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Original article

Comparing the process of converting land use purposes between socio-economic regions in Vietnam from 2007 to 2020

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ABSTRACT

Reporting land use changes over time is important for evaluating land resource management. This study applied GIS technology to determine land use fluctuations for the entire mainland territory in Vietnam. In particular, the research focused on two main issues: (1) spatial fluctuations of some main land groups in Vietnam, and(2) the rate of land use change in socio-economic regions in the two periods 2007–2016 and 2016–2020. Research results showed that the Forests land group showed a growth of over 14% and spatial fluctuations took place in all regions, except for two regions with little change in this land group: Red River Delta (RRD) and Mekong River Delta (MRD). Meanwhile, crops decreased by over 16% from 2007–2020 and appeared heavily in the Northern Midlands and Mountains (NMR), North Central and Central Coast regions (NCR), and Central Highlands region (CHR). Urban land group increased by 3% during 2007–2020. The speed of land use conversion also showed different results between economic regions and inthe two research periods. The results showed that the recent research period witnessed a higher rate of land use conversion in the regions compared to the period 2007–2016. In particular, the NMR region showed that the conversion rate was the largest in both stages.

KEY WORDS: land transformation, remote sensing, spatial-temporal pattern, land use change, land conversion

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1. Introduction

Human activities in the fields of industrial production, agriculture, forestry, and infrastructure development leading to land use change are a common phenomenon (MÜLLER & ZELLER, 2004) and areassociated with population growth (NYIRANSHIMIYIMANA & MUPENZI, 2020). Changes in land use can have different consequences for natural resources such as biodiversity (DAVISON ET AL., 2021), ecosystems (RIMAL ET AL., 2019), water (SINGH & SRIVASTAVA, 2023), soil (KHALEDIAN ET AL., 2012) as well as for economic growth (LUO & HE, 2023) and people's livelihoods (NGOC, 2013; RAHMAN ET AL., 2023). Understanding trends in land use change over time allows managers to make appropriate interventions that stimulate benefits and minimize negative consequences (AFUYE ET AL., 2024). They are implemented by considering the trade-offs between economic, social and environmental goals in the process of sustainable development.

Land use change is a change in the type of land use over time under the influence of natural, socio-economic factors, human exploitation, and use (NZUNDA ET AL., 2013). Everything in the natural world is never constant but isalways continuously changing. The driving force of all changes is the interaction between the components of nature.

Thus, to exploit the land resources of an area effectively, protect this valuable resource and not degrade the natural environment, it is necessary to study land fluctuations. Land use changes due to human use for socio-economic purposes may, or may not, be consistent with the laws of nature. In other words, land use change is to consider the process of change in land area through information collected over time to find rules and causes of change (TUAN, 2022). Therefore, to manage land effectively, monitoring and evaluating land use changes is indispensable (EL HAJ ET AL., 2023). This provides a comprehensive and general view of the land use situation in the areas (OZCAN ET AL., 2003). Monitoring land use changes also evaluates production potential and provides direction for the construction and development of a region or country (MOSAMMAM ET AL., 2017; HASAN ET AL., 2019).

Advances in remote sensing technology have allowed rapid analysis and identification of land use changes, especially in hard-to-reach and large areas (MACARRINGUE ET AL., 2022; ZHU ET AL., 2022). Compared to assessing changes using traditional methods, automation in assessing land use changes brings users greater benefits (SULTANI ET AL., 2009; PETROV ET AL., 2020). GIS allows users to perform functions such as visualization, mapping, decision support, presentation, and program customization (KEENAN, 2008). Besides, remote sensing data is spatial, so it is not only an objective database to understand changes in land cover in terms of quantity and distribution (BAYNARD, 2013), but it also allows the determination of the nature of changes in studies over time (SENF, 2022). Combining the results of remote sensing image analysis with socio-economic survey information will help researchers better understand the process of land use change. GIS has been applied in many studies related to land use intensity (LUO, 2019; MEIER ET AL., 2020; ERIKSTAD ET AL., 2023), land use management (AJIBOLA ET AL., 2021; MEHARAJBEGUM ET AL., 2023), land use planning (NYEKO, 2012; NGUYEN, 2024), land use efficiency (JALILOV ET AL., 2021; TUAN, 2023) and future land use forecasting (KHAWALDAH, 2016; DUMDUMAYA & CABRERA, 2023; CHISANGA ET AL., 2024).

The application of these technologies in the study of land use change in developing countries is of increasing interest, especially in South Asia and Southeast Asia (VADREVU ET AL., 2019). In these two regions, the most common land use changes include urban expansion (ARIFEEN ET AL., 2021), agricultural expansion (VADREVU ET AL., 2019), land desertification (TUAN & HEGEDŰS, 2022), and deforestation (VADREVU & OHARA, 2020). Some countries in South Asia, such as India and Nepal, have an increasing forest area thanks to sustainable afforestation measures (SOUTHWORTH ET AL., 2012). Meanwhile, Southeast Asia, including Indonesia, Cambodia, and Malaysia, continues to experience significant deforestation (PICHLER ET AL., 2021). One of the reasons for this is the rapid urbanization process in this region, which has led to the loss of agricultural land (RAHMAN ET AL., 2023). Vietnam is a developing country with a large urbanization rate in Southeast Asia, so land use change is taking place rapidly. Therefore, this study applies GIS technology to determine land use changes for the entire mainland territory of Vietnam. In particular, the study answers two main questions: 1) How do the changes in main land groups in Vietnam occur?, and 2) How does the rate of land use change in socio-economic regions occur through the two periods 2007–2016 and 2016–2020?

The study review the literature on the transformation of some major land groups in the world. Then, the research method and research model of this article are indicated. In this section, the author introduces the research location, research data sources as well as the calculation formula applied in this article. The results of the study are presented in the next section and are followed by a discussion section. In the discussion section, the author will point out similarities and differences in land use conversion trends in Vietnam and the world. Finally, the conclusion section with answers to the two research questions is indicated. The results of this research are intended to help scientists have an overview of the current state of land use conversion in Vietnam.

2. Trends in land use change of some major land groups in the world: literature review

The Earth has a total surface area of 510 million km^2, of which 29% is land and 71% is ocean. Of the 29% of land area, only 71% of the surface is habitable, so only 20% of the Earth's surface is habitable. Of this living area, 50% of the area is used for agriculture and about 1%–4% is used for the construction of infrastructure (nettzeno.co.za, 2024). According to FAO statistics (2019), agricultural land accounts for about 4.8 billion ha with 1.6 billion ha being crop lands, and forest land accounts for 4.1 billion ha. Thus, it can be seen that there are two main land groups in the world: agricultural land and forest land.

Therefore, this document overview will delve deeper into the land use conversion developments of these two land groups and the built-up land group.

In a study by WINKLER ET AL. (2021), they found that land use change has affected 32% (equivalent to about 43 million km^2) of global land area from 1960–2019. Research has determined that the level of forest area change is different in the Northern Hemisphere and the Southern Hemisphere. While the Northern Hemisphere has shown growth in forest area, the Southern Hemisphere has seen a decline due to deforestation. Nonetheless, globally, the amount of forest loss is estimated to be 0.8 million km^2, and the area used for agriculture has grown by 1.9 million km^2 (including 1 million km^2 for crops). TYLUKAVINA ET AL. (2022) also supported this result when the team's research results showed that deforestation that occurred globally from 2001 to 2019 was due to forest fires. This result is a bit different if compared with the research results of SONG ET AL. (2018). During the period from 1982–2016, forest area increased by 7.1%, equivalent to 2.24 million km^2, while agricultural land area decreased by 1.4% (equivalent to 0.88 million km^2) compared to 1982.

However, in a study on land use change over a recent period (2016–2020), YANG ET AL. (2023) showed similar results to those of WINKLER ET AL. (2021). During the period from 2016–2020, the area of crops and forest lands tend to increase at a rate of 0.25% and 0.22% respectively (YANG ET AL., 2023). Crops land area is also growing rapidly in the 21st century, especially in Africa (POTAPOV ET AL., 2020). Along with that, the area of redeveloped land showed the strongest growth with 3.41% (YANG ET AL., 2023). If considered over a 20-year time frame (2000–2020), the area of construction land has increased by 50%, and the largest increase was in Asia with 73% (POTAPOV ET AL., 2022).

It is forecast that the crops land area will expand by 0.9 million km^2 in the 20 years from 2010 to 2030, and it will expand by 1.2 million km^2 in the following 20 years (to 2050). By 2050, the area of grassland is also expected to increase by about 1.6 million km^2. In particular, the area of construction land is expected to increase by nearly 80%, equivalent to 0.5 million km^2 after 40 years (VAN DER ESCH ET AL., 2017). This area of built-up land will expand into the most fertile agricultural lands by about 50–63% (CHEN ET AL., 2020). The area of new urban land development will reach more than 1.6 million km^2 in the world by 2100 and urban land per capita will also double from 100 m^2 to 246 m^2 between 2000 and 2100 (GAO & O'NEILL, 2020). Meanwhile, forest land area is forecast to reach between 32.1 and 38.1 million km^2 by 2100 (HURTT ET AL., 2020).

3. Research methods

3.1. Research study

Geographically, Vietnam is a nation that is situated on the Pacific coast, Southeast Asia's Indochina Peninsula, and Southeast Asia. Vietnam's land borders with China to the north and Laos and Cambodia to the west spanning 4,550 km. The East Sea that borders the east. The Vietnamese mainland appears as a S-shape on the map, stretching 1,650 km in a north-south direction from latitude 23°23' North to 8°27' North. The continental area is roughly 500 km wide and 50 km narrow at its narrowest points. Vietnam's topography is varied, with plains, beaches, mountains, and a continental shelf. This is a reflection of the lengthy history of topographic and geological development in a hot, humid, monsoon-like climate that has undergone significant weathering. Large rivers' flow directions indicate that the ground gradually descends in a northwest to southeast direction. Therefore, Vietnam is divided into 6 socio-economic regions (Fig. 1) to assist national master planning for the period 2021–2030 and vision to 2050. Among these are the Red River Delta (RRD) (11 provinces) Mekong River Delta (MRD) (13 provinces), Central Highlands region (CHR) (5 provinces), Southeast region (SER) (6 provinces), North Central and Central Coast regions (NCR) (14 provinces), and Northern Midlands and Mountains (NMR) (14 provinces).

Vietnam is a development success story in terms of its economy. Vietnam has swiftly transitioned from one of the world's poorest countries to a lower middle-income country, largely due to economic reforms carried out since 1986 and favourable worldwide trends. GDP per capita increased sixfold in less than 40 years, from less than 600 USD/person in 1986 to over 3,700 USD/person in 2015. The proportion of the population living in poverty decreased to 4.2% in 2020 from over 14% in 2010 (TRUNG, 2022). Vietnam's economy, with its solid foundation, has proven to be extremely durable during times of crisis. It is anticipated that economic growth will accelerate to 5.5% in 2024 from 5% in 2023, driven by both increased local

consumer confidence and rising global demand (HOA, 2024). Over the following three years, real GDP growth is anticipated to rebound and, by 2026, return to its pre-pandemic average.

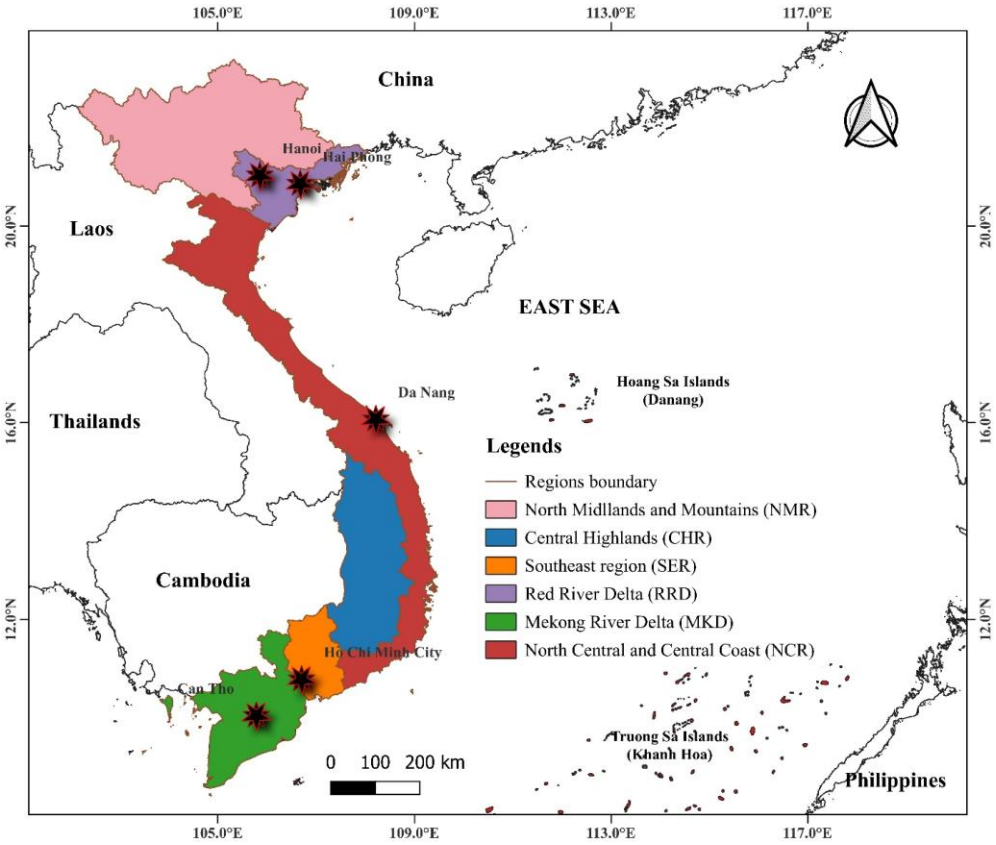

Fig. 1. Map of socio-economic regions in Vietnam (Source: author's own compilation, 2024)

3.2. Research model and data analysis

To conduct the research, input data was collected from JAXA (Japan Aerospace Exploration Agency) with an overall map of Vietnam for 3 years: 2007, 2016, and 2020 (Fig. 2). These maps were collected with a spatial resolution of 10 m with anaccuracy of 85%, 85.6%, and 90.5%, respectively for the years 2007, 2016, and 2020. This map data is divided into 12 categories, but the author has packaged the land layers together into 7 categories. These include water, urban land, rice, crops, barren land, forests, and aquaculture. These data were then imported into QGIS software for processing to analyze land use changes for economic regions in Vietnam. Along with that, based on the research questions, land use data in Vietnam was calculated. Then, the map layers through the two periods 2007–2016 and 2016–2020 were overlaid to find the spatial transformation of the land layers as well as the transformation matrix table. Based on the conversion matrix, the author calculated the land use conversion speed of the economic regions in Vietnam by some indices (Table 1).

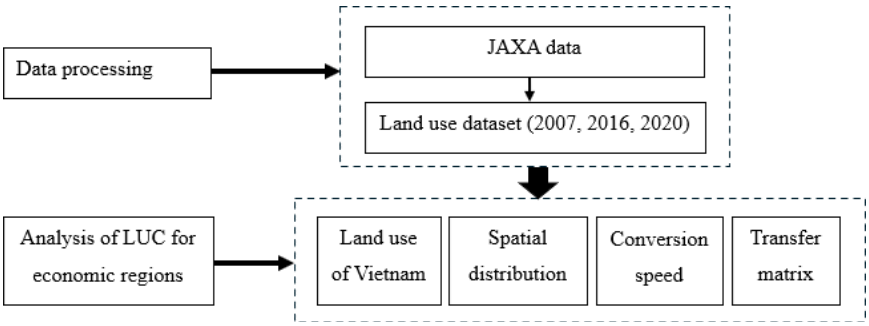

Fig. 2. Research model (Source: author's own compilation, 2024)

3.3. Some calculation formulae

Table 1. Several indicators are used in this research (Source: author's own compilation, 2024)

Indicator	Definition	Formula	Meaning
1. The degree of fluctuation of a type of land use (W_i)	This index is used to determine the degree of conversion of a type of land use in a certain area and time period	$W_i = \frac{A_{i2} - A_{i1}}{A_{i1}} x \frac{1}{T} x 100\%$	- A_{i1} và A_{i2} are the area of land use type i in the starting year and ending year in sequence
2. The degree of fluctuation of all land use types (W)	This index is used to determine the level of land use conversion of all land classes in a certain area and time period	$W = (\sum_{i=1}^{n} \frac{\mid A_{i2} - A_{i1} \mid}{A_{i1}}) x \frac{1}{T} x 100\%$	- T is the study period - n is the total number of land use types
3. Conversion matrix (A_{ij})	This matrix is used to determine the process of land use change between land use types in a certain area and time period	$A_{ij} = \begin{bmatrix} A_{11} & \cdots & A_{1n} \\ \vdots & \ddots & \vdots \\ A_{n1} & \cdots & A_{nn} \end{bmatrix}$	- A is the total land use of a certain area - i; j is the type of land use in the first and last years of the study period

4. Research results

4.1. Land use of Vietnam

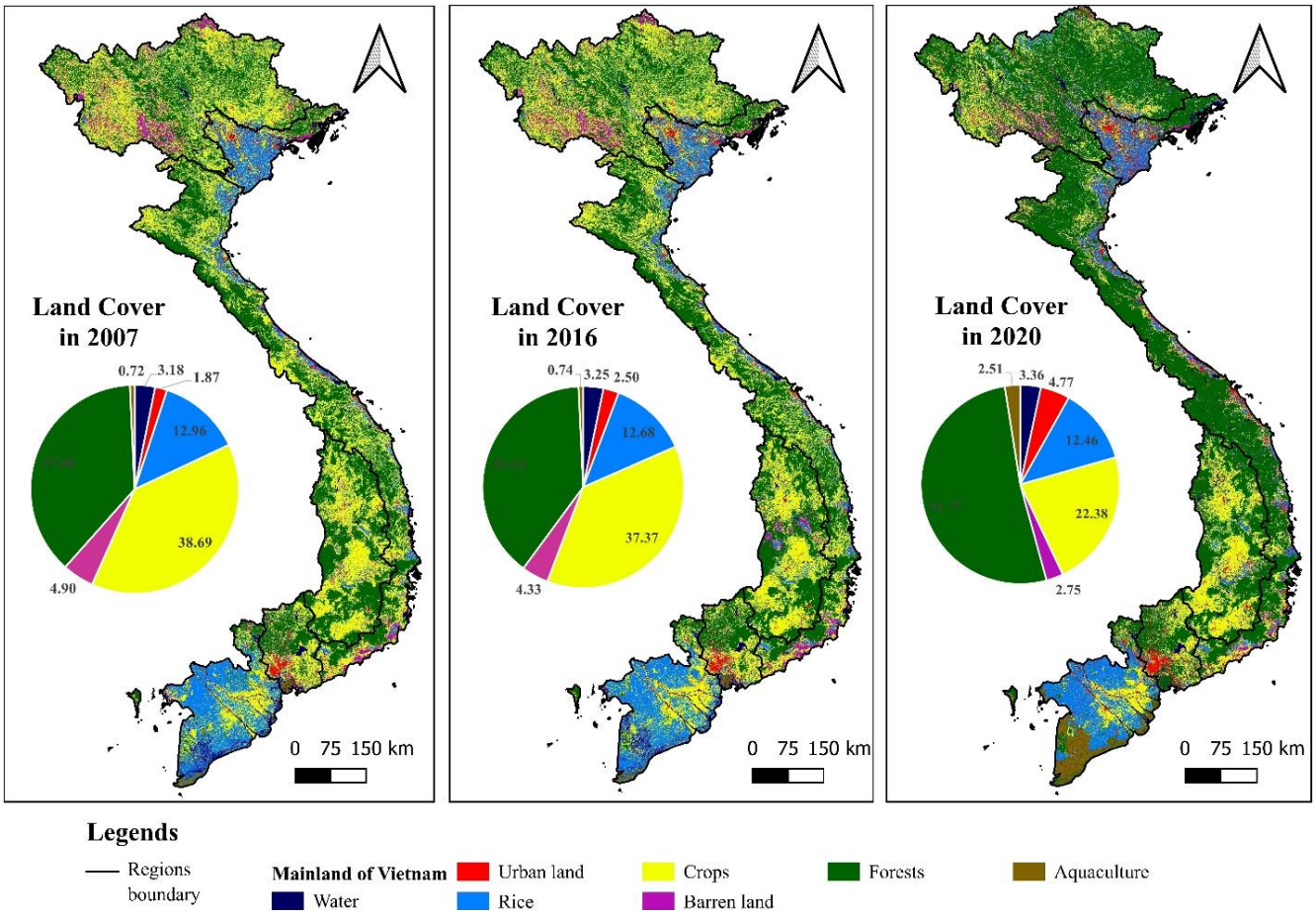

Fig. 3. Land use map and ratio of land use types in Vietnam in 3 years 2007, 2016, and 2020 (Source: author's own compilation from JAXA, 2024)

In Figure 3, it can be seen that the three main land groups in Vietnam are forests, crops, and rice. However, the area of these land groups fluctuated over time. While the area of forests grew strongly, the area of crops witnessed a large decrease. Rice's area had almost no significant change with a range from over 12% to nearly 13%, and it was concentrated mainly in 3 areas: RRD, MRD, and the northeast part of NCR. Besides, the area of forests accounted for the majority of Vietnam in 2016 and 2020, and it was only a little less (about 1%) compared to crops in 2007. In particular, 2020 witnessed the area of forests accounting for more than half of the land area in Vietnam (51.77%). This leaded to the area of forests increasing the most among all land groups with over 14% from 2007 to 2020. The area of forestswas mainly concentrated in 3 regions: NMR, NCR, CHR. These regions were also the main concentration of crop lands along with the MRD area in 2007 and 2016. Crops area decreased through stages. In the first 9 years from 2007 to 2016, the crops area decreased by about 1%, but in the later period from 2016 to 2020, the crops area had a large decrease of 15%.

In addition to the three main land groups mentioned above, there are two other land groups that witnessed growth: urban land and aquaculture. The growth rate in the period 2007–2016 was lower than the period 2016–2020 in both of these land groups. The area containing the most urban land can be seen in RRD and SER, where Vietnam's two special urban areas are Hanoi and Ho Chi Minh City, respectively. Additionally, the area of aquaculture is clearly seen on the land use map in Vietnam in 2020 in the MRD area. The remaining two land groups, water and barren land, witnessed two different trends. While the area of water showed no change, the area of barren land showed a slight decrease of about 2% over 13 years.

4.2. Comparing the conversion speed between regions through 2 stages

Table 2 indicates that the speed of land use conversion in Vietnam in the period 2016–2020 was many times higher than the period 2007–2016 in all economic regions. If only considered for each period separately, the speed of land use conversion between regions has different sequences. NMR is the region with the highest land use conversion rate in both periods. While MRD was the region with the lowest conversion rate in the period 2007–2016, it was the region ranked 2nd in this index in Vietnam in the period 2016–2020. In comparison, CHR, with a conversion rate of 2.99%, ranked last in the second stage, and it ranked near the bottom in the first stage with only 0.68%. The two regions including the two largest urban areas in Vietnam, RRD and SER, have opposite trends. In the first stage, the land use conversion rate in RRD was lower than in SER, but in the second stage, the conversion rate in RRD was about 3% higher than in SER.

Table 2. The degree of fluctuation of a type of land use(W_i) and all land use types (W) (Source: author's own calculations, 2024)

Unit: %		W_i							W
		Water	Urban	Rice	Crops	Barren	Forests	Aquaculture	
2007 – 2016	NMR	2.18	6.90	0.13	-0.66	-1.94	1.09	-4.64	0.98
	RRD	-0.02	3.67	-0.89	0.04	-3.34	1.01	-1.21	0.93
	NCR	0.76	2.75	-0.22	-0.92	-0.90	0.69	7.26	0.79
	CHR	4.72	5.40	3.15	0.07	7.83	-0.66	61.53	0.68
	SER	-0.62	2.47	-1.21	-0.67	-3.07	0.80	0.70	0.97
	MRD	-0.84	4.84	-0.27	0.67	-2.92	-0.53	0.56	0.56
2016 – 2020	NMR	15.35	41.52	18.21	-12.32	-9.30	11.41	-22.71	12.26
	RRD	2.55	12.49	-0.84	-11.63	-8.50	12.57	-4.34	7.45
	NCR	5.94	20.70	-1.22	-14.23	-2.15	8.51	396.47	9.99
	CHR	18.99	34.20	7.12	-2.09	-19.21	1.28	-4.69	2.99
	SER	0.74	14.35	-3.06	-3.37	-12.01	2.63	-17.55	4.41
	MRD	-12.76	42.86	-4.10	-9.45	-18.67	26.14	106.15	12.12

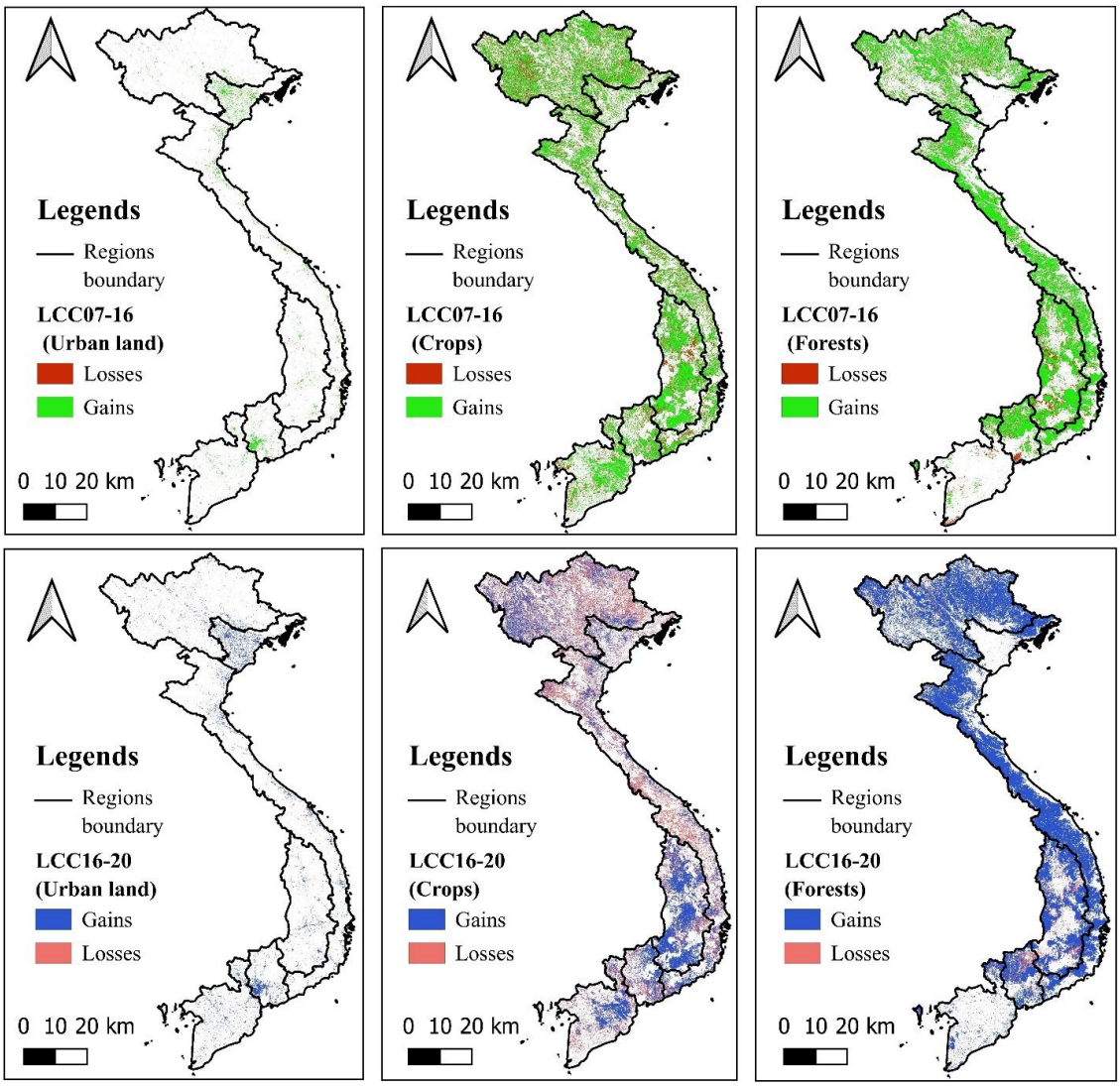

Fig. 4. Spatial distribution of three main land groups in Vietnam (Source: author's own compilation, 2024)

In terms of the conversion rate of each type of land use, only urban land is the land group that shows a positive conversion rate in theregions and in 2 stages. In particular, the two northernmost regions (NMR) and southernmost regions (MRD) of the country have the highest urban land use conversion rates in both periods. Although the forests land group has a positive conversion rate in the period 2016–2020, it still shows a loss of forest in the CHR and MRD regions in the period 2007–2016. A similar trend was also seen in rice lands as only NMR and CHR saw growth in this land group, while other regions showed a loss.

4.3. Analysis of fluctuations in some main land groups

As the results in section 4.1 indicate, the three main land groups in Vietnam are forests, crops and rice. However, due to the rice land group there is almost no change, remaining at above 12%. Therefore, the study did not explore the spatial variation of this land group. Instead, the study investigated the urban land group. This is a land group showing rapid growth in Vietnam. For the urban land group, the period 2007–2016 saw the greatest gains in the RRD, SER and the eastern edge of the NCR region (Fig. 4). These are also the three areas showing the greatest loss of urban land at this stage. However, spatial data sees greater gains for this land group in the 2016–2020 period in other regions of Vietnam. For example, expansion has spread to the western part of the NCR region. The achieved density is also denser in the two regions RRD and SER. In particular, the level of achievement is seen more clearly in the remaining three areas: NMR, CHR, and MRD. According to the author's calculations, NCR, MRD,

and NMR are the three regions with the largest growth in urban land in the period 2016–2020 with 1,878.5, 1,647.21, and 1,577.67 km^2, respectively (Appendix 1).

Regarding the crops land group, the levels of gain and loss of this land group covered nearly all regions in Vietnam in both periods. The first stage shows a clear gain and loss difference in NMR, NCR, and SER with reductions of 2,806.89, 3,063.5, and 430.72 km^2, respectively. However, the loss of this land group was seen more clearly in the period 2016–2020 in the NMR and NCR regions. All regions saw a negative difference between gains and losses. The maximum visible reach was in the CHR and NMR regions at 22,477.83 and 22,903.49 km^2, respectively. For the forests land group, the gain was greatest in the three regions NMR, NCR and CHR in both periods, in which NCR is the region with the largest gain in forests area with 49,480.02 and 66,317.28 km^2, respectively in 2 stages. However, the loss of area of this land group is also large, so the difference between gain and loss in NCR is lower than NMR in both periods.

5. Discussion

The common rule in the process of social development is the uneven development between countries. Within each country, there is also uneven development between regions and localities. This law also applies to the urbanization process in Vietnam, where there is uneven development across different economic regions. Research on land use conversion in Vietnam's six socio-economic regions also demonstrates this uneven urbanization process.

Considering the change in land area in Vietnam from 2007 to 2020, it can be seen that the area of forest and urban land tends to increase, while the area of crop land shows a sharp decrease. The results of this study show some similarities and differences in land change trends in Vietnam compared to the results of some other studies in the world. This result shows similarities with the research results of Song et al. (2018) about the two land groups:forests and crops, and it goes against the research results of Winkler et al. (2021). This result shows that afforestation and forest protection in Vietnam are moving in a positive direction. This result also shows that the land use conversion process in Vietnam is somewhat similar to some countries in the South Asian region, such as India and Nepal. This is an important premise for Vietnam to move towards sustainable development, bringing environmental and economic benefits. Besides, the area of rice-growing land group seems to have not changed after 13 years. Vietnam also has a policy to protect rice land and limit the conversion of rice land to non-agricultural uses. In case, it is necessary to convert part of the rice land area to other uses, the State will take measures to supplement the land area or increase the efficiency of rice land use. Therefore, the results of this study provide a positive assessment for food security protection policies in Vietnam.

In terms of the speed of land use conversion between economic regions in Vietnam, research results have shown that the conversion speed in recent years is higher than before. This shows a sign of dynamism in putting land into use and exploitation in Vietnam. Of all the land groups, urban land shows the greatest transformation in most of the six economic regions. This result shows that the urbanization rate in Vietnam is increasing, and it is seen as evidence for the urbanization process in this country. Of all economic regions, NMR is the region showing the greatest rate of transformation. This is the western and northern gateway to China, Laos, and ASEAN countries. This is also where there is a system of many large and small border gates, with potential to develop border gate economic activities. The ever-growing NMR will connect other localities in the country to trade, import and export goods with the Chinese market.

Land use conversion is closely related to the urbanization process, and urban development has become an important driving force in socio-economic development. Research results have shown that the rate of land use conversion in Vietnam in 2016–2020 is many times higher than that in 2007–2016 in all economic regions. This indicates a rapid change in the country's urban landscape in recent years. Technological infrastructure and socio-economic investments have expanded urban space in an increasingly synchronous and effective direction. The national urban system has grown strongly in both quantity and quality. It has become a driving force for the socio-economic development of the whole country and each region. Economic growth in urban areas averages 12–15% and is 1.5–2 times higher than the national average (Kien, 2022). Urban areas have made significant contributions to job creation, increased social welfare, break

throughs in attracting investment, developing science and technology, and innovation. The urban economy has grown at a high rate, contributing about 70% of Vietnam's GDP (KIEN, 2022).

Although the study has addressed the raised research questions, there are still some limitations that require attention and could potentially guide future research directions. Recent releases of high-resolution land use map products, like ESRI Land Cover and World Cover, operate on a global scale. As a result, the land use catalogue system and accuracy uncertainty limit them to the national scale. The JAXA's land use datasystem has solved this problem. However, the results of this system are subject to limitations. The 10 m high spatial resolution data were only calculated for 3 years: 2007, 2016, and 2020. Therefore, the study could only measure the changes in these time periods.

6. Conclusions

Land use change is a process in which human activities change the natural landscape, the way land is used, and the functions of land for economic activity. Land use changes can have negative impacts on living conditions and threaten human vulnerability. Therefore, land managers need accurate information about land use change to help analyze impacts and manage negative impacts from this process. This study was conducted in Vietnam with the goal of evaluating the land use conversion process in Vietnam, especially in the main land groups. The study also compared the speed of land use conversion between economic regions to contribute to creating scientific evidence for policy makers to refer to the development of socio-economic regions in Vietnam.

Research results have shown that the three main land groups in Vietnam are forests, crops, and rice. In particular, the forests land group showed a large growth of 14% from 2007 to 2020. In contrast, the area of crops decreased by over 16% in the same period. The rice land group showed an almost unchanged rate, remaining at over 12% of the total land area of Vietnam. In addition, the urban land group showed a strong growth of 3% after 13 years. The spatial distribution of fluctuations in some major land groups showed regional differences. While urban land fluctuated mainly in MKD, SER and the eastern part of NCR during 2007–2016, the fluctuations of this land group tend to shift to the west of NCR and appeared more clearly in the NMR and MRD from 2016–2020. The decline in thecrops land group was seen in NMR, NCR and CHR during 2016–2020. Compared to this, the forests land group seems to see little change in the two areas RRD and MRD.

The speed of land use conversion also showed different results between economic regions and the two research periods. The results show that the recent research period shows that the speed of land use conversion in regions is higher than in the previous period. In particular, the NMR region shows that the conversion rate is the largest in both stages. The urban land group shows the distinction of being the only land group showing positive conversion rates in both periods in all regions. It is also the land group with the highest average conversion rate compared to the remaining land groups. The two land groups crops and barren showed negative conversion rates in 6 economic regions during the period 2016–2020.

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Appendix 1. Gain and Loss of three main types of land in Vietnam (Source: author's calculations, 2024)

Unit: km²		Urban land			Crops			Forests		
		Gain	Loss	+/-	Gain	Loss	+/-	Gain	Loss	+/-
2007 – 2016	NMR	949.90	585.85	364.05	44,414.26	47,221.15	-2,806.89	43,173.86	39,314.27	3,859.59
	RRD	2,351.13	1,767.45	583.68	6,063.44	6,042.89	20.55	3,951.23	3,622.23	329.00
	NCR	2,269.04	1,818.34	450.70	33,813.37	36,876.87	-3,063.50	49,480.02	46,569.43	2,910.59
	CHR	698.82	470.14	228.69	24,004.93	23,849.86	155.07	27,347.20	29,063.96	-1,716.76
	SER	1,430.95	1,170.53	260.42	6,737.00	7,167.72	-430.72	568.55	8,039.17	-7,470.62
	MRD	960.70	669.35	291.35	13,794.59	13,009.94	784.66	3,153.15	3,310.38	-157.22
	Total	8,660.54	6,481.66	2,178.88	128,827.58	134,168.42	-5,340.84	127,674.02	129,919.45	-2,245.44
2016 – 2020	NMR	2,527.56	949.90	1,577.67	22,903.49	45,154.26	-22,250.77	62,879.95	43,173.79	19,706.16
	RRD	3,526.22	2,351.13	1,175.09	3,241.97	6,063.44	-2,821.47	5,938.59	3,951.23	1,987.36
	NCR	4,147.54	2,269.04	1,878.50	14,572.20	33,813.37	-19,241.17	66,317.28	49,480.02	16,837.26
	CHR	1,654.82	698.82	956.00	22,477.83	24,530.92	-2,053.10	28,828.64	27,420.70	1,407.95
	SER	2,252.41	1,430.95	821.46	5,829.38	6,737.00	-907.61	9,526.48	8,619.86	906.62
	MRD	2,607.91	960.70	1,647.21	8,580.68	13,794.59	-5,213.91	6,449.65	3,153.15	3,296.49
	Total	16,716.47	8,660.54	8,055.93	77,605.56	130,093.58	-52,488.02	179,940.59	135,798.76	44,141.83