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Analysis of the Spatial Characteristics and Influencing Factors of Large-Scale Land Acquisition Projects in Southeast Asia

Jing Han [1,2,*], Xiaoting Han [1,2] and Zichun Pan [3,*]

[1] School of Public Administration, Central China Normal University, Wuhan 430079, China; xiaotinghan@mails.ccnu.edu.cn
[2] Institute of Natural Resource Governance, Central China Normal University, Wuhan 430079, China
[3] College of Economics & Management, Northwest A&F University, Yangling 712100, China
* Correspondence: hanjing@mail.ccnu.edu.cn (J.H.); panzichun1996@nwafu.edu.cn (Z.P.)

Abstract: Southeast Asia is an essential region for companies carrying out large-scale land acquisitions (LSLAs). Exploring the distribution patterns and influencing factors of LSLA projects in this region is of great practical significance for summarizing the characteristics of LSLA projects in Southeast Asia, for gaining a thorough understanding of LSLA project development rules, and for formulating reasonable policies to guide local LSLA projects. This study explores the spatial distribution and influencing factors of LSLA projects in Southeast Asia using the mean center method, the kernel density estimation method, and the grey correlation method. The findings indicate the following: Firstly, the majority of LSLA projects in Southeast Asia are located in the Indo-China Peninsula, Cambodia, Myanmar, Laos, and other countries, which represent significant regions of interest for LSLA projects in this region. Secondly, the spatial distribution of LSLA intention projects and LSLA contract projects in Southeast Asia is similar, whereas LSLA production projects differ from the former two. Thirdly, the scale of LSLA projects in Southeast Asia is closely related to the host country's natural resources, socio-economic conditions, governance, and market environment. The total GDP, per capita arable land area, net foreign direct investment inflow, and political stability have been identified as exerting a significant influence on investment corporations' selection of LSLA host countries.

Keywords: large-scale land acquisitions; spatial distribution; influencing factors; land grab; Southeast Asia

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1. Introduction

Since the 21st century, the contradiction between the supply and demand of food for the global population, the contradiction between the supply and demand of bioenergy, and the contradiction between the supply and demand of land and water resources, coupled with an adjustment of the middle-class diet in developing countries, have become increasingly apparent; the competition for natural resources, particularly arable land resources, has become more intense; and large-scale land acquisition (LSLA) projects, which are notably characterized by acquiring the arable land of host countries, have become more and more prevalent [1–4]. Especially after the global food crisis and financial crisis in 2008, influenced by the expected shortage of global food supply and the reduced reliability of the grain trade, investing in agricultural land in other countries for agricultural production or controlling high-quality arable land resources in other countries has become essential for some large food-importing countries and financial institutions [5]. At the same time, climate change uncertainty has fueled host countries' concerns about the sustainability of resources available to support local food production [6]. According to the Food and Agriculture Organization of the United Nations (FAO), it is projected that to meet the demand for food from population growth and economic advancement by the year 2050, the global demand for arable land will need to increase from 1567 million hectares in 2012

to 1732 million hectares, as increasing investment in arable land and water resources in developing regions is the key to cope with constraints on agricultural growth [7]. To ensure food security, countries with a shortage of arable land resources, such as China, Japan, South Korea, and Saudi Arabia, have accelerated LSLA projects [8–10]. After the 2008 financial crisis, the financial departments of the United States, the United Kingdom, the Netherlands, and other countries have also actively participated in LSLA projects, which has led to a dramatic rise in the scale of LSLA projects [11–13]. Additionally, encouraging economically developed countries to invest in their agricultural sectors through LSLA projects has become an important strategic choice for some developing countries with abundant arable land resources but low levels of economic development through establishing tax incentives and reforming land tenure systems [14,15]. As land has become the "new gold", the network of participants in LSLA projects has expanded [16]. According to Land Matrix statistics, by the end of 2020, 2500 LSLA projects had been completed globally, with a transaction area of up to 12,083.73 million hectares. Most LSLA projects are distributed in developing countries of Southeast Asia, Russia and its neighboring countries, Sub-Saharan Africa, and Latin America.

Food security has always been a global strategic issue. It is linked to economic development, social stability, and national security. The impact of the COVID-19 epidemic and the Russian–Ukrainian conflict has put the supply chain of food and other crop products in Southeast Asia at risk of being disrupted [17]. It is imperative that decisive measures be taken to rectify the disparities in food accessibility. LSLA projects may be a pivotal instrument in fortifying global agricultural collaboration and averting potential food crises. The abundance of food crops in Southeast Asia and its geographical location are conducive to agricultural cooperation with investor countries, the rational allocation of agricultural resources, and the alleviation of of food shortages [18]. Southeast Asia, as a critical reserve area for arable land resources, has great potential for development and has become the third-largest trading region for LSLA projects. According to Land Matrix statistics, by the end of 2023, companies from 55 countries worldwide have invested in 398 LSLA projects in Southeast Asia, mainly including grain planting, cash crop planting, and biofuel planting. The total contracted area exceeds 355,800 hectares, accounting for 7.51% of the global total investment area. Eight host countries, including the Philippines, Cambodia, Laos, Malaysia, East Timor, Myanmar, Indonesia, and Vietnam, have signed 385 LSLA projects, accounting for approximately 17.50% of the total contracted investment projects worldwide. Southeast Asian countries play an important role as suppliers of agricultural products worldwide. Thailand and Vietnam are essential rice exporters and Myanmar is the second-largest soybean exporter [19]. The more relaxed regulatory environment in Southeast Asian countries has led to the development of the financial sector [20]. It is noteworthy that the prosperity of crops in countries where cash crops are predominantly cultivated, such as Laos, Cambodia, and Myanmar, is inextricably linked to the border areas of their neighbors, where they are usually processed, consumed, or exported [21].To expand the scale of trade and promote the integration of regional industrial chains, supply chains, and agricultural cooperation, East Asian economies are being integrated, which was accelerated by the establishing of the ASEAN Economic Community in 2015. In 2020, 10 ASEAN countries and 15 Asia–Pacific countries signed the Regional Comprehensive Economic Partnership (RCEP) Agreement. Since agriculture is the pillar industry of more than half of the members of the RCEP, the signing and implementation of the RCEP weakened the barriers to agricultural trade among member countries [22], and promoted regional agricultural trade and investment [23,24]. Meanwhile, the China–ASEAN Summit designated 2023 as the Year of Cooperation on Agricultural Development and Food Security. It is committed to promoting more resilient and sustainable agricultural development through the joint construction of the Belt and Road, the ASEAN Connectivity Master Plan 2025, and the ASEAN Indo-Pacific Vision (AIPV). Hence, bolstering LSLA projects in Southeast Asia is not only underpinned by robust policy environment support but also aligns with the agricultural development needs of Southeast Asian countries.

Given the focal nature of Southeast Asia in the global surge of LSLA projects, researching the spatial distribution characteristics of LSLA projects in Southeast Asia is of paramount importance. This research is not only of great significance for understanding the formation mechanism and influencing factors of LSLA projects in Southeast Asia but also has essential reference value for enhancing global agricultural output and the efficiency of land utilization efficiency. However, the existing literature on LSLAs in Southeast Asia is predominantly micro-focused, focusing on social equality, dynamic ecosystem balance, land tenure, land system security, land acquisition conflicts, and farmers' income [25–29]. Van argued that government-led LSLAs in Vietnam have been realized through the post-grabble land redistribution policy, which is essentially a non-egalitarian land grab that creates social inequality [30]. Woods used focus group discussions and random sampling methods to find that overseas farmland investment in Shan State in northern Myanmar has a "deprivation effect" on farmers' rights [31]. Meantime, LSLA projects exacerbate the masculinization of land power, women's access to land becomes more insecure, and women's rights are less secure [32]. During the process of LSLAs, the conversion of idle lands into commercial farms may exacerbate deforestation [33], and the conversion of forested landscapes into farmland is likely to cause problems such as landslides, which appear to lead to the loss of ecosystem services. LSLA projects have a spillover effect that can directly or indirectly cause land use changes [34]. Parks pointed out that due to elite capture and natural resource exploitation triggering the land dispossession of peasants, LSLA projects have been met with resistance by peasants in Cambodia's rural areas [35]. As a matter of fact, the poorer sectors of society, such as former land users and peasant laborers, are mostly opposed or resistant to LSLAs due to the infringement of their rights and interests. In contrast, elite social groups, such as land leasers, politicians, and some officials in the irrigation sector, have increased their access to the positive outcomes of LSLA projects and have actively steered LSLA projects [36]. It cannot be ignored that LSLAs usually have an impact on the commons, which can be seen in terms of both public resources and public property regimes. The capital-intensive and rationalized agricultural production systems of LSLAs are usually fenced off, depriving the users of public resources of their access rights, and thus of an important part of their livelihoods, since a change in land ownership is accompanied by a change in production technology, leading to indirect externalities that have an impact on the public property regime [37]. This process leads not only to land grabs but also to commons grabs. LSLAs have a direct impact on natural resources, and the process of investing in farmland abroad not only captures land resources, but also land-related public resources such as water, pasture, fisheries, and forests, for example, when the investment contract includes the right to water for downstream areas and users [38]. While LSLAs have resulted in the disappearance of some commons, others have emerged as outputs of LSLAs or through accompanying corporate social responsibility. Despite the shortcomings of the new commons resulting from LSLAs, the new commons remain promising as the role of civil society institutions in the new commons comes to the fore [39]. Local governments have formulated various policies, such as promoting inclusive business models, actively guiding contract farming, and improving social welfare, to minimize the negative impacts of LSLAs on the livelihood security of vulnerable groups and the ecological environment, and to create new employment opportunities [40]. Moreover, local governments have actively guided land titling to clarify land ownership and reduce land rights conflicts [41]. Southeast Asia is facing an agricultural transformation. It is imperative to explore how to integrate smallholder farmers into the global food production supply chain to ensure smooth LSLAs and food security in the region and to cope with changing demographics and increasing environmental and climatic challenges [42]. Some scholars have also focused on investment risk responses in an attempt to mitigate the negative effects of LSLA projects. They emphasize the continuing effect of land use policies and social planning in regulating the social impacts of LSLA projects [43]. Moreover, potential mitigation measures such as land clearing are proposed to address the increase in carbon emissions that may result from LSLAs [44]. In terms of driving factors, the host country's

management policy, macro-environment, and special advantages have become important pull forces in the formation of the pattern of LSLAs [45,46].

Overall, previous studies on LSLAs in Southeast Asia have provided an effective reference for analyzing the development patterns of LSLA projects. However, the majority of studies have focused on the adverse effects of LSLA projects on local economic development, especially farmers' rights and interests [47,48]. Only a few studies have concentrated on the spatial distribution of LSLA projects [49,50]. However, the various negative impacts of LSLA projects cannot explain why Southeast Asia has become a hot spot for LSLAs. Therefore, quantifying the spatial characteristics of LSLAs in Southeast Asia and identifying the factors that cause LSLA projects to exhibit these characteristics can fill some gaps in the current research from a geographic perspective. Based on this, we can deeply understand the patterns of LSLAs in Southeast Asia to assist host countries' governments in objectively understanding LSLA projects. This will compel relevant parties to fully use the local development opportunities brought by LSLA projects, thereby reducing regional economic, environmental, and social losses. Firstly, this paper analyses the spatial distribution characteristics of LSLA projects in Southeast Asia by applying the mean center and weighted mean center methods. Secondly, we employ the kernel density estimation method to illustrate the spatial agglomeration characteristics of LSLAs projects. Finally, the grey model is employed to investigate the internal reasons that determine this spatial feature.

2. Methods and Data

2.1. Mean Center and Weighted Mean Center

The mean center and weighted mean center methods are essential methods of spatial center statistics, which are mainly realized by calculating basic parameters related to distribution issues to characterize the center location of the spatial point data set. The mean center is analogous to the geographical distribution center of the event. In this study, the geographic coordinate location of the LSLA intention projects was used to calculate the mean center. The calculation formula is as follows:

$$(\overline{x}, \overline{y}) = \left(\sum_{i=1}^{n} x_i, \sum_{i=1}^{n} y_i \right) \tag{1}$$

In the formula, and the geographic coordinates of the investment project i, n is the total number of LSLA projects.

The weighted mean center is based on the mean center by assigning weights to distinguish the importance of different point data and to obtain the center location of the final data set by weighting. This study used the area of each LSLA intention project as the weight to calculate the weighted mean center. The calculation formula is as follows:

$$(\overline{x_w}, \overline{y_w}) = \left(\frac{\sum_{i=1}^{n} w_i x_i}{\sum_{i=1}^{n} w_i}, \frac{\sum_{i=1}^{n} w_i y_i}{\sum_{i=1}^{n} w_i} \right) \tag{2}$$

In the formula, w_i is the weight of the investment projects i, and x_i and y_i are the geographic coordinates of the investment project i.

2.2. Kernel Density Estimation

Kernel density estimation was first proposed by Rosenblatt as an estimation of the density of the neighborhood around the sample point data in a regular region with the help of moving cells, and was later developed into an effective means to explore spatial point distribution patterns. It is now widely used in the spatial distribution detection of various geographic events. The result can be presented as a map, which illustrates the

agglomeration and dispersion characteristics within a particular area. The calculation formula is as follows:

$$f(x) = \frac{1}{nh}\sum_{i=1}^{n} K\left(\frac{x - x_i}{h}\right) \tag{3}$$

In the formula, $f(x)$ is the kernel function, n is the total number of LSLA projects, h is the bandwidth, k is the kernel function, and $x - x_i$ represents the distance from the estimated point to the output grid. In this study, the location and coordinate information of LSLA projects was abstracted into point elements, and the kernel density values of each project type were calculated with the area of different kinds of projects as the weight. Finally, a kernel density map was made by ArcMap to visually reflect the specific agglomeration area and degree of LSLA projects in a particular area.

2.3. Grey Correlation

The grey system theory is an uncertain system research method alongside fuzzy mathematics and probability statistics. This method overcomes the high requirements of "large samples" as model assumptions in standard mathematical statistics. It is suitable for analyzing "small sample" and "poor information" cases to obtain relatively scientific conclusions by mining a small amount of data. Since LSLA projects sprouted in the macro background of global bioenergy industry development, financial crises, food crises, etc., identifying and researching their influencing factors is still a comprehensive and complex issue worth exploring. In addition to resource endowment as the most obvious influencing factor, LSLA projects would be affected by international politics, the economy, culture, geography, and other factors, and the various factors mentioned above have prominent unspecified characteristics.

Therefore, this study regarded LSLA projects as a grey system and took the LSLA host countries in Southeast Asia as the research area, constructed a grey correlation model between the entire area sequence of LSLA intention projects and the index sequence of influencing factors in each host country, and analyzed the degree of influence of different factors on LSLAs projects. The idea of obtaining the grey relative degree of association is to characterize the relationship between the change rates of different data sequence groups relative to the starting point. The closer the two sets of sequence curve geometric shapes are similar, the greater the grey relative degree of association and the smaller the degree of non-closeness. The calculation steps are as follows:

(1) Initial value image

$$X_i' = \left(\frac{x_0(1)}{x_0(1)}, \frac{x_0(2)}{x_0(1)}, \cdots, \frac{x_0(n)}{x_0(1)}\right) \tag{4}$$

In the formula, $x_0(n)$ is the sequence element, and n is the number of sequence elements.

(2) Start point zero image

$$X_i'^0 = (x_i'(1) - x_i'(1), x_i'(1) - x_i'(2), \cdots, x_i'(n) - x_i'(1)) \tag{5}$$

In the formula, $x_i'(n)$ is the initial value like the sequence element.

(3) Calculate the grey relative degree

$$\left|s_0'\right| = \left|\sum_{k=2}^{n-1} x_0'^0(k) + \frac{1}{2}x_0'^0(n)\right| \tag{6}$$

$$\left|s_i'\right| = \left|\sum_{k=2}^{n-1} x_i'^0(k) + \frac{1}{2}x_i'^0(n)\right| \tag{7}$$

$$\left|s_i' - s_0'\right| = \left|\sum_{k=2}^{n-1}\left(x_i'^0(k) - x_0'^0(k)\right) + \frac{1}{2}\left(x_i'^0(n) - x_0'^0(n)\right)\right| \tag{8}$$

$$\gamma_{0i} = \frac{1 + \left|s_0'\right| + \left|s_i'\right|}{1 + \left|s_0'\right| + \left|s_i'\right| + \left|s_i' - s_0'\right|} \tag{9}$$

In the formula, k is the sequence element, $\left|S_0'\right|$ is the gray area correlation between the sequences $x_0'^0$, $\left|S_i'\right|$ is the gray area correlation between the sequences $x_i'^0$, and γ_{0i} is the grey relative degree of association.

2.4. Data

The cases of this paper came from the Land Matrix statistical database. The database mainly collects and organizes global land transaction cases of more than 200 hectares, and the data are in a real-time update state, making it an authoritative data source for studying LSLA projects. The main principles of data collection are as follows: (1) The LSLA projects in Southeast Asia are all located outside the country of investment, and projects whose investment country and the host country are the same are not included. (2) Projects with a transaction area of 0 and the projects with non-agricultural investments, such as conservation, industry, tourism, etc., are deleted. (3) Due to the dynamically adjustable nature of Land Matrix case data, the deadline for case selection was set as December 2020 to increase the credibility of the study cases.

3. The Context of LSLA Projects in Southeast Asia

Statistics showed that among the 11 Southeast Asian countries, except Singapore and Brunei, nine other countries have LSLA projects, with 398 intention projects and a total investment area of 7.38 million hectares (Table 1). A total of 385 contract projects are recorded, with a contract area of 7.06 million hectares, accounting for 96.73% and 95.66%, respectively. Additionally, there are 133 production projects, with a production area of 1.1 million hectares, accounting for 33.41% and 14.97%, respectively. It should be noted that intention projects refer to projects that are planned to be carried out, mainly at the planning and design stage, and have not yet been designed for actual land use, contract projects are those for which further contracts or agreements have been signed, and production projects are those for which investment in production has already taken place on a contractual basis. These three project types reflect the different stages of LSLA projects from planning and contracting to actual production and utilization.

Table 1. The basic situation of LSLA projects in Southeast Asian host countries.

Number	Country	Intention Projects		Contract Projects		Production Projects	
		Area (ha)	Quantity	Area (ha)	Quantity	Area (ha)	Quantity
1	Indonesia	3,375,347	124	3,188,724	123	598,176	38
2	Myanmar	1,012,838	31	1,002,949	27	27,172	12
3	Cambodia	909,027	105	909,027	105	46,543	19
4	Laos	885,880	66	866,342	64	132,211	30
5	Vietnam	493,079	39	444,028	37	74,884	18
6	Malaysia	442,828	10	442,428	9	160,612	8
7	Philippines	184,870	19	162,570	17	32,209	6
8	Thailand	69,013	3	37,013	2	32,720	2
9	Timor-Leste	3000	1	3000	1	0	0

From the perspective of the area of LSLA intention projects and LSLA contract projects, Indonesia and Myanmar are essential LSLAs host countries in the region, with LSLA intended and LSLA contracted project areas in both countries exceeding 1 million hectares, which are, respectively, 3.38 million hectares and 1.01 million hectares. Regarding the

number of LSLA intention projects and LSLA contract projects, Indonesia, Cambodia, and Laos are the primary host countries in the region. The number of LSLA intended projects in all three countries exceeds 60, and the project contracting rate exceeds 95%. Notably, the project contracting rates in Indonesia and Cambodia are as high as 99% and 100%. However, LSLA intention project areas and LSLA contract project areas in Myanmar are relatively large, and the number of intention projects and contract projects is relatively small, which reflects that the country has the characteristics of a relatively large area of individual investment projects. Regarding project production, the production project areas in Indonesia, Malaysia, and Laos all exceed 0.1 million hectares, with 0.6 million hectares, 0.16 million hectares, and 0.13 million hectares, respectively. Regarding the number of production projects, Indonesia and Laos have an excess of 30, while Cambodia, Vietnam, and Myanmar have more than 10 production projects. Overall, Thailand and East Timor are host countries with relatively smaller LSLAs. The two countries have only 3 and 1 intention projects, respectively, with the area of intention investment below 0.1 million hectares. This is particularly the case for Timor-Leste, whose only project has not been commissioned.

4. Spatial Distribution of LSLA Projects in Southeast Asia

4.1. Spatial Distribution Characteristics of LSLA Projects in Southeast Asia

It can be seen from the calculation formulas of the median center and the weighted mean center that the most significant difference between the two is that the weighted mean center distinguishes the importance of different point data in the process of obtaining and using a specific attribute of the data concentration point as the weight to calculate the center position of the final data set. This paper used the median center based on the intention projects and the weighted mean center based on the area of the intention projects to reflect the spatial characteristics of LSLA projects in Southeast Asia. According to the coordinate data of LSLA projects, the spatial distribution of LSLA projects in Southeast Asia can be obtained using the preceding calculation formula and ArcGIS mapping tools (Figure 1).

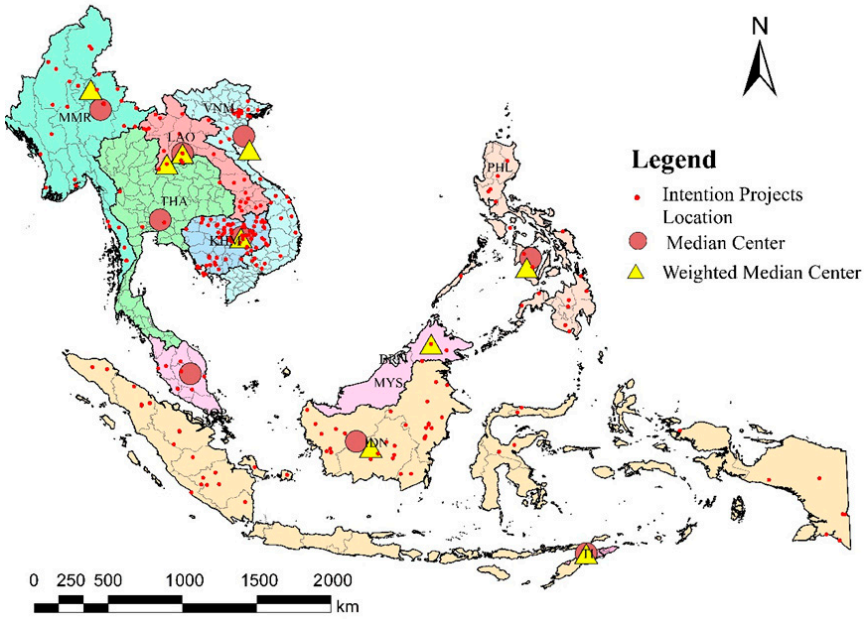

Figure 1. LSLA projects in Southeast Asia.

From the perspective of the spatial distribution of LSLA projects in Southeast Asia, it can be observed that, except for Thailand and East Timor, the remaining seven host countries have a relatively extensive distribution of LSLA intention projects. In terms of specific countries, LSLA projects in Myanmar are mainly distributed in the northern and southern coastal regions, Laos in the southern region, Vietnam and Cambodia in the southern and northern regions, Malaysia in the Malay Peninsula, and Indonesia in Sumatra

Island and Kalimantan Island; the Philippines is relatively evenly distributed. In addition, the two countries of Brunei and Singapore, with limited land area and weak agricultural development foundations, have not yet had LSLA projects.

A comparison between the median center and the weighted mean center of LSLA intention projects in Southeast Asia host countries revealed that the median center and the weighted mean center of the six countries of Myanmar, Laos, Cambodia, Vietnam, Indonesia, and the Philippines are relatively close, indicating a relatively concentrated distribution of project locations and areas. In addition, the center of the median project in Thailand is located in the south, while the center of the weighted mean is located in the north, suggesting that the northern region of Thailand has LSLA projects with larger investment areas. The median center of projects in Malaysia is located in the Malay Peninsula. In contrast, the weighted mean center is located in the Sabah area of Kalimantan Island in the east, reflecting that the country's investment projects are centered in the Sabah area. Since there is only one project in East Timor, the median center and the weighted mean center coincided.

4.2. Spatial Agglomeration Characteristics of LSLA Projects in Southeast Asia

The kernel density estimation method is usually used to reflect the relative concentration of the spatial distribution of point elements. The mapping result showed that the overall layout of LSLA intention projects in Southeast Asia is unbalanced, exhibiting specific spatial agglomeration characteristics (Figure 2). In terms of agglomeration regions, the main agglomeration areas of intention projects in Southeast Asia are located in five countries: Myanmar, Laos, Cambodia, Indonesia, and Malaysia. Combined with the value of kernel density, the above agglomeration areas could be roughly divided into three different levels of distribution types. The first level was the two project concentration areas with the highest kernel density values, one forming a clear cluster between Laos and Cambodia, specifically in the Champasak and Attapu regions in southern Laos and the Preah Vihear, Stung Treng, Ratanak Kirt, Mondul Kiri, Kratie, and Kampon Thom regions in northeastern Cambodia, and the other is the Barat and Tengah regions on Kalimantan Island in Indonesia; the second level was the project concentration area with higher kernel density, which consists of four independent groups, namely Sagaing and Shan(N) in Myanmar, Vientiane in Laos, and Sabah in Malaysia; the third level was the four project concentration regions with average kernel density values, located in the Riau region, Sumatera region, Kalimantan Timur region and Papua region of Indonesia.

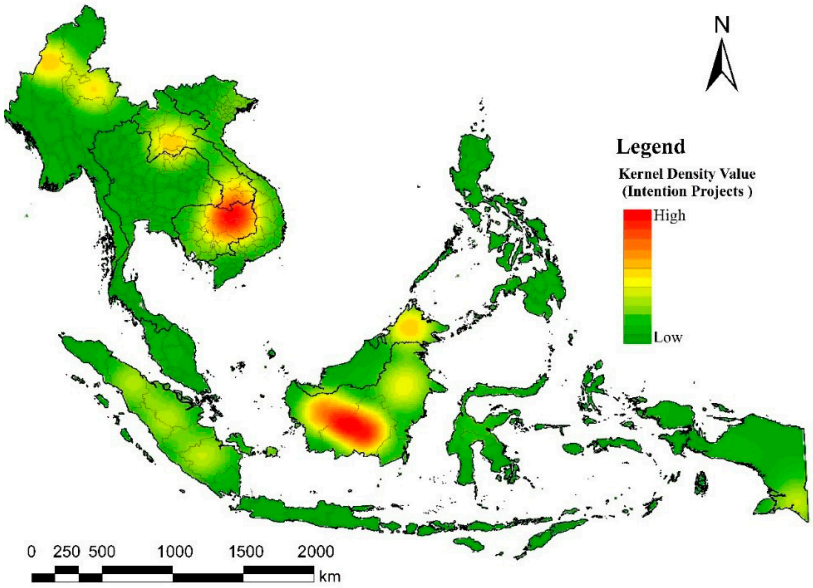

Figure 2. The kernel density distribution map of LSLA intention projects in Southeast Asian host countries.

The kernel density distribution map of LSLA contract projects in Southeast Asia was highly similar to the kernel density distribution map of intention projects, which also showed a spatial distribution characteristic of "small agglomeration and large dispersion" (Figure 3). The agglomeration regions of LSLAs contract projects were also distributed in five countries: Myanmar, Laos, Cambodia, Indonesia, and Malaysia, and the agglomeration regions could also be classified into three different levels of distribution types by combining the kernel density values. The two project concentration regions with the highest kernel density values and the four project concentration regions with higher kernel density values were consistent with the kernel density distribution of the intention projects. The main reason is that the contracting rate of LSLA projects in Southeast Asia is relatively high, with an average contracting rate of 92%, and the average value of the contract area to the intend area and the average value of the contract project number to the intend project number both exceeded 91%. The most notable discrepancy was observed in the Sumatra Utara region of Indonesia, where the kernel density value of the contract projects was slightly lower than that of the intention projects.

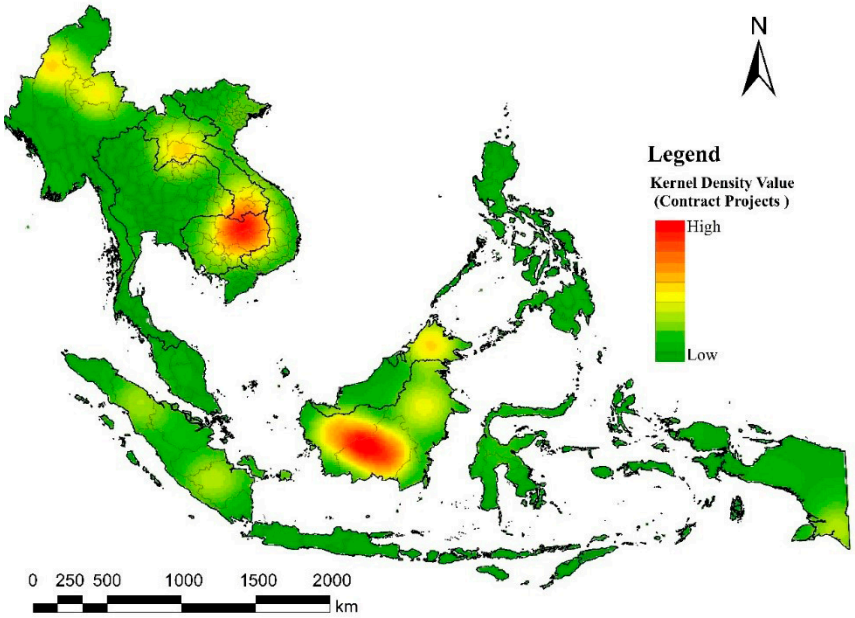

Figure 3. The kernel density distribution map of LSLA contract projects in Southeast Asian host countries.

The kernel density distribution map of LSLA production projects in Southeast Asia showed that the distribution of production projects could be broadly divided into two different levels of distribution types (Figure 4). The first level was the two project concentration regions with higher kernel density, both located in Indonesia. One was the junction of the Riau, Sumatra Barat, and Jambi regions on Sumatra Island, and the other was the Tengah area on Kalimantan Island; the second level was the two project concentration areas with average kernel density, namely the junction of southern Laos and northeastern Cambodia, and the Sabah region of Malaysia on Kalimantan Island.

After comparing the kernel density distribution maps of different types of LSLA projects in Southeast Asia, it was found that there was a coexistence of consistency and difference among LSLA intention projects, LSLA contract projects, and LSLA production projects. Among them, the spatial distribution of kernel density between the intention projects and the contract projects had high consistency, while the production project displayed notable differences from the former two. Overall, the junction of Indonesia's Barat and Tengah regions on Kalimantan Island had the most prominent distribution of all types, and southern Laos and the northeastern parts of Cambodia maintained a high degree of consistency in both intention projects and contract projects. In addition, Indonesia is

located at the junction of Riau, Sumatra Barat, and Jambi on Sumatra Island, which is a concentrated area for LSLA production projects. In short, the above regions exhibit a greater prevalence of projects and investment areas, and they are hot spots for LSLA projects in Southeast Asia.

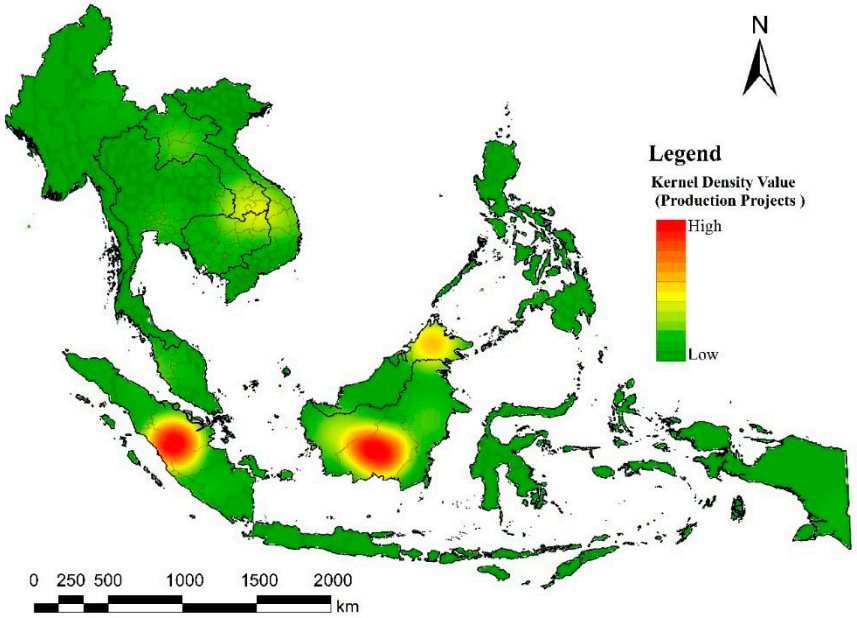

Figure 4. The kernel density distribution map of LSLA production projects in Southeast Asian host countries.

5. Analysis of Influencing Factors of LSLA Projects in Southeast Asia

5.1. Identification of Factors Affecting the Scale of LSLA Projects in Southeast Asia

Driven by the threat of global food insecurity and the vulnerability of food trade, LSLA projects have been independent of global agricultural foreign investment activities, which have been advocated by international organizations such as the FAO and the WB. In this context, since the vast majority of the world's reserve farmlands are located in developing countries, especially in sub-Saharan Africa, increasing land capacity through agricultural investment is the key to addressing the food security challenge [51]. As a matter of land resource utilization, transnational investment enterprises have also paid more and more attention to forming a global industrial chain of agricultural investment. Thereby, "acquisition and control" has become the distinctive feature of current LSLA projects [52,53]. Simultaneously, due to the inherent influence of transnational agricultural investment, LSLA projects have particularities in terms of capital injection, payback period, and project risks, which makes the factors affecting the development of LSLA projects more complicated. In previous studies on the factors affecting the development of LSLA projects, the primary issue considered is still the amount of land resources in the host country. Meanwhile, some scholars have proposed that the host country's institutional environment, market scale, and policy orientation also exert a more significant influence on the development of LSLA projects [54]. In addition, other scholars have analyzed the factors that influence the scale of LSLA projects, including the political situation of the host country, trade union activities, bilateral political relations, and financial instability risks [25,55,56].

Based on the above theoretical analysis and the data requirements of the grey correlation analysis, this paper used the area of LSLA intention projects of the host countries in Southeast Asia as the initial reference sequence. From the four dimensions of relatively "hard" resource base and relatively "soft" social and economic conditions, government governance, and market environment, a grey correlation analysis model was constructed to explore the factors affecting the scale of LSLA projects in Southeast Asia (Table 2). The

indicator data for the four dimensions were primarily sourced from the FAO database, the World Bank, the KOF database, the UNDP, and the foreign investment guide. The selection of data time points and periods mainly took into account the availability of statistical data and the connotation of indicators. The relevant data collection period was generally from 2000 to 2018, primarily based on the consideration that 2000 is when LSLA projects in Southeast Asia began to take shape.

Table 2. Construction table of grey correlation analysis sequence index.

Sub-Objectives	Indicator	Unit	Year	Data Source
Natural resources	Total area of arable land	hm^2	2016	Food and Agriculture Organization (FAO)
	Per capita arable land area	hm^2	2016	Food and Agriculture Organization (FAO)
	Grain yield	t	2016	Food and Agriculture Organization (FAO)
	Agricultural land (% of land area)	%	2016	World Bank
	Access to electricity (% of population)	%	2017	World Bank
Socio-economic conditions	GDP per capita	US dollar	2000–2018	World Bank
	Total GDP	US dollar	2000–2018	World Bank
	Social Globalization index	——	2017	KFO Swiss Economic Institute (KFO)
	Natural disaster mortality	%	2015	The United Nations Development Programme (UNDP)
	Population with at least some secondary education	%	2018	The United Nations Development Programme (UNDP)
Government governance	Political globalization index	——	2017	KFO Swiss Economic Institute (KFO)
	Political stability	——	2002–2018	World Bank
	Government effectiveness	——	2002–2018	World Bank
	Rule of law	——	2002–2018	World Bank
	Control of corruption	——	2002–2018	World Bank
Market environment	GDP growth (annual %)	%	2000–2018	World Bank
	Foreign direct investment net inflows	US dollar	2000–2018	World Bank
	Business environment	——	2019	World Bank
	The number of foreign investment Protection policies	——	2017	Foreign Investment Guide

5.2. Analysis of Factors Affecting the Scale of LSLA Projects in Southeast Asia

The results of the grey relative correlation calculation (Table 3) indicate that the scale of LSLA projects in Southeast Asian countries was closely related to the host country's natural resources, socio-economic status, government governance, and market environment. In this study, eight of the 19 selected indicators exhibited grey relative values above 0.70, and three indicators within the two dimensions of natural resources and the market environment demonstrated grey relative correlation values exceeding 0.70. The importance of the eight indicators was shown in order as follows: total GDP > per capita arable land area > total arable land area > net foreign direct investment inflows > political stability > the number of foreign investment protection policies > business environment > grain yield (Table 3).

According to the results of the grey correlation analysis, the following explanations can be made on the factors affecting the scale of LSLA projects in Southeast Asia. Natural resources were an essential factor affecting LSLA projects. The grey relative degree of the three indicators of per capita arable land area, total arable area, and grain yield exceeded 0.70. The reason is that Southeast Asia is endowed with a considerable amount of arable land, particularly in Cambodia, Laos, and Myanmar in the Greater Mekong Subregion, where the per capita arable land area exceeds the global average. In addition, developing

and utilizing arable land resources in Southeast Asian countries was relatively extensive. At present, the region still possesses a considerable reserve of farmland resources, such as 4.5 million hectares of available arable land in Laos, and the arable land area in Myanmar has reached an even higher 18.42 million hectares, which fully shows that the amount of arable land in Southeast Asia has become a significant factor in attracting LSLA projects. Specifically, the grey relative correlation value of the per capita arable land area was 0.9696, and the value of the total arable land area was 0.9388. This indicates that in terms of the amount of arable land, investors may pay more attention to the per capita arable land than the total arable land. As an indicator of the quality of arable land, the grey relative correlation value of grain yields also reached 0.7141, reflecting the fertile soil and abundant hydrothermal resources in Southeast Asia, and an excellent light–heat ratio, collectively contributing to the region's robust farmland output capacity. Currently, rice production in Southeast Asia accounts for nearly 30% of the total global production. The rice export trade accounts for 50% of the global exports, of which Thailand, Myanmar, and Vietnam represent the leading producers of rice. These countries have the world's three largest barns, with Thailand consistently ranking first in global rice export volume.

Table 3. The grey relative correlation result.

Sub-Objectives	Indicator	Grey Relative Correlation Value	Sequence
Natural resources	Total area of arable land	0.9388 *	3
	Per capita arable land area	0.9696 *	2
	Grain yield	0.7141 *	8
	Agricultural land	0.6855	9
	Access to electricity	0.5792	15
Socio-economic conditions	GDP per capita	0.6106	14
	Total GDP	0.9769 *	1
	Social Globalization index	0.641	12
	Natural disaster morLSLAsty	0.5553	18
	Population with at least some secondary education	0.5491	19
Government governance	Political globalization index	0.6781	11
	Political stability	0.8082 *	5
	Government effectiveness	0.6356	13
	Rule of law	0.5675	16
	Control of corruption	0.5671	17
Market environment	GDP growth (annual %)	0.6786	10
	Foreign direct investment net inflows	0.9159 *	4
	Business environment	0.7187 *	7
	The number of foreign investment protection policies	0.7244 *	6

* indicates that the grey relative correlation value is more significant than 0.70.

Second, for the socio-economic conditions, only the grey relative correlation value of GDP was more significant than 0.70 and as high as 0.9769, ranking first. This indicates that the total GDP, as the most effective indicator to measure the scale and degree of economic development of a country, has been prioritized by foreign investors. It is the basis for determining whether each host country possesses a superior investment and financing environment. It is often observed that favorable economic conditions result in enhanced investment returns and the assurance of investment security. Although the development level of the host countries in Southeast Asia varies widely, Malaysia and Thailand are in the middle of the world's development level, while Myanmar, Laos, Cambodia, and other countries are among the poorest countries. Still, the vast development potential of Southeast Asian countries has exerted a "pushing" effect on the interaction between the two sides in terms of capital, technology, and agricultural exports, which has an impact on the selection of LSLAs host countries. The grey correlation values of other indicators were

all l below 0.70, indicating that the ideal social environment of the host countries was not an essential consideration for foreign investors in LSLA projects.

Third, regarding government governance, the grey relative correlation value of the political stability indicator reached 0.8082, which indicated that the political stability of the host countries in Southeast Asia tended to be good. The probability of terrorist attacks and violent incidents motivated by political factors was low, which created an optimal political investment environment for LSLA projects and provided primary conditions for investment companies to adapt to the local environment and laws, reflecting that a good political atmosphere had an essential impact on the development of LSLA projects. However, except for political stability, the grey correlation values of all indicators were below 0.70, which to a certain extent showed that there were still many loopholes and deficiencies in the governance of Southeast Asia. In addition, several challenges existed, including inefficient government control, a grey legal environment, the prevalence of rent-seeking and corruption, and instability in some countries. These factors pose a significant obstacle to LSLAs, which is an investment activity with "high fixed costs and long payback periods".

Finally, in terms of the market environment, the grey relative correlation degree value of foreign direct investment net inflows, the number of foreign investment protection policies, and the business environment exceeded 0.70, and the grey correlation value of foreign direct investment net inflows was even greater than 0.9. The degree of economic openness, foreign investment policies, and market transparency of the host country were closely related to the scale of LSLA projects. The main reason is that Southeast Asia has a good investment environment in three aspects: foreign exchange control, land acquisition, and capital in and out. In addition, in recent years, with the assistance of the World Bank, the United Nations, and other international organizations, Southeast Asian countries have revised or reformulated numerous foreign investment policies and regulations to safeguard the legitimate rights and interests of foreign investors. These regulations and policies are also related to agricultural investment, including typical agricultural production contract systems, preferential policies for agricultural investment activities, and agricultural protection systems. In addition, according to the World Bank's "Business Environment Report 2019", countries such as Vietnam, Indonesia, and the Philippines have simplified the registration procedures for foreign-funded companies, canceled or reduced the minimum investment capital, and granted certain tax incentives to foreign-funded companies. Even countries such as Cambodia and Myanmar have witnessed varying degrees of growth from conducting business indexes, which has made it more convenient and efficient for investors to set up businesses in the host country, and the acquisition of construction permits, the procurement of electricity, the registration of property, and the payment of taxes are more convenient and efficient for investors. The continuous optimization of foreign investment policies in Southeast Asian countries and the continuous improvement of the business environment has markedly enhanced the capacity of these nations to expand imports and attract high-quality foreign direct investment. This has laid favorable conditions for foreign companies implementing LSLA projects in Southeast Asia.

6. Discussion, Implications, and Limitations

6.1. Discussion

There is a current path of financialization and energy diversification of food, and some agricultural powerhouses are striving to control the global food industry chain. In addition, natural disasters and major public health incidents have added new uncertainties to the food market. The resulting vulnerability of the global food trade is widely recognized, and the issue of food security is increasingly worthy of attention. Ensuring food supply and rational distribution of agricultural resources through LSLA projects has become an integral part of ensuring food security in food-deficient countries. Therefore, the main objective of this study is to analyze the spatial characteristics and influencing factors of LSLA projects in Southeast Asia, so as to provide a reference for the smooth implementation of LSLA projects.

Compared with previous studies, this study focuses on point elements to demonstrate the spatial distribution and spatial agglomeration characteristics of LSLA projects in Southeast Asia, providing more detailed information about LSLA projects in Southeast Asia. Different from focusing only on the negative effects brought by LSLA projects, this paper focuses on the current hotspot of LSLA projects in Southeast Asia, analyzes the influencing factors of LSLA projects from a comprehensive perspective based on identifying the distribution pattern of LSLA projects, and explores the complexity of the distribution of LSLAS projects and the diversity of the factors influencing them. It not only contributes to the further development of LSLA projects by investing in enterprises but also provides valuable guidance on enhancing the agricultural level of the countries in Southeast Asia.

The spatial distribution characteristics of LSLA projects show that the mean center and the weighted mean center of LSLA projects in the major host countries are relatively close to each other, reflecting better project location and area concentration in the above countries. Meanwhile, due to the high contracting rate of LSLA projects in Southeast Asian countries, the kernel density diagrams of intention projects and contract projects have a great deal in common, showing the characteristics of "small clustering and large dispersion", and the overall layout is not balanced. Further, from the two aspects of a relatively "hard" resource base and relatively "soft" social and economic conditions, government governance, and market environment, a gray correlation analysis model was constructed to explore the factors affecting the development of LSLA projects in Southeast Asia. The results show that adequate arable land resources and a strong output capacity are still the focus of attention for LSLA projects. Furthermore, it should be ensured that the host country has a favorable economic environment to provide a guarantee for investment security.

6.2. Policy Implications

The majority of Southeast Asian countries, with their favorable geographical locations, outstanding hydrothermal conditions, and massive potential for exploiting reserve farmland, have become an essential region for LSLA projects in the context of regional economic integration. Based on the platform of ASEAN, various investment countries and ASEAN countries have launched pragmatic cooperation in agricultural development, industrial chain integration, and industrial coordination. However, it is inevitable that the consequences of global economic expansion will have a detrimental impact on agricultural collaboration and investment. Therefore, proper consideration should be put on the agenda to improve the efficiency and security of foreign agricultural investment. Based on comprehensively analyzing the influencing factors of LSLA projects in Southeast Asia and combining the investment characteristics and resource endowment of the host countries, this study argues that LSLA projects in Southeast Asia can be planned and guided according to the following four aspects:

Firstly, the major food-producing countries of Thailand, Myanmar, and Vietnam should make full use of their superior soil and climate conditions and use their strong arable land output capacity as a point of attraction, combining high-density cultivation of food crops with the development requirements of LSLA projects. In Malaysia, the Philippines, Vietnam, and Indonesia, technical advantages should be utilized to increase the added value of cultivation, and investment in agricultural product processing should be carried out appropriately. At the same time, it is imperative to formulate a scientific and reasonable land investment policy to avoid the waste of resources and environmental damage caused by disorderly development. Secondly, the degree of economic development of the host country is also an important factor affecting LSLA projects. ASEAN should strengthen economic ties and rely on countries with higher economic levels, such as Malaysia and Thailand, to drive the economic development of poorer countries, such as Myanmar and Laos, through technical support and the export of agricultural products, so as to provide a superior investment and financing environment for the smooth implementation of LSLA projects. Thirdly, Southeast Asian countries should strengthen security cooperation and governmental control to create a favorable political climate for LSLA projects. At the same

time, they should strengthen their geo-cultural influence through the localization strategy of the investing enterprises, and enhance communication with social organizations, groups, and other sectors in the host countries to weaken the resistance to LSLA projects and establish a good social image. Finally, commercial insurance support for LSLA projects should be increased, focusing on improving investment internationalization. The risk control path system for LSLA projects should be better designed, and the negative impact of unexpected risk events on LSLA projects should be mitigated, dissipated, or even avoided.

6.3. Limitations

Despite our efforts to refine the analysis in this paper, some limitations remain. Due to the insufficient data transparency of LSLA cases, this study has not yet conducted in-depth research on the time series. In addition, restricted by the availability of statistical data in relevant countries, the research has also been subject to many restrictions in constructing an indicator system of factors affecting the scale of LSLA projects, and the scientific and rationality of the system have yet to be tested.

7. Conclusions

This paper used Land Matrix statistical cases to analyze the spatial distribution characteristics and influencing factors of LSLA projects in Southeast Asia. It mainly draws the following four conclusions:

(1) Nine countries in Southeast Asia, except for Singapore and Brunei, were identified as LSLA host countries, and most of LSLA projects were located in Indo-China Peninsula countries. Cambodia, Myanmar, and other countries were essential regions for LSLA projects, while Sumatra Island in Indonesia was the main area for LSLA projects.

(2) The locations and areas of LSLA projects in Myanmar, Laos, Cambodia, Vietnam, Indonesia, and the Philippines were relatively concentrated. Concurrently, Thailand and Malaysia focused on their northern and eastern regions.

(3) LSLA intention projects, LSLA contract projects, and LSLA production projects in Southeast Asia exhibited a coexistence of commonalities and differences, among which the intention projects and contract projects were more similar. However, there were significant differences between the production projects and the former two, and the concentration of production projects was less pronounced than the intention projects and contract projects, which were mainly clustered in Indonesia.

(4) This study used the grey correlation model to analyze the factors influencing the scale of LSLA projects in Southeast Asia and found that the LSLA projects were closely related to the factors of natural resources, socio-economic conditions, government governance, and the market environment of the host countries. In addition, the grey relative correlation between indicators such as the total GDP, the per capita arable land area, the total arable land area, the net foreign investment inflow, political stability, the number of policies to protect foreign investment, the conducting of business, and the grain yield of the host country and the area of LSLA intention projects all exceeded 0.70. The above factors exerted a considerable influence on the investment companies' selection of the host country for LSLAs.

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