terrains. Accordingly, the regional topography gradually decreases from North to South and from West to East, creating numerous plateaux. Compared to the sea level, the plateau topography has average height of 900–1000 m, gradually lowers from the North (1300 m) to the South (600 m), slightly protrudes in the middle and gently slopes to the two valley sides of Ba river and Con river. This terrain is typical with the process of surface erosion. Besides, the cubic-sized mountains on the pristine background is strongly divided with slope of 30–35^o, forming deep valleys of Dak Pne river and Ba river. Alternatively, the topography of semi–plateaus, plains and valleys distributed in the south of the studied area are characterized by exogenous activities of denudation – accumulation, accumulation – erosion (Duong, 2016; Nguyen et al., 2017).

In the studied area, the typical humid tropical is influenced simultaneously by climate circulation in the Central Highlands and Central Coast, which contains a various combination of terrains, including mountains, highlands, valleys and plains. The average temperature is 21–23^{o}C. Rainy season lasts from May to December with heavy rainfalls of over 2000 mm, while as dry season is short (3–4 months) and drought situation is not as serious as which has been happening in the South and West (K'Bang…, 2012; Vietnam Academy…, 2015). The hydrological system in this area is highly developed, including the mainstream and tributaries of the rivers Ba, Se San, Srepok and Con. The flow with thick density is relatively evenly distributed, averaging 0.34 km/km^2. Because of well-preserved vegetation, the plant density in the north is often higher than in the south.

According to the soil classification of FAO/UNESCO, there are six main soil groups with 14 soil types in this area (Nguyen et al., 1017), highlighted by Rhodic Ferralsols on basalt in the eastern region and Ferralic Acrisols formed by different rocks under weather change in the western region of the studied territory. In this area, several types of highland tropical vegetation are formed. They are evergreen broadleaf forest and mixed forest (broadleaf and coniferous) concentrated in low and medium mountains of Konkakinh National Park, Konchurang Nature Reserve and surrounding areas (Thai, 1999; Nguyen et al. 2017). The vegetation processes a primitive structure with many layers of canopy and thick cover. The anthropogenic vegetation is mainly plantation forest, exploited for planting agricultural and industrial crops such as coffee, rubber, pepper, sugarcane, rice and many other crops.

The studied area is inhabited by 6629 households with 30942 inhabitants and average density of 21 people/km^2. According to the Report of the master plan on socio-economic development for K'Bang district (2013), commune A Yun has the highest population density of 85 people/km^2, while commune Kon Pne has the lowest population density of 8 people/km^2. The population is predominantly ethnic (80%), mostly Ba Na. Besides, there are other ethnic minorities and migrant people such as Tay, Nung, Hmong, Dao… Kinh people live in Mang Yang district and the center of K'Bang district, distributed along the main road connecting communes.

Economic activities are mainly agricultural production, including cultivation and livestock. The southern region has a developed livestock industry. Shifting cultivation is the common habit and a food source for indigenous people. According to the survey results, up to 50% of households interviewed produce agricultural products on forest land with extensive culture. Most ethnic households in the buffer zone of the national park and reserved nature are lack of food for several months in a year. People often collect forest products for eating, borrow or sell unripe agricultural products for living and hold expectation for government aid.

Data collection. Based on topographic map and preliminary landscape map, we selected plots and routes to investigate. Survey results by plots and routes in different types of terrain were recorded to describe natural characteristics, human activities and their spatial differentiation. The boundaries of landscape units were checked, especially the boundaries of

different types and kinds of landscapes. Residents and local officials in studied area were interviewed. Databases were collected about the variation of vegetations cover in the changed, destroyed landscapes by human activities over the past 50 years.

Editing and establishing maps. To perform the research, we have edited component maps and developed natural – anthropogenic landscape maps of the study area in 2 periods (2005 and 2017). The MapInfo Pro 15, ArcGIS 10.2, ENVI 5.3 and satellite images SPOT 5 were used to build maps. Component maps were edited and built from the original map at the scale of 1:100 000. Map of natural – anthropogenic landscape in Konkakinh – Konchurang conservation territory was established at the scale of 1:50 000 based on overlapping and analyzing the combination of component maps and field survey results. Selected 6-range taxonomic systems contain: System → Subsystem → Class → Subclass → Type → Kind (Table 1).

Table 1.

Taxonomic ranges and classification criteria for the landscape in Konkakinh – Konchurang conservation territory

	Taxonomic range	**Classification criteria**
1	System of landscape	The decisive role of the atmospheric circulation regime in the process of climate formation in the belt
2	Subsystem of landscape	The decisive role of atmospheric circulation regime and the regulation of ecological regions of flora
3	Class of landscape	Relief configuration, which determines the homogeneity of two large processes, namely erosion and accumulation, in the real cycle
4	Subclass of landscape	The peculiarity of large relief forms manifests the property of non-border based on the combination of relief and typical geomorphological processes
5	Type of landscape	Bio-climate and anthropogenic activities determine the formation of vegetation
6	Kind of landscape	The natural – anthropogenic differentiation of vegetation on different soil types

Due to the homogeneity of the system and subsystem in taxonomic range, the legend of natural – anthropogenic landscape map does not represent these two ranges (Table 2).

For mapping the landscape, first, we edited the component maps in a uniform ratio of 1:50000. For vegetation maps, combined topographic maps and interpreting SPOT satellite images to produce a preliminary map according to the remote sensing image processing. From this map, a field survey was conducted in April 2017 to adjust the boundaries of the contours, to supplement and clarify the structure of vegetation. For the 2005 vegetation map, data lookups were conducted by interviewing residents who had lived and worked before 2005 and local officials in Son Lang (Kon Von 1, Kon Von 2, Kon Trang) and Dak Roong commune.

Used the method of overlaying map layers with program Arcgis 10 (License ESU006984479, ArcGIS Desktop Basic); execute the ***Intersect command***. For example: overlaying a vegetation map with 2 patches (Industrial crops and Annual crops) and a soil layer with 1 red-yellow soil patch. The results showed two new patches attributes: 1. Industrial crops in red-yellow soil, 2. Annual crops in red-yellow soil (Fig. 2a).

The landscape map (result map) of the study area is made by overlaying the component map layers (Fig. 2b). Accordingly, for every patch includes all attributes of the component map layers (also landscape properties).

Data analysis and evaluation. A comprehensive landscape assessment was used to determine the status of landscape components, including the identification of plants within forested areas, agricultural areas and grass and shrub landscapes. This method was also used to evaluate ecological succession within the landscape by comparing the comprehensive assessment with data from field surveys. The comprehensive assessment of collected data was conducted with reference to remote sensing data; established origins and development trajectories of forest plant, grass and shrubs communities; and biological and ecological

characteristics of crops in tropical monsoon conditions of Vietnam. On the basis of survey data and satellite images in some periods, identify typical landscapes to describe the secondary ecological succession over the past half century.

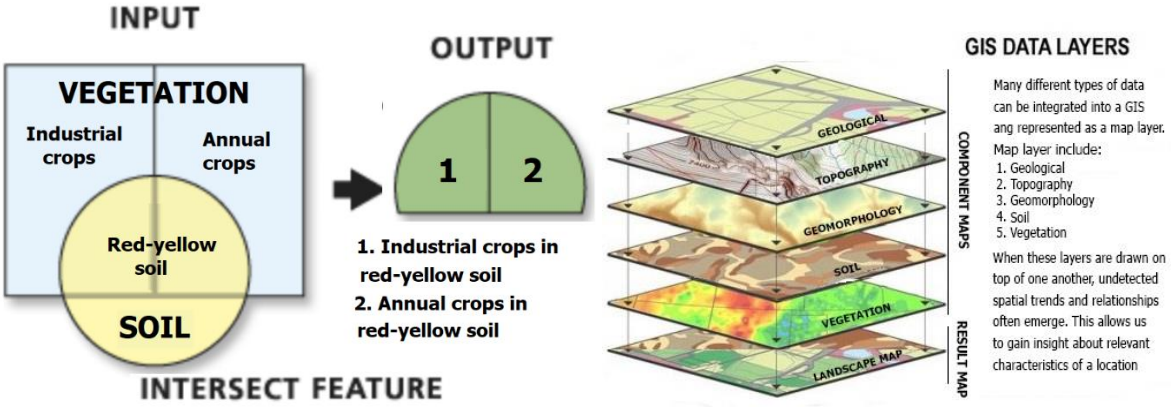
Table 2.

Legend of natural – anthropogenic landscape map in the Konkakinh – Konchurang conservation territory

LANDSCAPES CLASS	LANDSCAPES SUBCLASS	LANDSCAPES TYPE / LANDSCAPES KIND	Tropical monsoon highland climate, humid, average temperature of 22°C Total annual rainfall fluctuates: 1500–2800 mm, slightly lacking in moisture The rain season lasts 8–9 months, the dry season is 3–4 months							
			Natural vegetation			Anthropogenic vegatation				
			Evergreen board-leaf tropical forest	Wood and bamboo mixed forest	Grass-and and shrubs	Plantation forest	Industrial crops	Annual crops	Plant in residential areas	Reservoir
Basalt plateau	High plateau with erosion process	Rhodic Ferralsols	1	2				3	4	
		Xanthich Ferrasols	5	6				7		
		Haplic Lixisols	8					9		
		Ferralic Acrisols	10	11	12	13	14	15		
		Lithic Luvisols	16					17		
		Gleyic Luvisols	18					19		
		Lithic Leptosols						20		
		Haplic Lixisols						21		
		Reservior								22
Mountain	Medium mountains with erosion processes dominate	Gleyic Acrisols	23							
		Ferralic Acrisols	24	25	26	27		28		
		Rhodic Ferralsols	29	30				31		
		Lithic Leptosols	32					33		
		Lithic Luvisols	34							
		Gleyic Luvisols	35					36		
	Low mountains, landslide with erosion and accumulation processes dominate	Xanthich Ferrasols	37	38						
		Gleyic Acrisols	39			40				
		Ferralic Acrisols	41		42	43		44	45	
		Rhodic Ferralsols	46				47	48		
		Lithic Luvisols	49					50		
		Plinthich Acrisols						51		
		Gleyic Luvisols						52		
		Haplic Lixisols						53		
		Haplic Acrisols			54					
		Reservior								55

Contain table 2.

Plain and valley between the moun-tain	**Valley erosion and accumula tion**	**Rhodic Ferralsols**						56		
		Xanthich Ferrasols	57					58		
		Gleyic Acrisols	59	60				61		
		Ferralic Acrisols	62					63	64	
		Lithic Luvisols	65		66			67		
		Haplic Lixisols	68					69		
		Umbric Fluvisols						70	71	
		Lithic Leptosols						72		
		Plinthich Acrisols						73		
		Reservior								74
	Terraces and plains accumula te-invasion with the aluvi-deluvi precess	**Haplic Lixisols**						75	76	
		Gleyic Acrisols						77	78	
		Ferralic Acrisols	79		80	81		82	83	
		Haplic Acrisols				84		85		
		Eutric Fluvisols						86		
		Xanthich Ferrasols						87		



a) *b)*

Fig. 2. Method of intersect feature map layers

Results

Structural characteristics of natural – anthropogenic landscapes. Research results show that, the studied area consists of 1 system, 1 subsystem, 3 classes, 5 subclasses, 13 types and 87 kinds of landscape (Fig. 3 and Table 2).

System and subsystem of landscape: The researched territory belongs to the tropical monsoon landscape system. The influence of southwest monsoon and Southeastern highland monsoon resulted in a subsystem of tropical monsoon landscape.

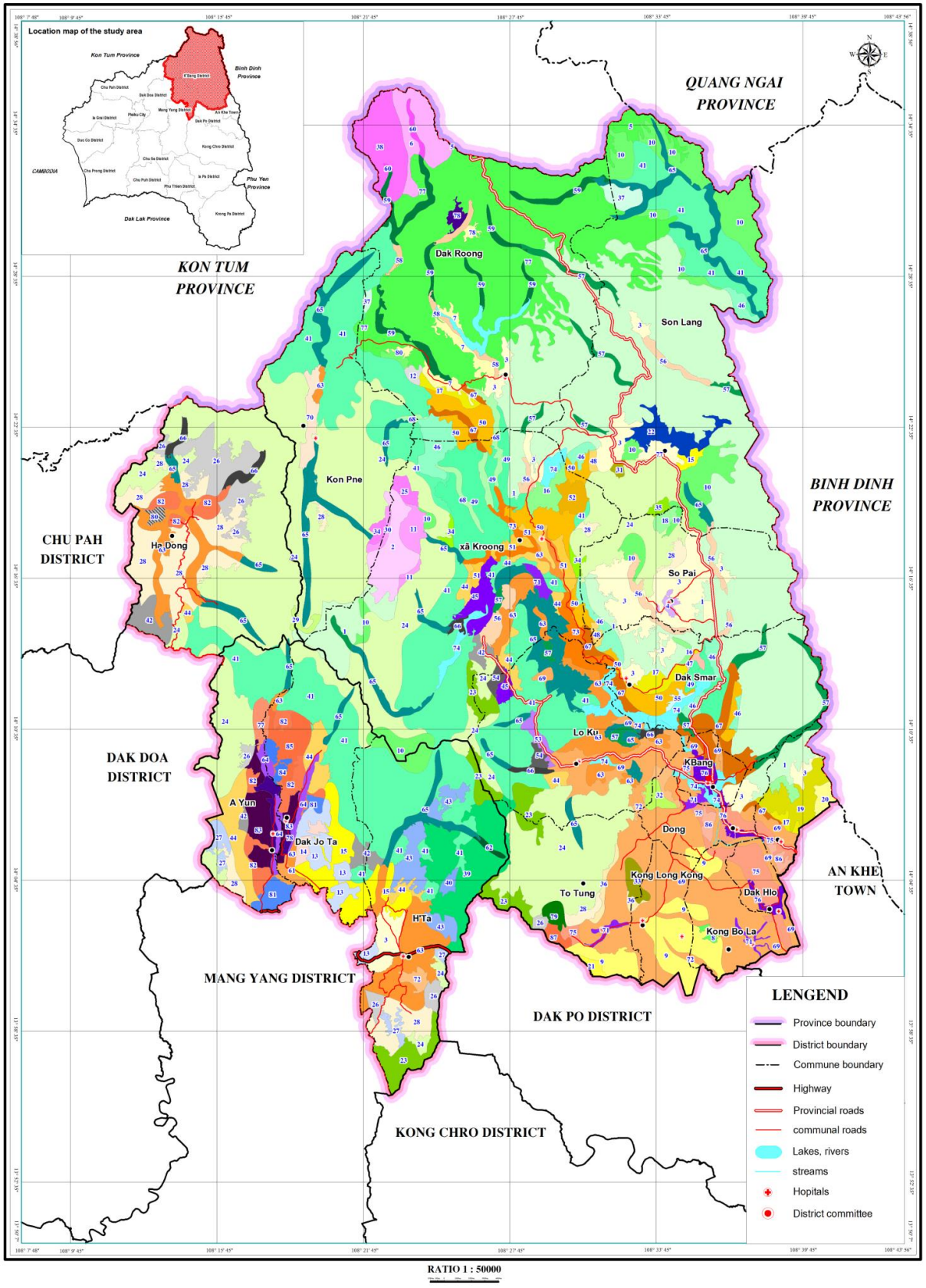


Fig. 3. Map of the natural – anthropogenic landscape in the Konkakinh – Konchurang conservation territory

Class and subclass of landscape: Konkakinh – Konchurang conservation territory is divided into 3 classes: plateaus, mountains (medium and low), and the class of plains and

valleys. In particular, the class of mountain is classified into 2 subclasses: medium mountain with elevation over 1000 m and low mountain with elevation from 600 to 1000 m. The class of plains and valleys includes plain subclass and valley subclass.

Type of landscape: Accordingly, the study territory has 13 types of landscape belonging to 3 groups: group of broadleaf evergreen tropical forests and natural – anthropogenic shrubs, grasslands; group of anthropogenic vegetation (annual crops and plants in residential areas); and group of aquatic landscape.

- Group of broadleaf evergreen tropical forests and natural – anthropogenic shrubs, grasslands: these types of landscape were influenced by human activities at different levels. They basically retained the properties and development under natural rule. In some places, they were disturbed by the strong and frequent human impacts (shown in the types of shrubs and grasslands).

- Group of anthropogenic vegetation are landscapes that have a component or coating surface built by humans. They have at least one component created by humans and tend to grow in the direction of human impact. In the group, there are 4 types of landscape: plantation forest, industrial crops, agricultural crops and plants in residential areas.

Diversity in class of mountain:

- Group of aquatic landscape: include the lakes which are mainly built by humans on regular flows such as irrigation lakes, hydroelectric reservoirs or multi-purpose lakes.

Diversity in classes of landscape. *Diversity in class of plateaus:* The class of the plateaus only has 1 subclass which is basalt plateaus, differentiated into 3 types with 22 different kinds. In particular, the type of evergreen broadleaf tropical forests and shrubs, grasslands has 10 kinds.

The type of anthropogenic vegetation on basalt plateaus is observed with 11 kinds. The most dominant and diverse one is the annual crops with 8 kinds, covering 90% of the total natural area. The type of aquatic landscape is not differentiated. There is only one kind (number 22), with an area of 9.22 km^2 and appearance frequency of one time. This is a valuable kind and very important in the basalt plateaus. It is the water supply and conditioner for the area, especially for annual crops and plants in residential areas.

- Subclass of medium mountain: differentiated into 2 types, with 14 kinds of landscape. The type of tropical forests and shrubs, grasslands has 9 kinds. This subclass also possesses the highest frequency of appearance, with 15 times. Several other kinds have a frequency of only 1 time (number 25, 29, 30... on the map). These kinds are distributed in the western part of the study area, belonging to 5 communes, including Kon Pne, Ha Dong, Kroong, A Yun and To Tun. The type of anthropogenic vegetation on medium mountain has lower diversity, including 5 different kinds, scattered throughout the study area.

- Subclass of low mountain: divided into 3 types with 19 kinds, widely distributed across the region. The kind of evergreen broadleaf tropical forests and shrubs, grasslands is quite diverse with 8 kinds. The type of anthropogenic vegetation on low mountain has a high diversity, divided into 11 kinds. These kinds are scattered throughout the studied area. In the subclass of low mountain, there is a type of aquatic landscape, consisting of only one kind (number 55).

Diversity in class of plains and valley:

- Subclass of valley erosion and accumulation: divided into 3 types with 19 kinds. This subclass has a high differentiation and diversity in the study area. The total area of 19 kinds is 443 km^2. The type of evergreen broadleaf tropical forests and shrubs, grasslands in this subclass own 7 different kinds. The type of evergreen broadleaf forests on Lithic Luvisols (number 65) has the frequency of 22 times, distributed but not concentrated in the vicinity of the Konkakinh mountain and the Konchurang Nature Reserve. The type of anthropogenic vegetation on the terrain of valley erosion and valley accumulation has a high diversity of kinds, including 11 kinds. Some kinds appear more frequently like the kind number 63 with 14 times. The aquatic

landscape type has 1 kind, but with high appearance frequency (9 times). This type plays an important role in economic development of research territory, especially agricultural sector.

- Subclass of accumulated – eroded terraces and plains: differentiated into 2 types with 13 kinds. This subclass has the lowest diversity of kinds in the researched territory. The type of evergreen broadleaf tropical forests and shrubs, grasslands in this subclass only consists of 2 kinds. The type of anthropogenic vegetation on accumulated – eroded terraces and plains is divided into 11 kinds, belonging to 3 groups: plantation forests, plants in residential areas and annual crops.

The transformation and succession of natural – anthropogenic landscapes. *Anthropogenic transformation – basic properties of landscape succession in Konkakinh - Konchurang conservation territory*

We have developed the natural – anthropogenic landscape map of 2005 (Fig. 4 and Table 3) to compare the landscape changes in Konkakinh – Konchurang conservation territory.

The landscape of this area has been strongly changed both in quality and quantity. The succession process from one type to another is quite common. Landscape maps in two periods (2005 and 2017) show that there were 94 kinds in 2005, while as only 87 kinds still existed in 2017. Some landscapes have been changed in area, some completely lost and replaced by new kinds. During these two periods, there were 43 kinds completely disappeared, 33 kinds newly formed and 51 kinds still retained with typical properties but changed in size.

It is easy to see that the type of shrubs, grasslands and perennial crops had been strongly changed. In the type of shrubs, grasslands, there were 24 kinds in 2005, out of which only 6 kinds still retained their properties but changed in area in 2017. The remaining 18 kinds had completely transformed into other kinds. For the type of perennial crops, among 13 kinds observed in 2005, only 2 kinds (14 and 47) retained the properties in 2017. The remaining 11 kinds were converted to other kinds. In addition, the type of plants in residential areas also changed quite robustly (from 9 kinds in 2005 to 7 kinds in 2017), among which only 3 kinds still retained their original attributes, 6 kinds disappeared, and 4 kinds were newly formed.

The remaining types have experienced a fluctuated but not significantly obvious modification. From 22 kinds in 2005, the type of evergreen broadleaf tropical forests lost 3 kinds and integrated 4 new kinds in 2017 (23 kinds). The type of plantation forest also lost one kind, formed 4 new kinds in 2017. The total number of kinds in this type is 6. The type of wood and bamboo mixed forests has been also changed with one kind lost and 6 kinds newly formed.

The variation of landscape in Konkakinh – Konchurang conservation territory is not only shown in the number of landscapes lost and newly formed, but also by statistics on area of kinds in 2 periods (Table 4). The results from Table 4 show that all kinds of landscape have been changed in area size. Landscape number 42 represented the largest change, with 112.53 km^2 reduced, from 125.33 km^2 in 2005 to 12.80 km^2 in 2017. The landscape number 1 also experienced a dramatic change, with an increase from 73.44 km^2 in 2005 to 342.01 km^2 in 2017. A number of other kinds also had quite large changes in area, including landscapes 3, 24, 41, 49, 50, 62, 63, 65, 69 ranged from 30 km^2 to 60 km^2.

However, there were also several kinds that changed slightly in area, kept the original status. Typically, landscape number 6 only changed 0.0004 km^2, landscape number 21 changed 0.0005 km^2. Other kinds of landscape such as number 23, 32, 48, 52 had slight changes in area, ranged from 0.24 km^2 to 0.65 km^2.

Human impacts have been strongly influencing and transforming landscapes in both positive and negative directions. In the positive direction, grasslands and shrubs have been gradually replaced by industrial and annual crops or plantation forests. These changes increase the surface area, by which it helps to reduce the risk of natural disasters and especially increase the economic value of the landscape. The fact that several kinds in the type of evergreen broadleaf tropical forests also enlarged in term of area proves that policies on forest protection and economic stability for residents have brought positive effects. However, there are still

impacts such as deforestation for timber or burning for shifting cultivation, which also causes different negative trends, proved by the decline of natural forest area in the territory.

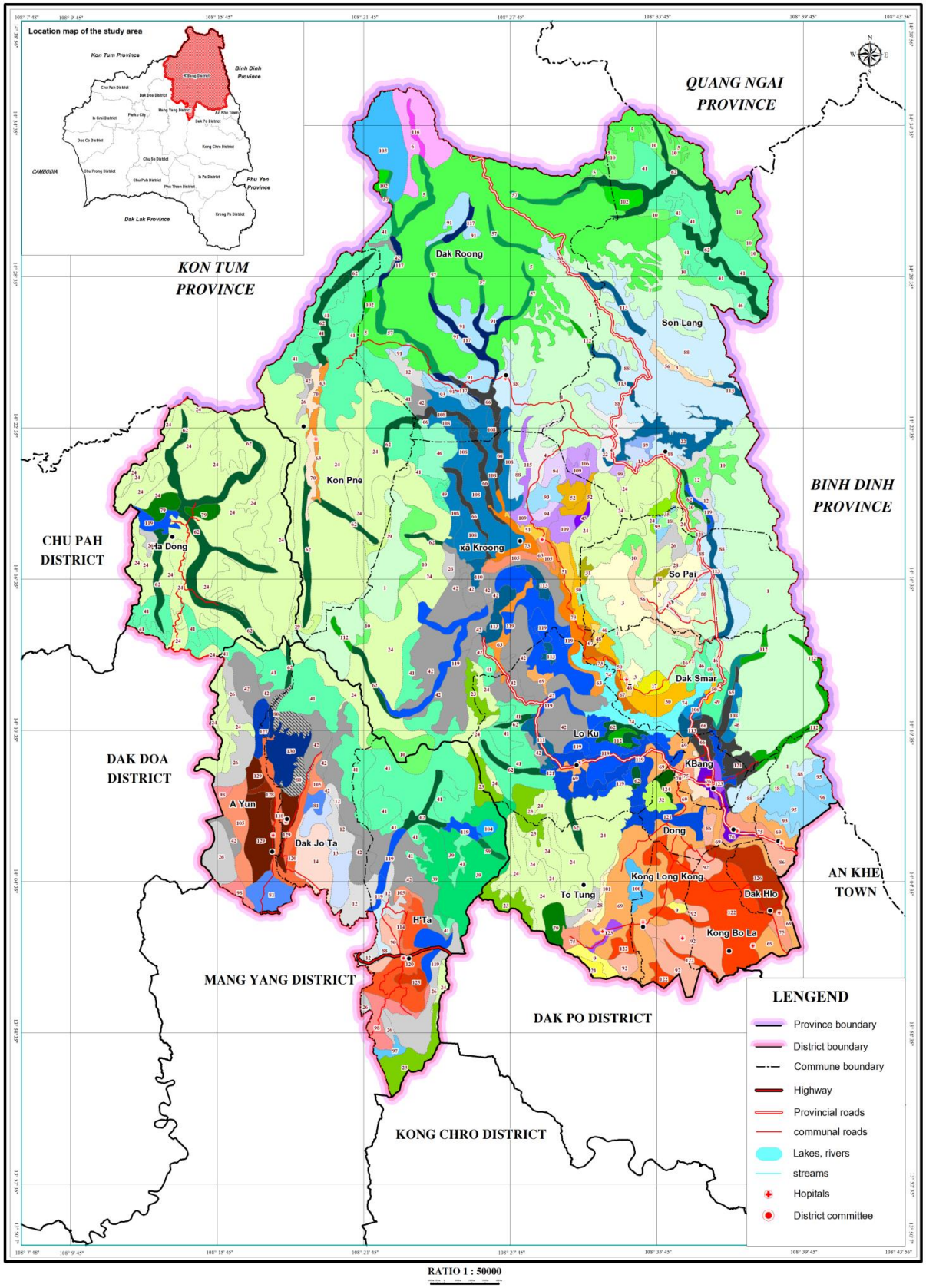


Fig. 4. Map of the natural – anthropogenic landscape in the Konkakinh – Konchurang conservation territory (2005)

Table 3.

Legend of natural – anthropogenic landscape map in the Konkakinh – Konchurang conservation territory (2005)

LANDSCAPES CLASS	LANDSCAPES SUBCLASS	LANDSCAPES TYPE / LANDSCAPES KIND	Tropical monsoon highland climate, humid, average temperature of 22°C. Total annual rainfall fluctuates: 1500–2800 mm, slightly lacking in moisture. The rain season lasts 8–9 months, the dry season is 3–4 months							
			Natural vegetation			Anthropogenic vegatation				
			Ever-green board-leaf tropical forest	Wood and bamboo mixed forest	Grass-land and shrubs	Planta-tion forest	Industrial crops	Annual Crops	Plant in residential areas	Reservoir
Basalt plateau	High plateau with erosion process	Rhodic Ferralsols	1		88	89	90	3	4	
		Xanthich Ferrasols	5	6	91					
		Haplic Lixisols					92	9		
		Ferralic Acrisols	10		12	13	14			
		Lithic Luvisols	16		93			17	94	
		Gleyic Luvisols	18		95					
		Lithic Leptosols			96					
		Haplic Lixisols						21		
		Reservior								22
Mountain	Medium mountains with erosion processes dominate	Gleyic Acrisols	23		97					
		Ferralic Acrisols	24		26		98	28		
		Rhodic Ferralsols	29					31	99	
		Lithic Leptosols	32		100					
		Lithic Luvisols						101		
		Gleyic Luvisols	35							
	Low mountain, landslide with erosion and accumuation processes dominate	Xanthich Ferrasols	102		103					
		Gleyic Acrisols	39		104					
		Ferralic Acrisols	41		42		105		45	
		Rhodic Ferralsols	46		106			48	107	
		Lithic Luvisols	49		108			50	109	
		Plinthich Acrisols			110			51		
		Gleyic Luvisols						52		
		Haplic Lixisols			111					
Plain and valley bet-ween the moun-tain	Valley erosion and accumu-lation	Rhodic Ferralsols	112		113		114	56	115	
		Xanthich Ferrasols	57	116	117					
		Gleyic Acrisols	59				118			
		Ferralic Acrisols	62		119		120	63		
		Lithic Luvisols	65		66			67		
		Haplic Lixisols			121		122	69	123	
		Umbric Fluvisols						70		

Contain table 3.

		Lithic Leptosols	124				125			
		Plinthich Acrisols						73		
		Reservior								74
	Terraces and plains accumu-late-invasion with the aluvideluvi precess	**Haplic Lixisols**					126	75	76	
		Gleyic Acrisols			127		128			
		Ferralic Acrisols	79		80	81	129			
		Haplic Acrisols			130					
		Eutric Fluvisols						86		

Table 4.

Statistics on area of landscape kinds in 2 studied periods (2005 and 2017)

Kinds of landscape in 2017	**Area (km^2)**	**Kinds of landscape in 2005**	**Area (km^2)**	**Changes**	**Kinds of landscape in 2017**	**Area (km^2)**	**Kinds of landscape in 2005**	**Area (km^2)**	**Changes**
1	342.01	**1**	268.57	***73.44***	**66**	7.17	**66**	25.76	***-18.59***
2	14.69				**67**	22.42	**67**	3.70	***18.71***
3	64.97	**3**	29.80	***35.17***	**68**	8.80			
4	1.65	**4**	16.48	***-14.82***	**69**	121.84	**69**	64.23	***57.60***
5	191.65	**5**	182.03	***-9.62***	**70**	5.75	**70**	7.29	***-1.55***
6	14.39	**6**	14.39	***-0.0004***	**71**	6.00			
7	7.58				**72**	7.23			
8	0.92				**73**	13.52	**73**	9.50	***4.02***
9	32.15	**9**	3.68	***28.47***	**74**	25.72	**74**	14.62	***11.1***
10	62.21	**10**	60.61	***1.6***	**75**	21.88	**75**	9.89	***11.98***
11	5.79				**76**	8.41	**76**	4.92	***3.48***
12	1.31	**12**	23.96	***-22.64***	**77**	6.80			
13	13.44	**13**	11.44	***1.99***	**78**	6.61			
14	2.76	**14**	10.96	***-8.19***	**79**	2.52	**79**	9.83	***-7.30***
15	22.45				**80**	2.14	**80**	7.64	***-5.50***
16	6.28	**16**	1.74	***4.54***	**81**	7.51	**81**	8.89	***-1.38***
17	8.56	**17**	3.23	***5.33***	**82**	18			
18	3.76	**18**	2.18	***1.58***	**83**	13.08			
19	10.57				**84**	2.51			
20	2.48				**85**	8.93			
21	1.52	**21**	1.52	***-0.0005***	**86**	3.18	**86**	5.46	***-2.28***
22	9.22	**22**	9.59	***-0.37***	**87**	1.92			
23	28.46	**23**	27.93	***0.53***			**88**	103.64	
24	383.11	**24**	423.62	***-40.51***			**89**	1.54	
25	2.61						**90**	4.64	
26	28.58	**26**	41.60	***-13.02***			**91**	20.16	
27	5.93						**92**	26.97	
28	58.19	**28**	3.89	***54.30***			**93**	8.25	
29	1.75	**29**	3.63	***-1.88***			**94**	4.75	
30	1.64						**95**	12.96	
31	1	**31**	1.91	***-0.91***			**96**	2.02	
32	3.06	**32**	3.52	***-0.46***			**97**	1.62	
33	3.71						**98**	9.49	
34	3.86						**99**	1.24	
35	1.38	**35**	2.4	***-1.02***			**100**	4.17	
36	2.85						**101**	1.58	

Contain table 4.

37	4.95						**102**	5.74	
38	19.13						**103**	18.07	
39	33.94	**39**	32.57	***1.37***			**104**	1.45	
40	1.48						**105**	15.48	
41	295.20	**41**	223.09	***72.11***			**106**	1.58	
42	12.80	**42**	125.33	***-112.53***			**107**	3.24	
43	14.24						**108**	44.65	
44	29.85						**109**	8.87	
45	9.03	**45**	0.88	***8.15***			**110**	1.63	
46	23.46	**46**	18.84	***461.52***			**111**	3.35	
47	0.84						**112**	11.06	
48	2.03	**48**	1.79	***0.24***			**113**	19.84	
49	38.08	**49**	6.74	***31.34***			**114**	1.78	
50	32.33	**50**	13.43	***18.9***			**115**	2.43	
51	7.17	**51**	4.74	***2.43***			**116**	1.5	
52	4.56	**52**	5.21	***-0.65***			**117**	9.73	
53	2.91						**118**	10.42	
54	3.40						**119**	61.28	
55	0.90						**120**	15.92	
56	15.80	**56**	7.59	***8.21***			**121**	25.98	
57	22.63	**57**	18.08	***4.55***			**122**	43.86	
58	4.79						**123**	3.38	
59	18.33	**59**	0.94	***17.39***			**124**	1.49	
60	1.68						**125**	2.31	
61	2.48						**126**	12.35	
62	0.98	**62**	73.91	***-72.93***			**127**	3.85	
63	68.52	**63**	10.86	***57.66***			**128**	1.53	
64	6.91						**129**	17.73	
65	82.41	**65**	1.81	***80.6***			**130**	9.45	

Characteristics of ecological succession of landscape. In this studied area, the secondary ecological succession is deforestation from the consequence of shifting cultivation and nomadic habits (Fig. 3). In the past, original landscape in the study area was the evergreen broadleaf tropical forest. In 1975, after local people set the forests on fire for cultivation, the broadleaf vegetation was destroyed, creating conditions to develop and form a landscape of grasslands and shrubs interbred with dead trees. No more vitality was seen inside the burn-to-ashes trees. Therefore, the type of grasslands and shrubs was maintained from 1975 to present day. Landscape number 66 represents this succession (Fig. 5a).

Since 1975, Ba Na ethnic people with shifting cultivation and nomadic habits had formed a type of upland fields after deforestation. By early 1990s, ethnic residents renovated the land and cultivated agricultural crops or industrial crops, which formed the roots for upland fields or perennial crops. Landscape number 47 represents this succession (Fig. 5b).

Local residents, consisting of mainly ethnic minorities with nomadic farming livelihood, have destroyed forests and formed upland fields since 1995. When the soil was exhausted and the productivity was poor, people migrated to new lands. After a while, the natural vegetation was restored and formed the secondary forest landscape called restored forest after shifting cultivation. Landscape number 41 represents this succession (Fig. 5c).

Another ecological succession abundantly occurred in this studied area is the secondary ecological succession caused by the large-scale forest exploitation (Fig. 6). From 1975 to 1995, to develop the economy, the exploitation of timber exploded widely, leading to the consequence of leaving landscapes with tree stumps, shrubs and grasslands. After 1995, due to local policies, these landscapes were gradually replaced by forests of *Hevea brasiliensis* (Willd. ex A.Juss.) Müll.Arg. (rubber tree).

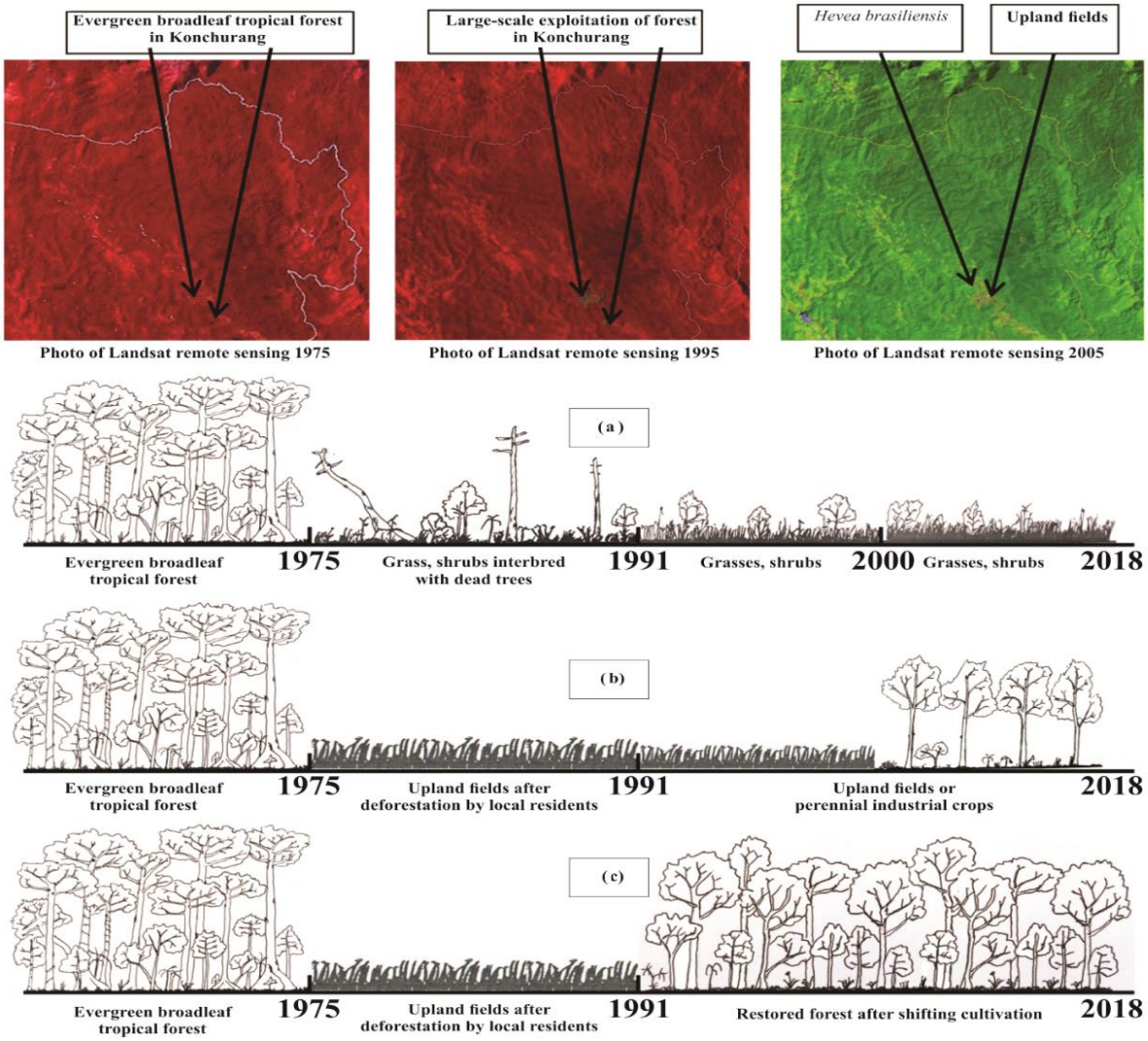


Fig. 5. Ecological succession of landscape in Konchurang Natural Reserve (above, landscape images on remote sensing photos for some periods)

By 2013, due to the reduction in rubber latex value, local residents began to replace rubber trees by *Litsea glutinosa* (Lour.) C. B. Rob. for higher economic benefits. Landscape number 14, which was discovered in the Dak Jo Ta commune, is typical for this succession (Fig. 6a).

Similar to the first stage of the "5a" ecological succession, in 1995, the type of evergreen broadleaf tropical forests was replaced by tree stumps, shrubs and grasslands. After that, local people started to use these areas for cultivation, and then formed typical upland fields. The main crops were upland rice, cassava, corn..., which were maintained until now. The kinds of landscape number 77, 82 and 85 in Konkakinh National Park are typical examples (Fig. 6b).

After about 20 years, natural forest vegetation in the landscape has been gradually recovered. The vegetation has a simple structure constituted by low trees blended with young trees.

However, the climate parameters of the forest landscape are gradually restored, which is the basis for the evergreen broadleaf tropical forest landscape to be formed after a short time. The landscape number 41 represents this succession (Fig. 6c).

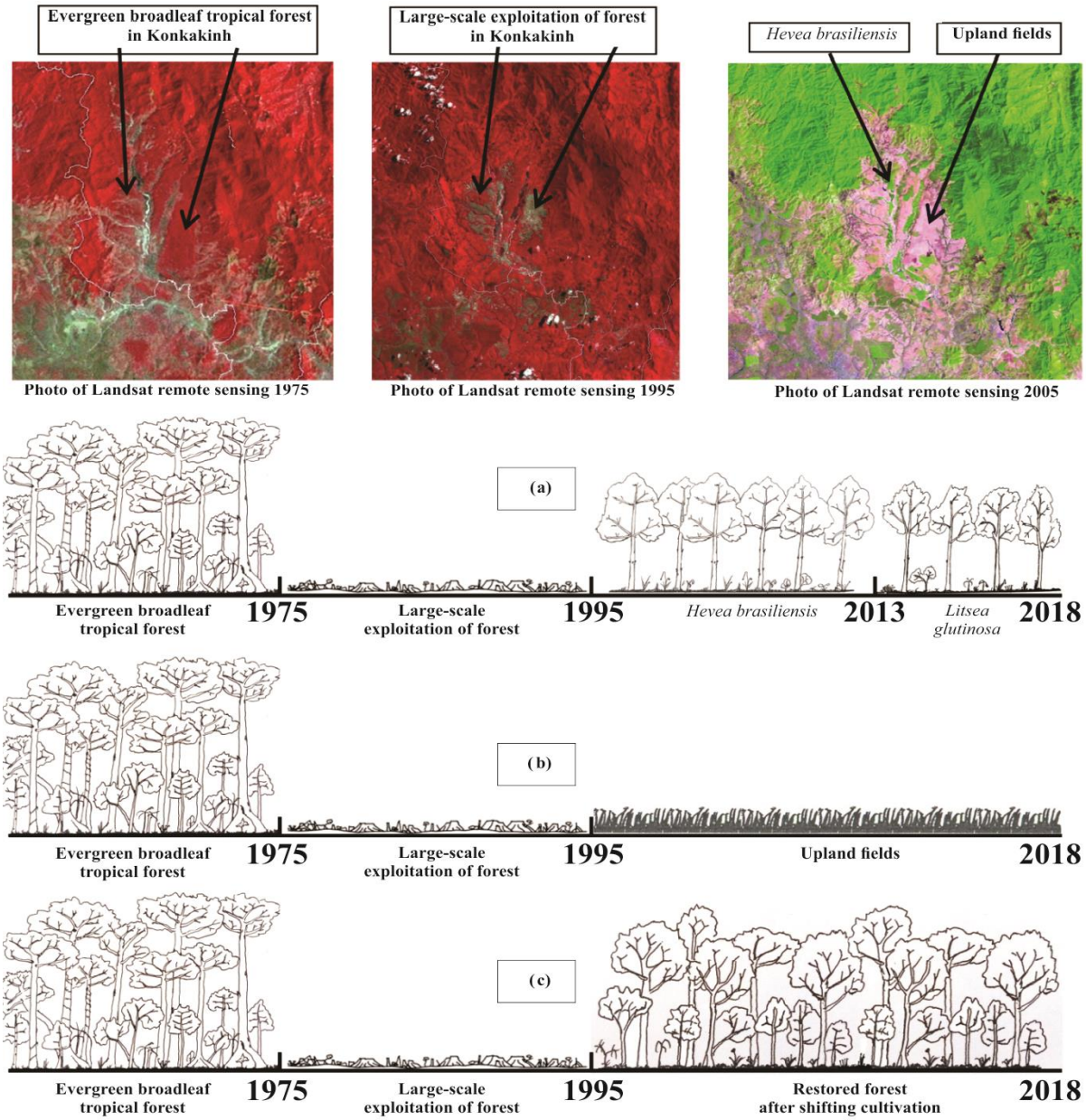


Fig. 6. Ecological succession of landscape in Konkakinh National Park (above, landscape images on remote sensing photos for some periods).

Discussion

The differentiation on natural conditions and human activities had contributed to the formation of natural – anthropogenic landscape system in the Konkakinh – Konchurang conservation territory, which is quite diversified and plentiful. The landscapes in the study territory have been influenced by human activities at different levels. Although there are still landscapes that keep the development under natural rule, other landscapes change dramatically, depending on direct impacts of human, (especially, the types and kinds of landscapes through the drastic transformation of the plant component – vegetation). Class of mountain landscape has the highest diversity, with 5 types and 33 kinds (in which, subclass of medium mountain: 2 types, 14 kinds and subclass of low mountain: 3 types, 19 kinds). The diversity of landscapes in this studied area is lower than the diversity of mountains class in the area Sathay – Ngochoi, Kontum province, where the latitude is similarities (6 types and 39 kinds) (Nguyen et al., 2018),

and higher than mountains area in Dak Lak province (1 type and 27 kinds) (Phan, 2018), which located in the south of studied territory. The diversity in studied area is due to two reasons: the first, is that the landscape kinds of evergreen broadleaf tropical forest are well preserved in Konkakinh National Park and Konchurang Natural Reserve, the second is the diversity in agricultural landscapes, especially the landscape kinds of annual crops.

In the class of plain and valley between the mountains, the diversity is low, especially the landscape evergreen broadleaf tropical forest (only 6 kinds), but higher than the diversity of plain and valley class in the area Sathay – Ngochoi (Nguyen et al., 2018). However, the landscapes of annual crops have high diversity (15 kinds), while in this class in Sathay – Ngochoi is only 3 kinds. This shows strong human impacts on lowland landscapes, turning forest landscapes into agricultural landscapes and plantation landscapes.

The landscape has been affected by long-term impacts of human activities on different scales and levels, especially the forest development policies and cultivation habits. Human impacts are the main cause of dramatic changes at the type range and especially at the kind range. This is proved in the period from 2005 to 2017, there were 43 kinds completely disappeared, 33 kinds newly formed and many kinds still retained with typical properties but changed in size. These changes are considered more influence than many other areas of Vietnam, higher than the area Sathay – Ngochoi, where were 17 kinds completely disappeared, only 12 kinds newly formed in 11 years (2005–2015) (Nguyen et al., 2018).

The drastic change of the types of shrubs, grasslands and perennial crops is due to the habits of indigenous people (Bana people) often change places of living and cultivation areas, as well as burning forests for cultivation land. In addition, in the last past 15 years, local policies have contributed to transform shrub, grasslands, agricultural crops landscapes to industrial crop landscapes. On the contrary, there are many kinds of landscapes that are expanded in size, increased the number of contours. In which landscapes group of evergreen broadleaf tropical forest due to successful regeneration and restoration policies covered on terrain has a thick soil layer as in landscape class of the basalt plateau.

Secondary ecological succession is particularity of the types and kinds landscape in the studied area. Under the impact of natural and anthropogenic factors, the landscape succession experienced in different stages and trends. This result is also consistent with the studies of Gusev A. P. (2012) when he studied landscapes in the southeast of Belarus and Triskov A.A. (2012) when he studied succession of vegetation of zonal ecosystems in Russia and the author's own (Nguyen et al., 2018) when researched at the triple boundary area Sathay – Ngochoi in Vietnam's territory. Many kinds of landscape in this area experienced a process of development with abundant changes caused by living behaviors and livelihood of local residents. Depending on the location and characteristics of human impacts, the succession of landscape, especially at the range of kind, has taken place in different directions and stages. In the studied area in the last past 50 years, landscapes kinds often experience through 3–4 stages of the succession sequence. This result is consistent with the author's own studies in many different regions of Vietnam such as Giolinh District, Quangtri Province, Sathay-Ngochoi area, Kontum Provinces. (Nguyen et al., 2019). Meanwhile, when study the characteristics of vegetation successions in zonal ecosystems in temperate region, from the pioneering stage to the climax stage, Triskov A.A. (2012) recorded from 2 to 6 stages; or the study results of Marilia Cunha Lignon et al. (2009) on the mangrove forest succession in the Cananéia-iguape coastal system, Brazil has recorded 4 stages of succession from sediment deposition to the formation of mangroves with the dominant of *Avicennia schaueriana* Stapf & Leech. ex Moldenke. Gusev A. P. (2015) noted that the recovery succession of the landscape after human impact is 6 stages. When studying the development stage of plants on deglaciated terrain, Li Chang recorded 3 stages of succession chain (Li Chang et al. 2014). Thus, on a concrete territorial unit, in addition to the natural elements and properties of plants, the rule of ecological succession is also regulated by groups

of human factors such as policies, practice of cultivation and the types of territory exploitation (Nguyen et al., 2019).

The length of each stage of ecological succession of landscape in the studied area is not the same according to each development direction of the landscape. It depends closely on changing the farming practices of indigenous people and the local policies. For example, in the buffer zone of Konchurang Natural Reserve, before 1955 was a primeval forest, after that was 16 year of grassland, shrub and stage of the recovery forest was 27 years (Fig. 4c). This result is similar to the research results of the author group (Nguyen et al., 2018) in Quangtri Province and Sathay - Ngochoi area, Kontum Province. When studied, Gusev A.P. (2015) found the lengths of stages are very different. Accordingly, the length of the 6 stages of ecological succession is respectively: 1, 2, 5–6, 8–12, 20–30, 60–80 years. Research results of Li Chang et al. show that, the length of the succession stage is very different. Accordingly, the three stages of the succession sequence are respectively: 9–13, 13–102 and 110–400 years (Li Chang et al., 2014).

The ecological succession of the landscape in the studied area can be "repeated" but there has been a marked change in the structure, plant species composition, quality and fertility of soil, characteristics of soil hydrology, microclimate... For example, the transition between the annual crops group and the grassland, shrub landscape group after the 3–7 years cycle is due to the cultivation practices of the ethnic Bana. In addition, the internal transformation of the industrial crop landscape (replacing these industrial crops with others) in the 5–10 years cycle also creates a very short stage of ecological succession. These properties and rules show that, if landscapes do not well managed and have reasonable technical measures, the ecological succession of many kinds will take place in the direction of gradual degradation (both in quality of components that create landscape as well as economic efficiency and environmental quality).

Conclusions

Konkakinh – Konchurang conservation territory has a special geographical position in Vietnam and a deep differentiation of natural and anthropogenic components. In particular, the humid tropical climate is affected simultaneously by climate circulation in the Central Highlands and Central Coast on the terrain intertwined by mountains, plateaus, valleys and plains.

The differentiation of natural and anthropogenic conditions has formed the landscape of Konkakinh – Konchurang conservation territory with 1 system, 1 subsystem, 3 classes, 5 subclasses, 13 types and 87 kinds. Types of evergreen broadleaf tropical forests and annual crops have a large area and a wide distribution, containing primitive or affected forest ecosystems typical for the Central Highlands of Vietnam.

Under the human impacts, the landscape had experienced considerable transformations. In the period of 2005 – 2017, 43 kinds of landscape completely disappeared, 33 kinds were newly formed, and 51 kinds retained their properties but changed in size. Types of shrubs, grasslands and perennial crops changed strongly in both quantity and quality. Over the past 50 years, the landscape ecological succession in the studied area has been occurring together with the anthropogenic properties. The ecological succession, with various directions, cycles and stages, has changed the evergreen broadleaf tropical forests under some intermediate stages into shrubs, grasslands, industrial crops or restored natural forest.

In the future, anthropogenic actions will main the main factor that make the change and ecological succession of landscape of Economic efficiency and quality of the environment depend on the human impact on the landscape of Konkakinh – Konchurang conservation territory. This is an important basis, should be noted to build policies and plans for territorial development.

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ТРАНСФОРМАЦИЯ И ЭКОЛОГИЧЕСКАЯ СУКЦЕССИЯ ПРИРОДНО-АНТРОПОГЕННЫХ ЛАНДШАФТОВ ЗАПОВЕДНОЙ ТЕРРИТОРИИ КОНКАКИНЬ-КОНЧЫРАНГ, ВЬЕТНАМ

Нгуен Данг Хой[1], Нго Чунг Зунг[1], Данг Хунг Кыонг[1,2], Колесников С.И.[2], Тишков А.А.[3]

[1]Совместный Российско-Вьетнамский Тропический научно-исследовательский и технологический центра, г. Ханой, Вьетнам.
[2]ФГАОУ ВО «Южный федеральный университет», г. Ростов на Дону, Российская Федерация
[3]Институт географии РАН, г. Москва, Российская Федерация
e-mail: danghoi110@gmail.com

Изучение характеристик разнообразия, изменения и экологической сукцессии ландшафтов является важным при определении территориальной дифференциации, особенно в муссонных тропиках, как Центральное нагорье Вьетнама, где наблюдается сильная дифференциация по азональности. Заповедное территория Конкакинь-Кончыранг имеет особое географическое положение, расположено в северо-восточной части провинции Зялай и отличается глубоким разделением природных и антропогенных компонентов и факторов. На влажный тропический климат этой области одновременно влияет Центральное нагорье и Центральное побережье. Как разнообразные природные условия, так и сильное антропогенное влияние, способствовали созданию типичной природно-антропогенной ландшафтной системы в изучаемом районе. Природно-антропогенные ландшафты достаточно дифференцированы от 1 системы, 1 подсистемы, 3 классов, 5 подклассов, 13 типов и 87 видов. Ландшафтное разнообразие

проявляется в закономерности высотной поясности. Разнообразие ландшафтов отражается не только по их количеству, но и по частоте встречаемости какого-либо определенного ландшафта на исследуемой территории. В течение периода исследований с 2005 по 2017 год наблюдали значительные изменения в ландшафтах исследуемой территории, как в количественном, так и в качественном отношении. В течение примерно 13 лет, ландшафты изучаемого района сильно изменились. В 2005 году насчитывалось 94 вида ландшафта, включая группы вечнозеленых широколиственных тропических лесных ландшафтов, кустарников, саванн, агроландшафтов. Сравнение этих двух периодов показывает, что исчезли 43 вида ландшафта и сформировано 33 новых вида. Остальные ландшафты имеют колебания в площади. В этом изучаемом районе формирование типичной ландшафтной сукцессии обусловлено деятельностью местных жителей. Вечнозеленый широколиственный лесной ландшафт под воздействием человека привел к катастрофическим изменениям. Сукцессионные изменения происходят в короткие промежутки времени, что приводит к созданию новых ландшафтов.

Ключевые слова: Заповедная территория, разнообразие, изменение ландшафта, антропогенное влияние, Конкакинь-Кончыранг.

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