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Spatio-temporal Dynamic Patterns of Rural Area Development in Eastern Coastal China

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Abstract: The aim of this study is to evaluate the current state of rural area development at the county level in the eastern coastal China. An evaluation index system including 18 factors was developed, and a rural development index (RDI) was constructed to evaluate rural development state in 2000, 2004, and 2008. The quantitative evaluation indicated the following results. 1) This study derived four dominating components by means of principal component analysis, which can explain 78.2% of the total information, namely agricultural production input, the basic condition of agriculture, the comparative effectiveness of grain production, and the household′s own basic conditions. 2) Since the turn of the new millennium, the rural area in the eastern coastal China has experienced a rapid development in general. Well developed, developed, moderately developed and undeveloped rural areas respectively occupied 29.32%, 22.33%, 21.91%, and 10.51% in 2008. 3) The countryside had maintained a sound momentum of developing trend between 2000 and 2008, while the rural development in the eastern coastal China lacked sustainability. And 4) industrialization, urbanization, original economic basis, and location are four major driving forces of the disparity of rural area development in the eastern coastal China. Given these results, the strategies and policies for the improvement of each rural group were put forward.

Keywords: rural area development; rural development evaluation; new countryside construction; eastern coastal China

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1 Introduction

Rural area development plays a vital role in urbanization and regional economic growth of China (Long *et al*., 2009). However, due to many natural and social factors, especially the dual structure of rural-urban areas, rural China still faces many problems. These problems have been summarized as the ′three dimensional rural issues′, and highlighted by Chinese central government. Insight into the driving factors behind the performance of rural regions, the important basis for seeking a solution to addressing rural issues, has been the focus of rural studies and national development policy (Terluin, 2003).

Rural area development is a complex process influenced by human and natural resources, industry and employment, science and technology, and traditions. Thus, rural development is not only a basic and prior research field, but a challenging and difficult one as well (Liu *et al.*, 2008; Long *et al*., 2012). In the past 30 years, the perception of rural development has undergone considerable changes, and rural development has become a multi-dimensional issue (Bülent *et al*., 2010). From an international perspective, researchers and government agencies have conducted many studies on rural energy, rural land use, non-agricultural industrial development, and rural development policy evaluations. The results of

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these studies show that the research on rural development is getting increasingly multidisciplinary. Researchers in economics, sociology, geography, and other areas have contribute a lot to rural development (Taele *et al.*, 2006; Liu *et al.*, 2010). Some countries have adopted different strategies to facilitate agricultural and rural development, including the rural revival plan in France, the green revolution in India, rural development through land consolidation and village renewal in Germany, the new village movement in South Korea, the income doubling plan in Japan, *etc*. (Lan and Huang, 2006). In Europe, general driving forces like macroeconomic developments and demographic changes will also have major impacts on rural areas (Westhoek *et al*., 2006). These strategies tactics were regarded as a key way of achieving sustainable development, maintaining economic growth, and promoting regional equality between rural and urban areas.

Currently, with rapid industrialization and urbanization, China′s rural industry, employment, and land use structures are undergoing rapid changes. Rural development is currently going through a new stage of transformation and uplifting (Liu, 2007). Chinese central government has identified agriculture and rural development as the top priority of its sustainable development strategy (Liu *et al*., 2008). Since 2004, the central government has issued nine ′No. 1 documents′ consecutively, which all are focused on addressing rural development issues. In 2006, the central government adopted a macro-strategy known as ′New Socialist Countryside Construction′. Policy makers have an urgent need for scientific evaluation of rural development in China so as to make wise decisions. Thus, it is important to formulate a framework for assessing the regional rural development state, designing rational strategies, adopting innovative approaches for sustainable development, and providing suggestions with regard to new research problems on rural development in the future.

Rural development today, however, as a multi-level, multi-factor, and multi-faceted process, is much more diverse, complex, sophisticated, and global than those of the last century (Kennedy *et al*., 2001), and is also much more difficult to measure. Development generally measured in gross domestic product per capita is unilateral and limited. Hence, an evaluation indicator index system was developed, and multi-dimensional methods were introduced in this study to explore rural development state and inequalities of the eastern coastal China. The eastern coastal China has been chosen to be the study area of this paper, because with rapid industrialization and urbanization, rural industry, employment, and land use structures are undergoing rapid changes in the rural area. So it is important to explore the temporal evolutionary rules and spatial heterogeneity patterns of rural area development, which is essential to the establishment and implement of different rural development policies, and the promotion of coordinated development between urban and rural areas.

2 Materials and Methods

2.1 Study area and data

The eastern coastal China consists of 7 provinces and 3 municipalities from the north to the south: Beijing, Tianjin, Hebei, Shandong, Jiangsu, Shanghai, Zhejiang, Fujian, Guangdong, and Hainan. Covering approximately 9.16×10^5 km^2, this area had 4.797×10^8 persons in 2008. In the same year, the rural population was 2.116×10^8, accounting for 44.1% of the total population. This percent means that the urbanization level of the eastern coastal area reached 55.9% in 2008, showing that urbanization rate of this area is reaching the peak and that this area is entering the intermediate and even later phase of industrialization (Liu *et al*., 2008).

During the last three decades since the adoption of economic reform and opening up policy in 1978, industrialization and urbanization in the coastal China has accelerated. Metropolitan areas such as ′the Beijing-Tianjin-Hebei′, ′the Changjiang (Yangtze) River Delta′ and ′the Zhujiang (Pearl) River Delta′ have grown vigorously. Rapid urbanization and the centralization of population and industries have been the main characteristics of urban-rural integrated development in the study area (Liu *et al*., 2008). As a result, the rural area in this region has changed significantly. Rapid economic development in rural areas in this region is an obvious case. In 2008, the per capita net income of rural residents was 6673 yuan (RMB), which was much higher than that of national average (4760 yuan). In fact, the income of this region in 2008 (6673 yuan) increased by 45 times compared with that in 1978. On one hand, more and more people engaged in the primary industry have been transferred to the secondary and tertiary industries, especially to the tertiary industry. The level of urbaniza-

tion has been increasingly lifted, accompanied by a stoppable transformation in land use patterns; on the other hand, a serious problem in rural settlement areas has happened on a large scale and has been expanding its influence at an alarming rate. They are widely scattered apart without an orderly arrangement, wasting precious arable farmland. In addition, the agricultural structure had been transformed from the traditional farming-based production to diversified development involving farming, forestry, animal husbandry, and fishery. Accompanied such a transformation is the gradual widening of regional disparities and the gap between the urban rich and rural poor. At the same time, the transformation has also created problems such as land degradation, and increased deterioration of rural environments. Therefore, it is of paramount importance to coordinate interregional development, and urban and rural developments so as to protect the eco-environment. Thus, as Long *et al*. (2009) suggested, rural development in eastern coastal China can be regarded as a miniature of the rural development of China. Therefore, we selected the eastern coastal China as the study area to evaluate the state of rural development in this paper.

Data at the county level used in this study ranged over two time serials: from 2000 to 2004 as well as from 2004 to 2008. A large number of counties were referred to in each period. The socio-economic data used in this study derived from the Natural Resources Database of China, China Statistical Yearbook (National Bureau of Statistics of China, 2001–2009), and China Rural Statistical Yearbook (National Bureau of Statistics of China, 2001–2009). Land use data were gleaned from the reconnaissance investigation into land utilization in 2000, and detailed investigations on land use and land change in 2004 and 2008.

Based on the methods of literature review and expert consultation, an evaluation index system including 18 variables was developed. And then these variables were grouped into four main topics, namely rural economy, agricultural production, rural domestic living conditions, and regional base. An overview of these groups and the 18 variables is shown in Table 1.

2.2 Evaluation method

The principal component analysis was used to extract important factors for the evaluation of rural develop-

Table 1 Evaluation index system and descriptive statistics for variables studied

Group	Variable	Label	Mean	SD	Min.	Max.
Rural economy	Output of agriculture (10^4 yuan/yr)	OA	111996	91047	2021	1202215
	Output proportion of forestry, animal husbandry and fishery to agriculture (%)	OPFHF	45.85	15.60	7.92	96.92
	Proportion of income from non-agricultural industries to the gross income of rural economy (%)	PINAI	44.95	23.01	0.25	92.24
	Output of rural industries (10^4 yuan/yr)	ORI	493701	718152	857	983842
Agricultural production	Proportion of non-agricultural population to total rural population (%)	PNAP	27.67	13.83	10.80	98.37
	Gross output of agricultural machinery per unit cultivated land area (W/ha)	GOAM	5560	6720	1053	95500
	Proportion of stable yielding area to total cultivated land area (%)	PSYA	55.16	21.86	1.40	100.00
	Proportion of effectively irrigated land area to total cultivated land area (%)	PEILA	39.85	15.55	1.77	89.81
	Equivalent net amount of inorganic fertilizer use per unit cultivated land area (t/ha)	EIF	0.335	0.214	0.020	2.483
	Pesticide use per unit cultivated land area (kg/ha)	PU	13.08	10.26	1.35	77.43
Rural domestic living condition	Per capita electricity consumption in rural areas (kwh/(yr·person))	PEC	743.40	480.18	8.95	4605.76
	Net income per farmer (yuan/yr)	NIF	3149	1095	344	7545
	Per capita grain consumption (t/(yr·person))	PGC	0.401	0.150	0.021	0.922
	Net income of rural area (10^4 yuan/yr)	NIRA	197368	228914	2329	2663715
	Per capita cultivated land area (ha/person)	PCLA	0.050	0.100	0.001	1.162
Regional base	Size of rural labor force (number)	SRLF	262555	171418	11853	2002000
	Proportion of labor engaging in non-agricultural productions to gross size of rural labor force (%)	PLGN	42.46	20.18	0.17	92.94
	Productivity of agricultural labor (yuan/yr)	PAL	8080	5192	1331	53975

Note: agriculture includes farming, forestry, animal husbandry and fishery

ment. The output of the principal component analysis was used to develop a rural development index (RDI) (Bülent *et al*., 2010). The variables with the two highest factors loading in absolute terms in each factor enter the RDI, which can be generally defined as follows.

$$RDI = \sum \lambda_i \cdot X_i' \quad (1)$$

where λ_i is the factor loading of the weight of the variable i, X_i' is the standardized Z-value of the indicator variable i.

To describe the rural development state at a particular given time, the evaluation model of rural development dynamics is established (Wang and Bao, 1999):

$$K = (RDC_b - RDC_a)/(RDC_a \times T) \quad (2)$$

where K is the dynamics of rural development within a certain time period; RDC_a and RDC_b are the initial and final evaluation values of rural development conditions over the period studied, respectively; T is the duration of the study. If T is expressed in years, the value of K is the annual variation rate of rural development.

3 Results and Discussion

3.1 Evaluation of rural development state

3.1.1 Identifying important factors for evaluation of rural development state

In order to pick out important factors for the evaluation of rural development state, a principal component analysis was applied; and the dominating four components were extracted from 18 variables. According to the results of the principal component analysis with rotation (Table 2), four components can explain 78.21% of the total information.

Based on varimax method, the component matrix was rotated (Table 3), and the main factors whose absolute factor loadings are higher than 0.5 are marked in bold. Only three of the 18 variables do not have dominating factor loadings, namely PU, OPFHF and PEC.

As the most important component, the first factor which consists of GOAM, EIF, PAL, NIF, and OA variables can explain 23.20% of total variance. These variables are mainly related to the input of agriculture including fertilizer, machinery and so on. As rational peasants, farmers expecting high yield and income will exert high agricultural investment in the whole farming process. Therefore, this factor is named as agricultural production input and GOAM and EIF with the two highest factor loadings are taken as indicator variables.

Factor 2, incorporating PEILA, PSYA, PLGN, and PINAI, is related to the basic condition of agriculture. PEILA and PSYA, for example, can reflect the development status of agricultural irrigation facilities. These elements affect agriculture production directly and farmer′s income indirectly. On the other hand, with the worsening basic conditions, rural area development is greatly sabotaged. Therefore, factor 2 is nominated as the basic condition of agriculture, and PEILA (0.796) and PSYA (0.743) are chosen as representatives of this factor.

PGC, PNAP, and PCLA represent factor 3. These elements are mainly related to the abundance degree of cultivated land, and grain consumption. However, the negative coefficient (–0.769) of PGC illustrates that the comparative effectiveness of grain production is very low, which dramatically undermined farmers′ enthusiasm for farming. In other words, the probability of arable land use conversion increases significantly. Therefore, factor 3 is named as the comparative effectiveness of grain production and PGC and PNAP of high factor loadings are taken as representatives for the factor.

Factor 4, consisting of the SRLF, NIRA, ORI and OA, represents the size of the rural labor force. Rural labor, whether it is engaged in agricultural production or non-agricultural production, is the main force of the house hold income. To some extent, the size of the rural labor force determines the level of rural area development.

Table 2 Principal component explained

Factor	Initial eigenvalue			Rotation sum of squared loading		
	Total	Percent of variance (%)	Cumulative percent (%)	Total	Percent of variance (%)	Cumulative percent (%)
1	5.41	31.85	31.85	2.92	23.20	23.20
2	3.11	18.27	50.12	2.89	20.01	43.21
3	2.66	15.64	65.76	2.69	18.80	62.00
4	2.12	12.45	78.21	2.15	16.21	78.21

Table 3 Rotated component matrix

Variable	Factor (component)			
	1	2	3	4
GOAM	**0.799**			
EIF	**0.668**			
PAL	**0.606**			
NIF	**0.603**	0.436	0.466	0.303
PU	–0.417			
PEILA		**0.796**		
PSYA		**0.743**		
PLGN		**0.644**		
PINAI		**0.596**		
PGC			**–0.769**	
PNAP			**0.625**	
PCLA	0.310		**–0.564**	
OPFHF	0.269		0.475	
SRLF		0.028		**0.932**
NIRA				**0.748**
ORI				**0.658**
OA	**0.527**			**0.621**
PEC		0.478		

Note: variables names are expressed by labels which are consistent with Table 1

Because of this, factor 4 is named as the household′s own basic conditions and SRLF and NIRA are accepted as indicator for this factor.

3.1.2 Spatio-temporal patterns of rural development state

Based on identifying important factors for evaluation of rural development state, rural development index (RDI) is defined as the sum of the standardized Z-values of the indicator variables multiplied with the factor loading consisting of the weights of the variables. In order to graphically reveal the overall state of regional rural development, the nature break method was applied to clustering rural development index into four categories as shown in Fig. 1. Category I, well developed rural area; category II, developed area; category III, moderately developed area; and category IV, undeveloped area.

In 2000, the rural areas in the eastern coastal region were generally not so well developed. Most of the rural areas fall into categories III and IV (Table 4). An absolute majority of them fall into the category of undeveloped. Only a few had reached the moderately developed level. Most of the rural areas in the Changjiang River Delta were in the moderately developed and developed categories while the congregation state had not emerged in the Zhujiang River Delta yet (Fig. 1).

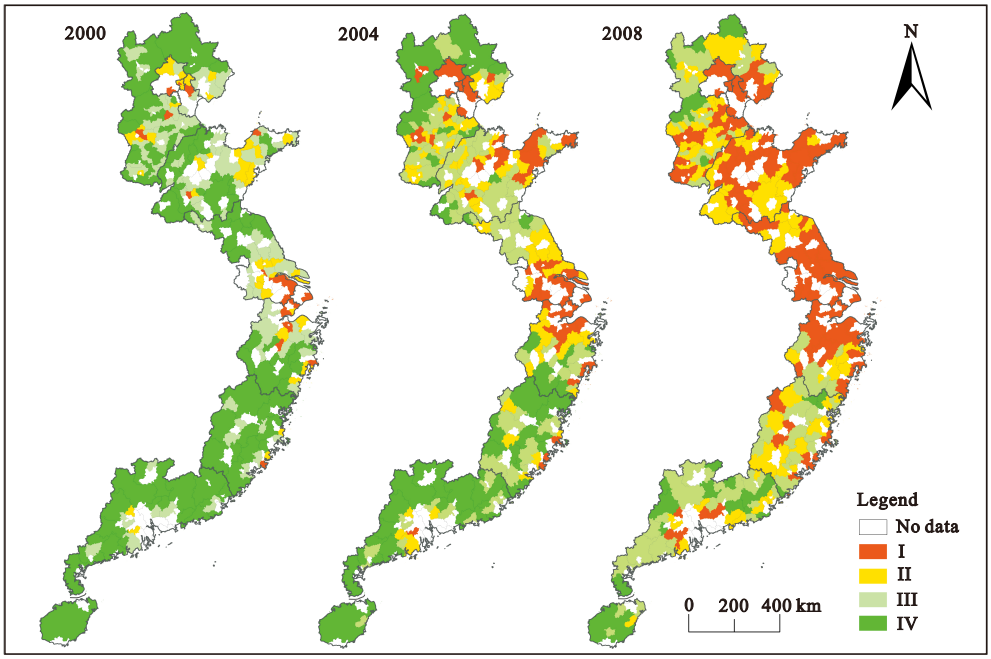

Fig. 1 Evaluation of rural development in eastern coastal China in 2000, 2004 and 2008 (I, well developed rural area; II, developed area; III, moderately developed area; IV, undeveloped area)

Table 4 Basic statistical characteristics of each category of rural development

Category	2000		2004		2008	
	Number of counties	Area of each category to total area (%)	Number of counties	Area of each category to total area (%)	Number of counties	Area of each category to total area (%)
I	27	2.31	86	10.85	210	29.32
II	48	5.99	90	13.65	136	22.33
III	145	21.00	159	23.54	99	21.91
IV	269	54.77	154	36.03	44	10.51

By 2004, most counties had come out of undeveloped level. Of particular notice is that some individual areas such as Kunshan, Zhangjiagang, Taicang, Shunde, even reached the highly developed level. The four categories accounted for 10.85%, 13.65%, 23.54% and 36.03%, respectively, of the total study area (Table 4). The overall regional pattern had generally formed. A high degree of congregation was located in the Beijing-Tianjin-Hebei Zone in the north, the Shandong Peninsula, the Changjiang River Delta in the central and east, and the Zhujiang River Delta in the south. The congregated development state was especially prominent in the Changjiang River Delta. Since the beginning of the 21st century, the external driving forces of regional industrialization and urbanization have been enhanced, and the rural development level has improved accordingly.

In 2008, the ratio of rural areas in each of the four categories to the total study area stood at 29.32%, 22.33%, 21.91%, and 10.51%, respectively (Table 4). In general, rural development in the most of countryside had surpassed the moderately developed level. The overall rural development pattern had been further enhanced while regional disparity had been enlarged. The strong development in the Changjiang River Delta remained unabated, and its sphere of influence had increasingly expanded to cover such areas as the central and southern Jiangsu, Shanghai, the northern and eastern Zhejiang. However, rural development in mountainous rural areas in the northern Hebei, central Hainan, and northern Guangdong were lagging behind. Therefore, more attention should be devoted to promote coordinated rural development within rural regions.

3.2 Dynamic degree of rural development

In order to realistically reflect the dynamic evolution pattern of rural development, the value of the dynamic degree of rural development was grouped into four types with the thresholds for all types set as: type I, < 0 (recessionary area); type II, 0.0002–0.0450 (sluggish development area); type III, 0.0451–0.0720 (stable development area); and type IV, 0.0721–0.1920 (rapid development area).

3.2.1 Dynamic degree of rural development during 2000–2004

Most rural areas were at the sluggish development stage while a few had the stable development conditions during 2000–2004 (Fig. 2). Under the guidance of the socialist market system, private and collective enterprises were thriving, and the pace of non-agriculturalization in the countryside had been accelerated with an increased income from salary. These changes have considerably revitalized and promoted the rural socio-economy, especially in the southern Jiangsu and Zhejiang. Due to the increased input into agricultural production, optimization of structure in cultivation, production and management within the agricultural sector, non-farming industries, such as forestry, animal husbandry and fishery, and other high-efficient industries all experienced rapid development. The overall efficiency of agricultural production increased significantly. The advent and expansion of non-agricultural industries in the countryside had become one of the most important driving forces for the stable development in the rural areas, thus laying the foundation for the prosperity of rural socio-economic development in the future.

3.2.2 Dynamic degree of rural development during 2004–2008

In 2004–2008, the speed of rural development was comparable to that over the previous period mentioned above. However, regional disparities were enhanced even more. For instance, 71.42% of the rural areas had the development status, and a few areas (such as Chunan, Panan, Changshan, Qingtian, in Zhejiang) were in the category of rapid development condition (Fig. 2). The fast advance of industrialization and urbanization continued to be a major driving force for rural socio-econo-

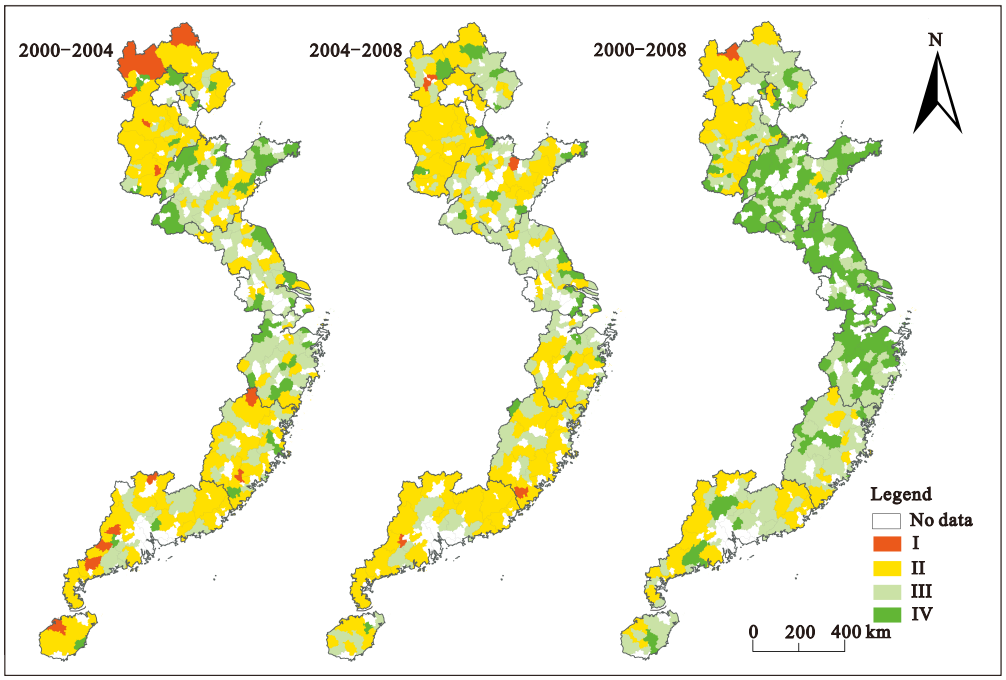

Fig. 2 Dynamic degree of rural development in eastern coastal China during 2000–2008 (I, recessionary area; II, sluggish development area; III, stable development area; IV, rapid development area)

mic development. During this period, the upgrading of rural industries had been accomplished gradually; the output value of rural industries had been on steady increase; salary income had become the principal contributor towards the total income for farmers; the standard of living had reached the well-off level for rural residents universally; agricultural production technologies and management had been increasingly modernized; and the pursuit of large-scale and high-efficient agricultural production had become the new norm.

3.2.3 Dynamic degree of rural development during 2000–2008

Since the 2000s the countryside in the eastern coastal region had maintained a sound momentum of development trend. At the beginning of this period, 51.94% of the areas had the sluggish development condition, and 30.06% had the stable development condition. A comparative analysis of the dynamic degree pertaining to the 2000–2004 and 2004–2008 periods reveals that more than half of the region (50.18%) had a dynamic degree of rural development in the second period lower than that over the first period. It suggests that the potential of rural development lacks sustainability. In terms of spatial variability, Zhejiang, the southern Jiangsu and the eastern Shandong Peninsula, especially Fenghua and Cangnan in Zhejiang Province, all had maintained favorable development tendencies while the western Hebei, the central Fujian, and so on did not have an optimistic prospect of development (Fig. 2).

3.3 Major driving forces of disparity of rural areas development

The disparity of rural area development had been gradually enlarged as discussed above. The analysis results suggested that industrialization, urbanization, original economic basis, and location were four major driving forces of the disparity of rural area development. For a long period of time the Changjiang River Delta, the Zhujiang River Delta, the Beijing-Tianjin-Hebei Zone, and eastern the Peninsula have become the congregated developed areas thanks to the advantageous location, favorable external environment for industrialization and urbanization, and a strong ability to innovate and self-develop. By comparison, rural socio-economic development in the mountainous areas in the northern Hebei, the southern Shandong, the northwestern Fujian, the western Guangdong and Hainan were all lagging behind as a consequence of unfavorable natural settings, remote distance from the influencing sphere of big cities, a lack of resources for developing non-farming industries, a low level of modernization in agricultural production, and continuously draining of rural labor force. These

areas have become poverty-stricken. Therefore, it is of enormous significance to promote balanced rural development through coordinating socio-economic activities within the region and developing innovative models of poverty alleviation in order to build a harmonious society.

3.4 Strategy and policy for improvement of rural area development

The counties were divided into four groups according to RDI values and K values as shown in Fig. 3 and Fig. 4. These groups are named high-fast (HF), high-low (HL), low-fast (LF) and low-slow (LS), respectively. For example, the HF type stands for the counties which are in high RDI values and fast dynamic degrees. In 2008, 36% of the total territory of eastern coastal China belongs to LS type, and 21%, 13% and 30% of the total area is shared by HF type, HS type, and LF type, respectively.

Both HF and HS types are mainly located in the southern Hebei, Shandong, Jiangsu and the northern Zhejiang. These types are adjacent to central cities with high population density. However, the stable development of this group changed, resulting in negligence, encroachment or even deprivation of agricultural production. For instance, non-agriculturalization of farmland had quickened, leading to rapid decline in per capita arable land.

For these types, it is suggested that the strategy and policy for further development should be focused on careful land use planning, by which local government can effectively allocate land resources for various users

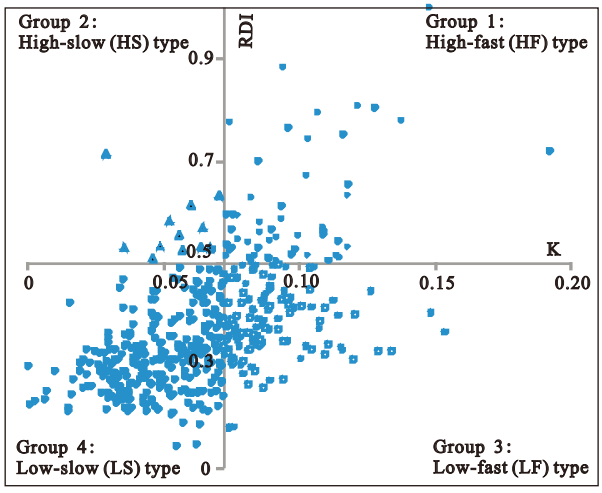

Fig. 3 Distribution of counties based on values of RDI and K

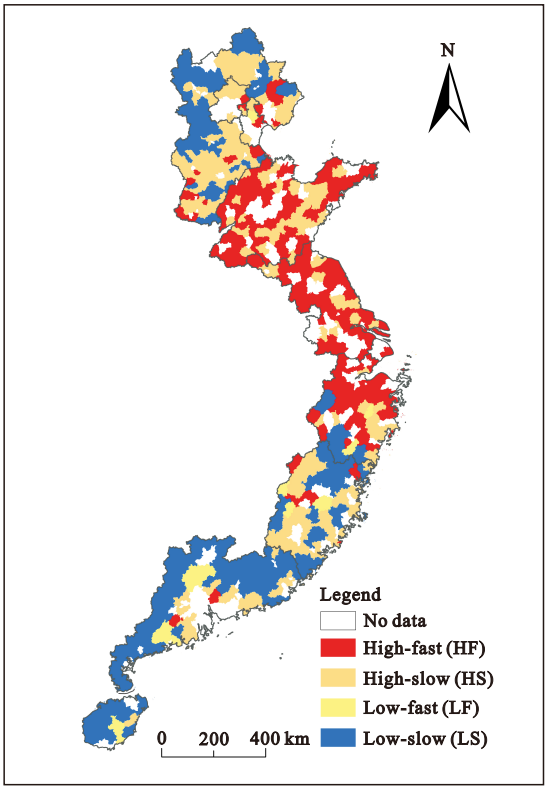

Fig. 4 Rural development types in study area

to increase total land value and to prevent serious arable land loss. From a perspective on industrial development, it is thought that urban agriculture should be fostered in the suburbs as the main pillar industry.

In contrast to HF and HS types, the LF and LS types consist of counties that are mainly located at hilly or mountainous areas, keeping a long distance from major cities. Furthermore, those counties exert weak driving power of industrialization and urbanization. Thus, arable land loss in these regions is slower than that in the regions in HF and HS types. Arable lands in the regions of LF and LS types are used for grazing, forestry, and farming. The economy of these regions is depressed, given that both the comparative advantage of agricultural production and that of rural development had remained consistently low. A huge number of farmers in these areas have migrated to urban areas, leading to problems resulted from insufficient labor force for rural development. Thus, a large quantity of farmland have been abandoned or left fallow. The regions in this group stands are undeveloped rural areas, lacking self-development ability.

For this group, it is suggested that the strategy and policy for development should promote public invest-

ment in physical and social infrastructures such as village clinics, town and county hospitals, rural schools, rural cooperatives, *etc*. based on a scientifically designed village system. Another effective way to improve the regional eco-environment is to develop ecological agriculture based on its natural resources endowment such as the strategy of one village one industry, one village one production, ecological agriculture, and so forth.

4 Conclusions

Rural areas in the eastern coastal China experienced a rapid development during 2000–2008. These rural areas generally had a backward level of development in 2000. By 2004, the overall regional pattern of development level had become roughly established. In 2008, a large majority of the counties reached the upper moderate development level in general. However, regional disparity has been enlarged than ever before. The Changjiang River Delta, the Zhujiang River Delta, the Beijing-Tianjin–Hebei Zone, and the eastern Shandong Peninsula became the congregated developed areas. In contrast, the mountainous rural areas in the northern Hebei, the southern Shandong, the northwestern Fujian, the western Guangdong and Hainan were still lagging behind in their development level. And the results show that industrialization, urbanization, original economic basis, and location are four major driving forces. Hence, it is suggested that Chinese central government should develop and implement different policies for different regions according to their natural and socio-economic conditions.

According to RDI values and K values, the counties in the eastern coastal China were divided into four groups, named high-fast (HF), high-low (HL), low-fast (LF) and low-slow (LS), respectively. For further development, the group of developed counties including HF and HS types needs to effectively allocate land resources for various users to increase total land value and to prevent serious arable land loss. The strategy and policy for the rest types are to promote public investment in physical and social infrastructures, and develop eco-agriculture based on its natural resources endowment.

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