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The disparity between actual land use and the land use plan in Ky Anh district, Ha Tinh province: a consideration of the post - assessment of land use plans

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Abstract. Ky Anh district is a coastal district located in the southern area of Ha Tinh province. During the 2000s, this area experienced significant changes under the national slogan, "industrialization and modernization." In this area, there were few large scale regional development projects before the first half of the 2000s. However, during the latter half of the 2000s, a national large scale project, the "Vung Ang Economic Zone" and other regional development projects were established.

The main objective of this report is to clarify the disparity between actual land use and the land use plan in this area. Finally, we indicated our empirical conclusion concerning the disparity between actual land use and the land use plan by classifying land use. Understanding these situations will contribute to establishing scientific database of regional potentiality for sustainable development.

The result showed that there is a difference between agricultural/forestry and industrial land. Analysis results showed that: 23,344.7 ha of unused land in Ky Anh District were to be transformed into forest land; Agricultural land has been expanded from 12,886.12 ha (2001) to 22,127.94 (2010). Meanwhile, rice fields for cultivating paddy rice, a typical Vietnamese crop, decreased from 8,725.31 ha (2001) to 6,978.57 ha (2010), industrial land has been increased from 246.02 ha (2001) to 3,286.92 ha (2010). It was concluded from this result that agricultural and forestry land use planning are more difficult than industry, which implies that we must develop methods to increase the precision of agricultural and forestry land use planning.

Keywords: Landuse, landuse plan, Ky Anh, GIS, Remote Sensing.

1. Introduction

The land use transition has been increasing rapidly throughout the world, especially in economic developing countries [1]. E.F. Lambin and P. Meyfroidt pointed out that the causal mechanisms behind land use transitions can invoke two different types of changes. On one hand, land use transitions can be associated with the negative feedback that arises from the depletion of key resources or a decline in the provision of important ecosystem goods and services [2]. The authors use the term "socio-ecological feedback," which refers to changes in land use decisions that result from severe

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degradation in ecosystem services caused by past land use practices. Furthermore, it is important to note that these are endogenous changes in a socio-ecological system. On the other hand, land use transitions can be caused by socio-economic change and innovation, which occur independently from an ecological system and follow their own dynamics. These changes are exogenous: they can be driven by urbanization, economic development, or globalization and still have an impact on land management and thus lead to a land use transition [2]. Apart from policy and socio-economic factors, changes in the use of land by agricultural or forestry are determined by a range of mainly time-invariant, natural conditions such as rainfall, topography, soil quality, and other geo-physical and agro-ecological variables [3]. Chomitz and Gray (1996) developed a widely cited spatially explicit model based on survey and satellite data from Belize [4]. They assessed the effect of roads on land use and employed a land rent model based on theories developed by Ricardo and on Thünen. Nelson and Hellerstein (1997) estimated a similar model for Mexico [5], including corrections for spatial dependence. Both models rely on satellite data to derive land cover and employ geophysical data and limited secondary information for socio-economic characteristics as in-dependent variables [6].

In this paper, we clarify actual land use transitions and examine land use plans associated with regional socio-economic change and innovation in Vietnam that is dynamically transforming under the high growth of the economy. Administrative systems in Vietnam have traditionally emphasized "planning" in regional policies. However, after the Doi Moi period, regional policies - especially land use plans - have not always proceeded as planned. One reason may be the increased number of stakeholders in land use relationships. In spite of the disparity between planned and actual land use, there are few studies on the relationship between actual land use transitions and land use plans.

The main objective of this paper is to clarify the disparity between actual land use and the land use plan in Ky Anh District, Ha Tinh Province, Vietnam. During the 2000s, this area experienced significant changes under the national slogan, "industrialization and modernization". We analyzed actual land use transitions using Geographic Information System tools and Remote Sensing data, and we examined the land use plan using document analysis (from 1973 to 2009). After these analyses, we made a comparative analysis of the results. Finally, we indicated our empirical conclusion concerning the disparity between actual land use and the land use plan by classifying land use.

2. Land Use Transitions in Ky Anh District

2.1. The Study Area

Ha Tinh Province is located in the northern part of Central Vietnam. It has an area of 6,026.5 km^2 (hill and mountain areas represent about 80% of the landmass) and a population of 1.29 million (2007). Nghe An Province, Quang Binh Province, and the Lao People's Democratic Republic border it to the North, South, and West, respectively. In Ha Tinh Province, there were few large scale regional development projects before the first half of the 2000s. However, during the latter half of the 2000s, a national large scale project, the "Vung Ang Economic Zone" and other regional development projects were established. Most of

these projects were established in Ky Anh District. Ky Anh District is located in the southern area of Ha Tinh Province between latitudes 17° 57' 10" N and 18° 10' 19" N and longitudes 106° 11' 34" E and 106° 28' 33" E (Figure 1). It has an area of 1055.9 km^2, and there are 33 towns and communes including 268 villages in Ky Anh District. It has a population of 172,539, and 83,565 of them are classification as workers (2009). This area is considered to be typical of rural Vietnam because the population of agricultural and forestry workers accounts for 67.23% of the total worker population (2009).

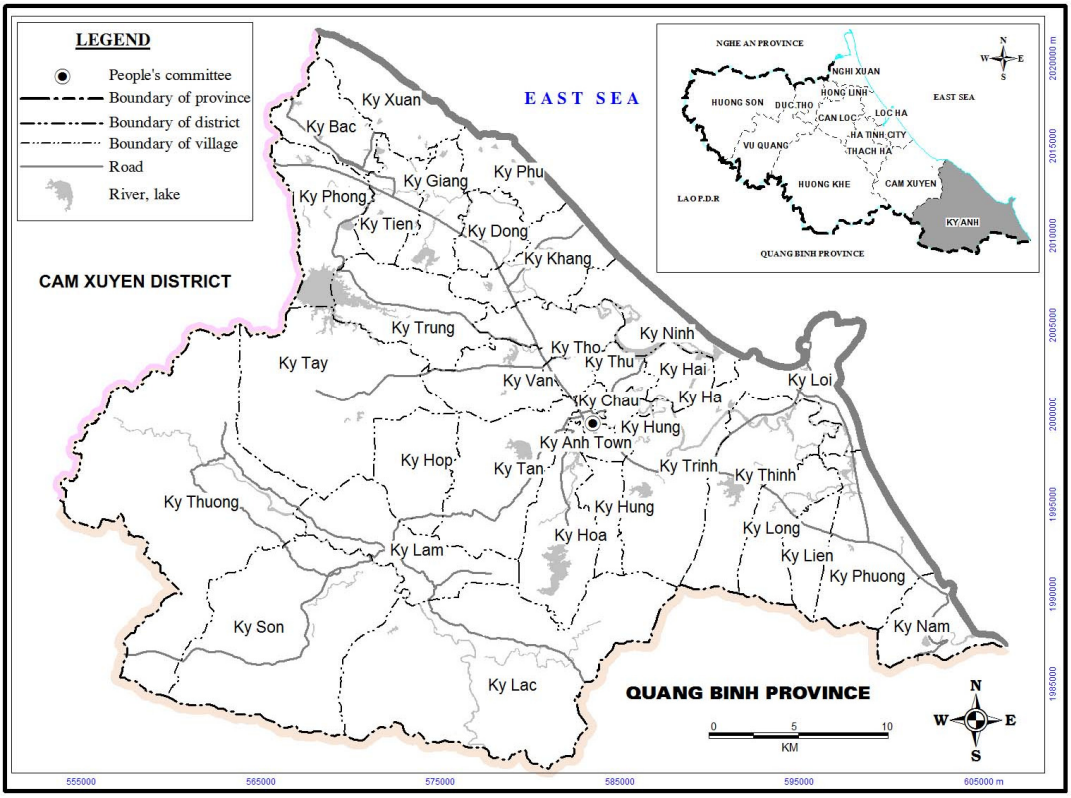

Fig. 1. Administrative Map of Ky Anh District.

2.2. Data Source and Method

In order to clarify the broad, long-term transition of land use, we categorized land use classifications in 1973, 2000, and 2010 using GIS. We used the following data sets for analysis.

(i) Landsat satellite images from 1970, 2000, and 2010. These images were obtained using the Earth Science Data Interface (ESDI) at the Global Land Cover Facility (GLCF) and ALOS images (Advanced Land Observing Satellite).

(ii) Topography map at scales of 1:25.000 and 1:50.000 of 1960 and 2000, respectively.

(iii) A local map boundary and an administrative map (province, district). These maps were obtained from the Information and Communication Technology Department for Natural Resources and Environment-Vietnam.

We used the following methods: (i) interpretation of satellite images, (ii) spatial and non-spatial GIS analysis, and (iii) statistical analysis of the land use data (maximum likelihood classification). More specifically, we went through the following analysis processes.

1. Data standardization (shapefile format) by ArcToolbox.

2. Geographic coordinate system standardization by ArcCatalog (WGS 84-zone 48).

3. Interpretation of satellite images by Envi 4.5 software.

- Layer stacking
- Mozaicking scene
- Subset image by boundary
- Establishment of key interpretations
- Supervised classification
- Export to ArcGIS software

4. Data analysis by ArcToolbox (spatial and non-spatial GIS analysis).

5. Statistical analysis of the land use data.

6. Map editor by ArcMap.

Table 1. The Land Use Transitions

	1973		2000		2009		INDEX (number of year 2000=100)
	ha	%	ha	%	ha	%	
Agricultural land*	13014.83	12.32	12886.12	12.20	25224.94	23.89	195.75
Forestland	15075.30	14.28	20802.98	19.70	44052.18	41.72	211.76
Habitation area	920.12	0.87	929.08	0.88	1199.08	1.14	129.06
Unused area	71850.48	68.04	65100.91	61.65	25347.72	24.00	38.94
Other land	4738.17	4.49	5879.81	5.57	9774.98	9.26	166.25

* Aquaculture land is included in agriculture land according to the Classification of Ministry of Natural Resources and Environment. (Source) The result of analysis.

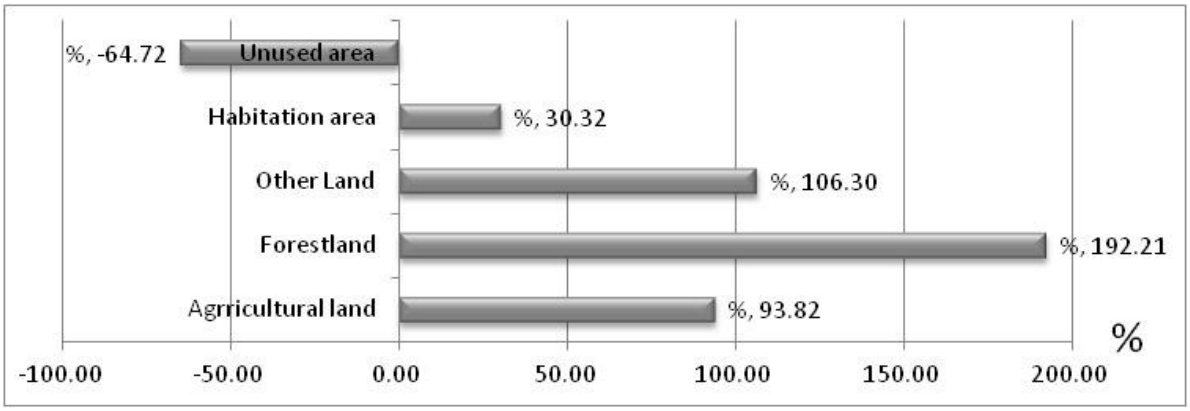

Fig. 2. Increasing Rate of Land Use (from 1973 to 2009) (Source) The result of analysis.

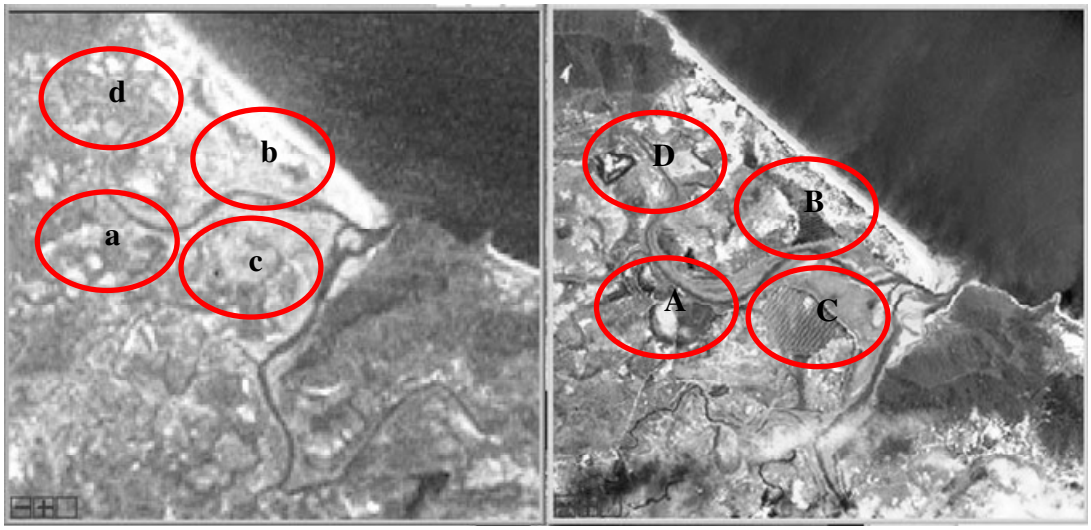

Fig. 3a. Landsat MSS 1973 (Ky Hai commune) (Source. http://glovis.usgs.gov/).

Fig. 3b. Landsat ETM 2000 (Ky Hai commune) (Source. http://glovis.usgs.gov/).

2.3. The Result of Spatial Analysis by GIS

Agricultural land use covered 13,014.83 ha of the total area (12.32%) in 1973, 12,886.12 ha (12.20%) in 2000, and 25,224.94 ha (23.89%) in 2009. Over 35 years, from 1973 to 2009, agricultural land use in Ky Anh District expanded by 93.82%(Figure2). An examination of the satellite images from various dates provides a visual evidence of the agricultural expansion. For instance, there were no aquaculture ponds from the Landsat MSS image 1973 (Figure 3a; a, b, c, and d); However, the Landsat ETM 2000 image (Figure 3b; A, B, C, and D) shows that a few ponds have been appeared. Actually, there are several aquaculture ponds on the ALOS image in 2010 (Figure 3c; 1, 2, 3, and 4). After the latter half of the 1900s, the conversion of inefficient land for planting rice to aquaculture production was occurring throughout Vietnam. Currently, the most popular aquaculture model is the use of shrimp ponds for exporting and meeting domestic demands, followed by crab and other aquatic products. A typical characteristic of aquaculture is that its scale is normally small due to difficulties in land areas [7].

Forest land use accounted for 15,075.30 ha of the total area (14.28%) in 1973, 20,802.98 ha (19.70%) in 2000, and 44,052.18 ha (41.72%) in 2009. Over 35 years, from 1973 to 2009, forest land use expanded by 192.21% (Figure 2).

Unused areas covered 71,850.48 ha of the total area (68.04%) in 1973, 65,100.91 ha (61.65%) in 2000, and 25,347.72 ha (24.00%) in 2009. Over 35 years, from 1973 to 2009, the amount of unused area was reduced by 64.72% (Figure 2). This type of land use transition was influenced by economic development and industrialization policies. During this period, unused areas were diverted for other land uses such as agriculture, forestry, habitation areas, and other land.

Fig. 3c. ALOS Image 2010 (Ky Hai commune) (Source. ALOS research-PI401-HDDuan).

Habitation area covered 920.12 ha of the total area (0.87%) in 1973, 929.08 ha (0.88%) in 2000, and 1,199.08 ha (1.14%) in 2009. This type of land use was expanded due to the urbanization process in rural areas. As such, these areas are sparsely populated on the topography map in 1960 (Figure 4a), but they are densely populated on the ALOS image in 2010 (Figure 4b).

Here we compare the result of land use transitions from 1973 to 2000 and from 2000 to 2009. The land use transition during the latter period is more dynamic than that of the former. It was a different situation for major urban areas in Vietnam such as Hanoi or Ho Chi Minh City. These areas experienced dynamic land use transitions starting in the late 1990s [8]. In contrast, rural areas in Central Vietnam failed to keep up with economic development in the 1990s. In the 2000s, rapid economic development began in rural areas of Central Vietnam. Therefore, our analysis focuses on the land use transitions in the 2000s.

We express the actual land use by the index (number of years 2000 = 100). From our analysis, we observed that the areas of every type of land use increased. In contrast, the unused areas decreased (by 38.94%). From this result, we can confirm the progress toward "effective use of land."

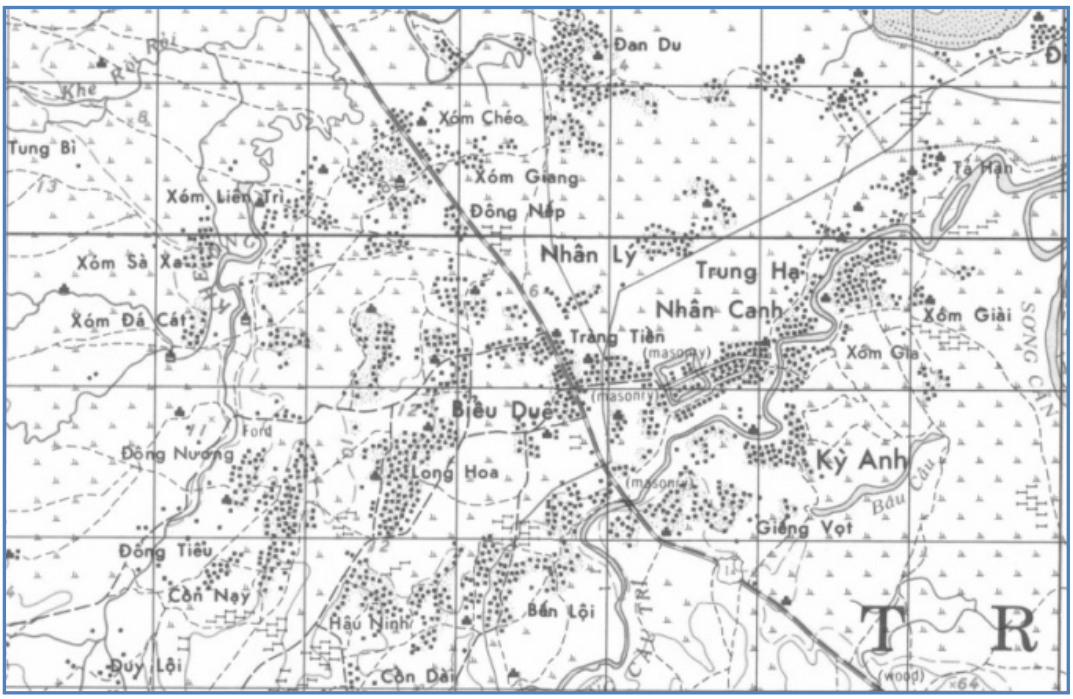

Fig. 4a. Topography Map of Ky Anh center in 1960 (Source. CIREN).

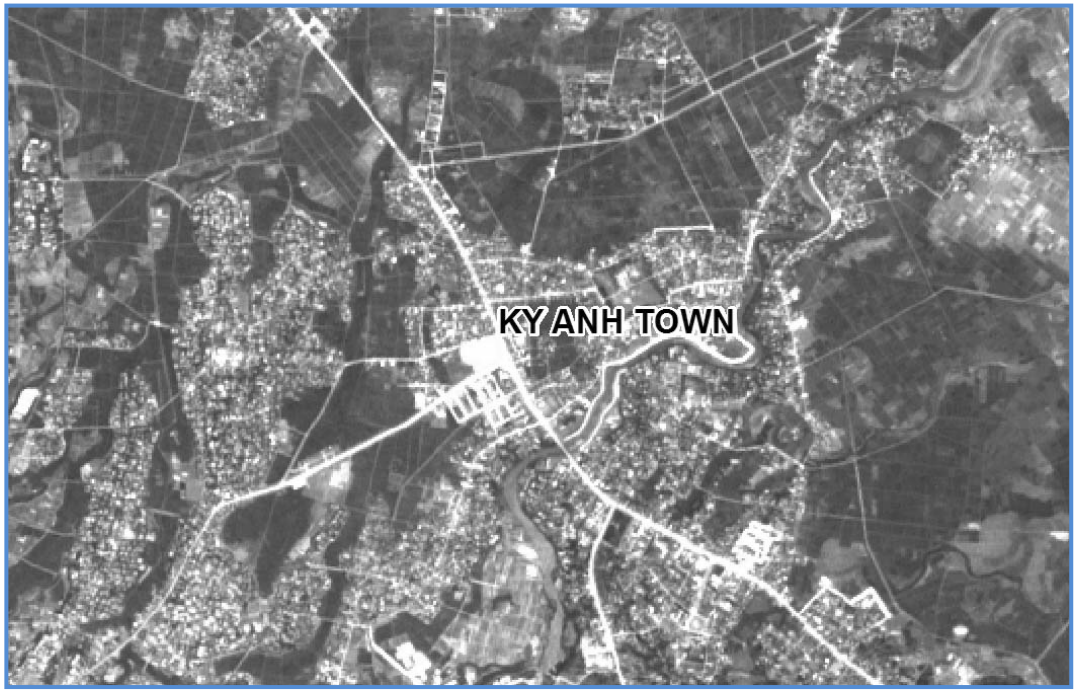

Fig. 4b. ALOS image of of Ky Anh center in 2010 (Source) Alos research-PI401-HDDuan.

3. The Land Use Plan of the People's Committee in Ky Anh District

The People's Committee in Ky Anh District formulated the land use plan for 2001 - 2010 based on the forecast of an 11 - 12% per year economic growth rate from 2001 to 2005, and on the forecast of 13 - 15% per year economic growth rate from 2006 to 2010 (People's Committee, Ky Anh District, 2003) [9]. Specifically, the forecast for the economic growth of the agriculture, forestry, and fisheries sector was 48% for 2001 - 2005 and 35% for 2006 - 2010. The forecast for the industrial sector was 25% for 2001 - 2005 and 35% for 2006 - 2010, and the forecast for the commerce and service sector was 32% for 2001 - 2005 and 30% for 2006 - 2010. From these forecasts, we can observe that the People's Committee put much value on economic growth in the agriculture, forestry, and fisheries sector in period of 2001 - 2005. However, from 2006 until 2010, the People's Committee put much value on economic growth in the industrial sector.

The main aim of this plan is to transform unused land into forest land, agricultural land, and industrial zones (Table 2). Next, we examine the detailed plan for each land use type.

Table 2. The Land Use Plan

	2001 ha	2005 ha	2010 ha	INDEX (number of year 2000 = 100)
Agricultural land	12886.12	15750.23	22127.94	171.72
Forestland	20802.98	31177.01	45273.98	217.63
Other land	5879.81	7556.15	9693.69	164.86
Habitation area	929.08	1072.71	1277.58	137.51
Unused area	65347.20	50289.10	27472.01	42.04

(Source) The People's Committee in Ky Anh District, 2003.

According to the plan, forest land would be doubled from 20,802.98 ha (2001) to 45,273.98 ha (2010). We express the index (number of years 2001 = 100) of 2010 as 217.63. The plan to double the forest land was influenced by the large-scale reforestation programs of the central government - the 135 program, the "Five Million Hectare Reforestation Program," and the 327 program. For instance, the "Five Million Hectare Reforestation Program," which was introduced in 1998, focuses on timber production to support industrial activities. This program increased the percentage of forest land of all over Vietnam from 28% to 43% until 2010 by reforesting five million hectares. According to the land use plan, 23,344.7 ha of unused land in Ky Anh District were to be transformed into forest land. This land was not only meant for the forest industry (commercial forest land), but also for environmental conservation on the grounds that the transformation plan included 12,033.6 ha for

"forest resource protection, especially natural forest areas."

Agricultural land would be expanded from 12,886.12 ha (2001) to 22,127.94 (2010). The index (number of years 2001 = 100) of 2010 is expressed as 171.72. Specifically, agricultural land under permanent crops (e.g., orchards) would be expanded from 556.65 ha (2001) to 10,324.27 ha (2010). In contrast, rice fields for cultivating paddy rice, a typical Vietnamese crop, decreased from 8,725.31 ha (2001) to 6,978.57 ha (2010). It should be pointed out that the plan would transform not only unused land but also rice fields to agricultural land under permanent crops.

Building lots (included in "other land" in Table 2) are one of the remarkable land uses in the plan. Under the planned industrialization of rural areas, building lots, especially those in industrial zones, would be increased from 246.02 ha (2001) to 3,286.92 ha (2010). The index (number of years 2001 = 100) of 2010 is expressed as 1336.04. It should be noted that the tremendous expansion of this land use in the plan is in accordance with the economic development policy in this area.

4. Disparity between Actual Land Use and the Land Use Plan

In this section, we compare the planned land use with the actual land use. From the satellite images, we can observe that the actual areas of forest land and habitation areas are smaller than those indicated in the plan. In contrast, the actual areas of agricultural land and other land (including industrial zones and so on) are bigger than those indicated in the plan (Table 3). In order to investigate the reasons for this disparity, we examine the socio-economic statistical data (Table 4).

Tabel 3. Disparity between Actual Land Use and the Land Use Plan

	Disparity (ha)
Agricultural land	3097.00
Forestland	-1221.80
Other land	81.29
Habitation area	-78.50
Unused area	-2124.29

(Source) The result of analysis.

Tabel 4. Major Socio-Economic Indicator

I tems	Unit	2000	2005	2009
Population	person	162,916	171,784	172,539
Populations of worker		76,240	79,686	83,565
Agriculture and Forestry		63,845	60,445	56,182
Fishery		3,228	5,844	7,396
Industry		3,520	3,966	6,049
Construction		322	732	1,391
Service		2,828	3,625	5,593
Other		2,497	5,533	8,753
Total of GDP	Million dongs (1994 prices)	468,859	847,572	1,446,337
GDP of Forestry		18,460	30,586	15,454

GDP of Industry	11,317	29,202	80,255

(Source. Statistical Data Book of Ky Anh District).

The worker population in the agriculture and forestry industries has consistently declined for 10 years, and forestry production rapidly decreased in the latter half of the 2000s. We can expect a negative external factor for forestry. This is one reason that the area of the actual forest land is smaller than the planned area. In contrast, the population of industrial workers increased after 2005. This was likely due to the establishment of processing plants for agricultural products established in Ky Anh District - for example, a Taiwanese food company's factory used cassava to produce condiment.. The establishment of these factories affects both regional industry and regional agriculture. That is, industrialization in this area results in an expansion of agricultural land and an increased production of permanent crops.

The worker population in the construction industry shows a rapid increase. This is related to the "Vung Ang Economic Zone." The project was established in accordance with Decision No. 72/2006/QD-TTg dated 3rd April 2006 of Prime Minister. This zone has an area of 22.781 ha and is located to the south of Ky Anh District. The goal of this project is to construct an area that is both a regional economic zone and an international economic zone. The Vung Ang Economic Zone is connected to Cau Treo and Chalo border gates through national roads. This is the shortest route from the Vietnamese sea port to the capital of Laos and northeastern area of Thailand. This economic zone is part of a plan to construct not only an international trading port and industrial area, but also resort and residential areas [10].

5. Conclusions

This report empirically clarified the disparity between planned land use and actual land use in Ky Anh District in the 2000s. In Ky Anh District, the "Vung Ang Economic Zone" created a distinctive socio-economic change in the 2000s. However, concerning the aspect of land use, the result of our analysis indicates that there is a disparity between agricultural/forestry land and industrial land. It was concluded from this result that agricultural and forestry land use planning is more difficult than that of industry, which implies that we must develop methods to increase the precision of agricultural and forestry land use planning. In accordance with that viewpoint, we recommend an ex-pose assessment of the land use plan focusing on agricultural land and forestry land.

In order to assess the agricultural and forestry land use plans, especially at local level, it would be useful to introduce a method for gathering local knowledge from rural residents, because many rural residents are stakeholders who are affected by agricultural and forestry land uses.

In Japan, an ex-post assessment method for land use is being developed based on a workshop at local level involving resident participation and spatial analysis by GIS (N. Fujisawa, 2002). A possible direction for our future research would be to clarify the land use assessments of rural Vietnamese residents at the micro level by applying such an assessment method.

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