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Combination Model for Rural-Urban Fringe Area

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ABSTRACT

Combination model is determined by the proportion of urban land use functions, residential properties and the proportion of agricultural land use. It was also calculated based on the distance bands and square grid. The main problem that occurs is the difficulty to trace the boundary of the rural-urban fringe clearly because of mixing urban nature and province in the region. This study examines this problem by comparing results and interpretation of three models with the same data using GIS function. This study analyzed land use type changes using three models for 1990, 2000, 2010, and compared these changes with the zoning status in each period. This study demonstrates that combination model is the most appropriate model for rural-urban fringe area location because the location of inner fringe and outer fringe balanced and reasonable than the other two models, based not only on the proportion of land use but also based on the distance to the city center.
Keywords: combination-model, location, rural-urban fringe, land-use, GIS

INTRODUCTION

This paper is concerned with land use between urban area, rural area, and how to find an appropriate model to identify the location of the rural-urban fringe area. Land use as a human activity product on earth's surface shows a large variation, within both local and regional city. An understanding of land use forms that characterise the built-up area, urban-rural transition area, and the countryside itself, is a matter of principle to do its spatial structure differentiation. And understanding of 'urban' and 'rural' also needs attention - especially 'urban' related to urban life and 'rural' associated with countryside life. Aspects of life itself consist of urban and countryside aspects: political, social, economic, cultural, psychological, technological, and physical. In discussing this morphological approach, someone insisted on the physical aspect, and one of which is land use.

To distinguish between types of urban and rural land use, these kinds of linkages with agricultural land became the main focus because most of the provincial land use type is associated with agricultural activities. Thus appears the term 'urban agricultural land' and 'rural agricultural land'. Lands located in urban area (morphologically) are used for agricultural purposes, while 'rural agricultural land' has many examples and is common in rural area. Such land use includes: rice field, dry land, garden mix, etc. Thus, identifying with provincial agricultural or non-urban agricultural is not entirely correct, but linking the proportion of 'urban agricultural land' compared with 'urban non-agricultural land' is small, its presence ignored. Similarly, 'rural non-agricultural land' and 'rural agricultural land' types dominate land use in rural and urban areas. To dominate land use type in rural and urban, the definition of 'dominance' is used for any discussion of spatial structure in terms of land use type. The main problem lies in the transition area from the appearance of a 'real urban' to 'real rural' appearance. In this transition area, the domination problem appears to be blurred, especially for regions moving from urban to rural. However, counting of land use type can be achieved with the grid system approach, administrative approach or physical approach. From the calculation of land use area in each cells (grid system approach) or 'areal units' (administrative and physical approach), the percentage of land use orientation can be known and sub zone of each cell can be determined also [1].

The rural-urban fringe area is the most important area in the city because if city center is insufficient, the target of urban development will move to the rural-urban fringe area. This situation has happened not only in developed countries but also will occur in developing countries including Indonesia. Indonesia is one of the most highly populated countries in the world with a population of over 237 million people in 2010. Land use changes in the rural-urban fringe area that are fast and large-scale have given rise to various problems that are quite complex in several Indonesia cities, especially in terms of agricultural land conservation. In fact, it is difficult to trace boundaries of the rural-urban fringe area clearly because of the mixing of urban and provincial properties in an area once. For this reason, this research is important for rural-urban planning for developed countries and developing countries, especially in Indonesia, if there is an aim to make an appropriate strategy to anticipate urban development in the rural-urban fringe area. This research also will present a new model that can be used by planners to identify rural-urban fringe area location. The approach towards determination of the

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rural-urban fringe location consists of two kinds: the grid system approach, which entails dividing an area into cells; the administrative approach creates an administrative region as area units, then cells or unit area are classified into urban fringe division.

The objective of this research is to identify rural-urban fringe area location based on combination model and the main purpose is to prove that the combination model is an appropriate model for rural-urban fringe area. This study investigates this problem by comparing results and interpretation of three models with the same data. Firstly we discuss three models used to identify rural-urban fringe area location using urban-rural land use, spatial structure, and combination model. Secondly, we analyse land use type changes in the study area, using three models for 1990, 2000, 2010, and compare them with the zoning status of each period. Thirdly, we examine the three models to determine the most appropriate model for rural-urban fringe area.

LITERATURE REVIEW

There are many studies about land use changes at the national scale as well as the smaller scale, such as cities or villages [2,3,4,5,6]. These studies have regarded a region as an aggregated system that can be used to estimate only the amount of land use change [7]. Braimoh and Onishi identified the factors responsible for residential and industrial/commercial land development in Lagos [8]. They classified land use into four units: (1) Residential, (2) Industrial/commercial, (3) Non-urban, and (4) Water.

T.L. Smith's discussion of the 'urban fringe' around Lousiana marked the first use of this term, signifying 'the built-up area just outside the corporate limits of the city' [9]. Kurtz and Eicher differentiate between 'fringe' and 'suburb' while Wissink defines 'fringe', 'suburbs', 'pseudo-suburbs', 'satellites' and 'pseudo-satellites' [10]. Schnore distinguishes between 'satellites' and 'suburbs' [11]. A number of writers have described different types of suburbs, some of which could be synonymous with the 'fringe' of another research worker.

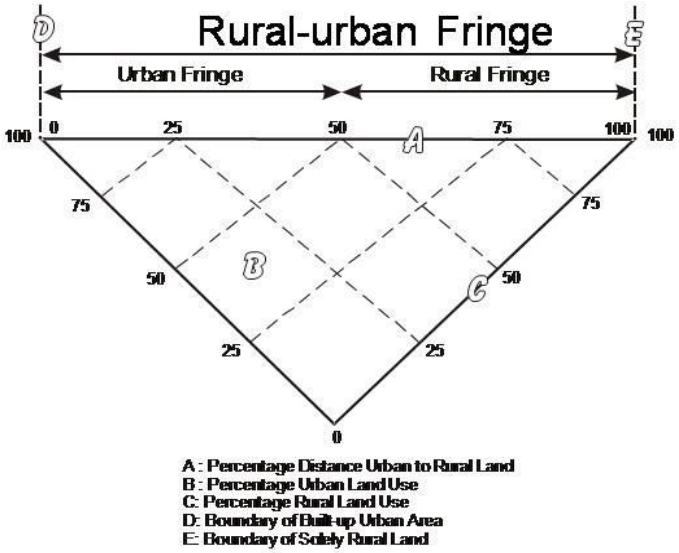

Fig. 1 Rural-urban land use triangle [12]

Pryor calculated the percentage of urban land use, percentage of provincial land use and percentage of distance from the main urban area [12]. The three components are combined in the rural-urban land use triangle model. The creation of this model based on the idea of gradual transformation from city to village or vice versa. The 'distance decay principle', where the further away from the 'real urban' appearance will increasingly blur in the town, also applies here. In contrast, the village became clear appearance. In other words, it can be said that the dominance of urban land use forms will increase if it closes to urban area and vice versa. Pryor suggested four sub zones in the 'regional city' (Fig. 1): (1) urban area, (2) urban fringe, (3) rural fringe, and (4) rural area [12]. The urban area is the area that land use forms dominated by urban, while the rural area is dominated by agriculture. The urban fringe, that sub zone of the rural-urban fringe in contact and contiguous with the central city, exhibits a density of occupied dwellings higher than the median density of the total rural-urban fringe. The rural fringe, that sub zone of the rural-urban fringe contiguous with the urban fringe, exhibits a density of occupied dwellings lower than the median density of the total rural-urban fringe. Furthermore, the rural-urban land use typical of the fringe.

Studies of land use changes and rural-urban fringe have been superficial in many regions. It seems that rural-urban fringes are negleted because of the difficulties of grasping the spatial relationships between land use changes and rural-urban fringes location.

Yunus adds new sub zone in sub zone differentiation according to Pryor [1]. They are located between the urban fringe and rural fringe: (1) urban areas; (2) urban fringe; (3) urban-rural fringe; (4) rural fringe; (5) rural areas [13]. The urban area is the area where the land use is 100 per cent urban-oriented, while the urban fringe is the area (zone) dominated mainly by forms of urban land use (more than 60 per cent of urban land use and less than 40 per cent of rural land use). Urban fringe areas are located from the border point of the urban built-up to within 40 per cent of the point (calculated from the overall distance of a 'real urban' to 'real rural'). Rural fringe is a sub zone of the percentage of its urban land use in balance with its rural land use. The comparison ranges from 40 per cent to 60 per cent where the explanation is more than 40 per cent urban land use and less than 60 per cent of rural land use. In this condition, a zone shows the comparison of urban land use in balance with provincial land and the structural transformation of land use will occur, although it is not as fast in the urban fringe area (Fig. 2).

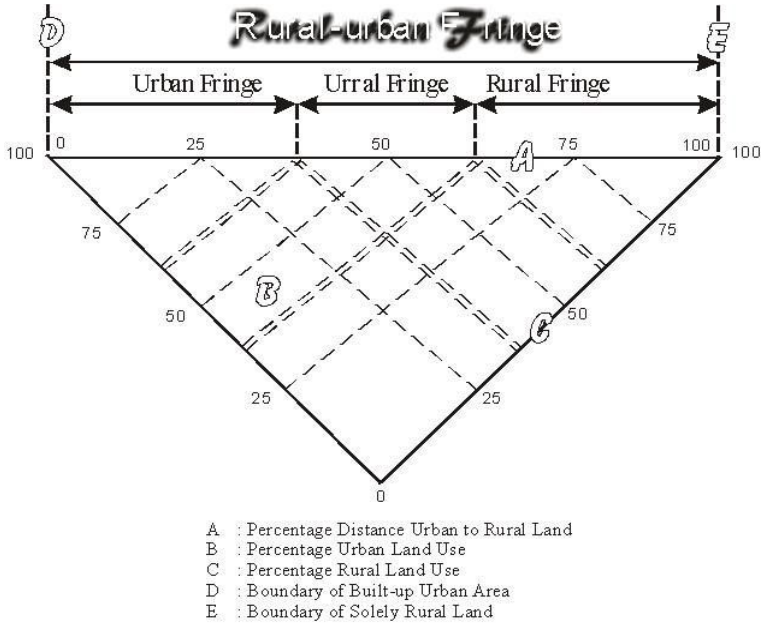

Fig. 2 Rural-urban land use model [13]

Provincial land use dominates the sub zone of the rural-urban fringe, where at least 60 per cent of its land use form is rural. Transformation of land use structure runs more slowly than the sub zone of rural fringe. The rural area is an area which all land use forms are geared towards agricultural land use. The process of structural transformation of the general land use factors is associated with distance from built-up area, but in areas located along transportation routes and at locations near the junction of the ring road and radial roads, the distant decay principle associated with the acceleration of transformation structure of land use do not apply.

Slightly different from the opinion of Pryor and Yunus, especially in areas that lie between the 'real urban' and 'real rural', Russwurm suggests three sub zones: (1) inner fringe; (2) outer fringe, and (3) urban shadow zone [14]. Russwurm also identified regional rural-urban fringe (the term of Pryor). This structure, based partly on Russwurm [15,16] and Bryant [14], is particularly helpful, since it stresses the notion of continuum between urban area and rural hinterland (Fig. 3). As another opinion, the basic problem is the dominance of the introduction of the existing sub zone. The inner fringe is marked by a number of agricultural land conversions to non-agricultural land. Penetration of land owners rather than farmers happens a great deal in this sub zone. The outer fringe is the area/sub zone where village land use is dominant. Provincial land conversion into urban land happens a great deal, but the frequency is not as high as in sub zone of inner fringe. Infiltration of urban appearance begins to appear in this zone. In the cities of Western countries, cemeteries and land for stacking carcasses are among the characteristics of the outer fringe areas. This is reasonable because such forms require vast land that is plentiful and cheap. Land ownership is still dominated by farmers. The urban shadow zone is the area where the elements of urban morphology begin to infiltrate, but is still minimal. This zone bordered directly with real urban areas. The

distributor of its zone is a conceptual model only. Not all cities are marked by a sequence of sub zone such as in the model and it not always spread evenly in all directions.

The structure represented in Fig. 3, is, of course, an 'idealised' one. The full sequence of types does not occur around all centers or even in all directions. Sometimes an abrupt change may occur in fringe to rural hinterland. On the south bank of the Montreal region, for example, the metropolitan influences are reduced significantly to the south-east of the river [17].

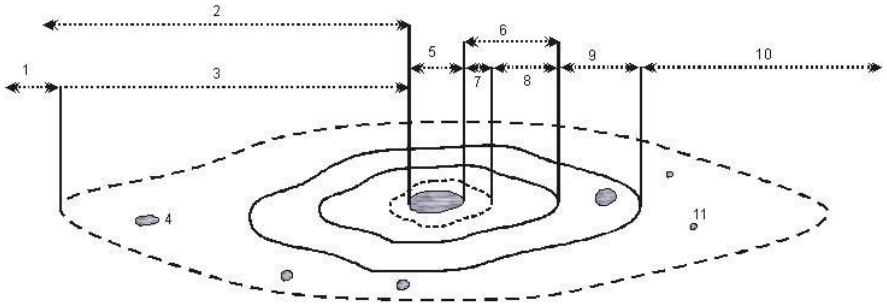

Fig. 3 Spatial structure model [14]

MATERIALS AND METHODS

Aerial photographs were taken in 1990, 2000, and 2010 and are used as the data for the research. Based on these data, 17 classifications were identified (Table 1). It was difficult to obtain the data of land use every five years. We created digital maps of four types of land-use with grid data (Fig. 4).

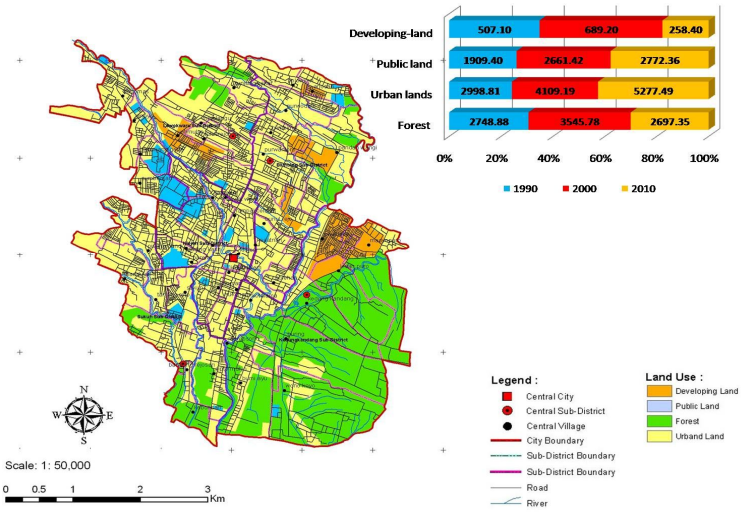

Fig. 4 Land-use types

The 17 classifications divided into four land-use types: forest/farmland (F); urban-land (U); public-land (P); developing-land (D). The overall classification system is shown in Table 1. The percentage of land-use types in each period obtained by overlaying land-use and grid data. The percentage of dwellings, industry,

office-affairs, military, commercial, and public land occupied more than 80 per cent. Forest and farmland occupied less than 20 per cent.

Table 1 Classification of land-use types

Land use types	No.	Classification
Forest and farmlands	1	Paddy field
	2	Moor
	3	Plantation
Urban lands	4	Dwellings
	5	Industrial
	6	Office affairs
	7	Military
	8	Commercial
Public land	9	Terminal
	10	Road/drainage
	11	Education
	12	Liturgy
	13	Recreation
	14	Water reservoir
	15	Healthiness
	16	Green space
Developing land	17	Vacant

In this research, we used a combination model to identify rural-urban fringe area location. In this model, rural-urban fringe area location is determined by the proportion of urban land use functions, residential properties and the proportion of agricultural land use [18]. It was also calculated based on the distance bands and square grid (Fig. 5). The basic research division of rural-urban fringe area location is divided into two sub zones. The first is inner fringe, in which non agriculture land began to be dominant. The built-up environment and the natural environment are balanced (40 per cent to 60 per cent of agricultural and conservation areas). It covers an area of around 2 km from the city centre. The second sub zone is the outer fringe, in which land use is dominated by provincial features (60 per cent to 90 per cent of agricultural and conservation areas). It covers an area from more than 2 km and up to 5 km [19].

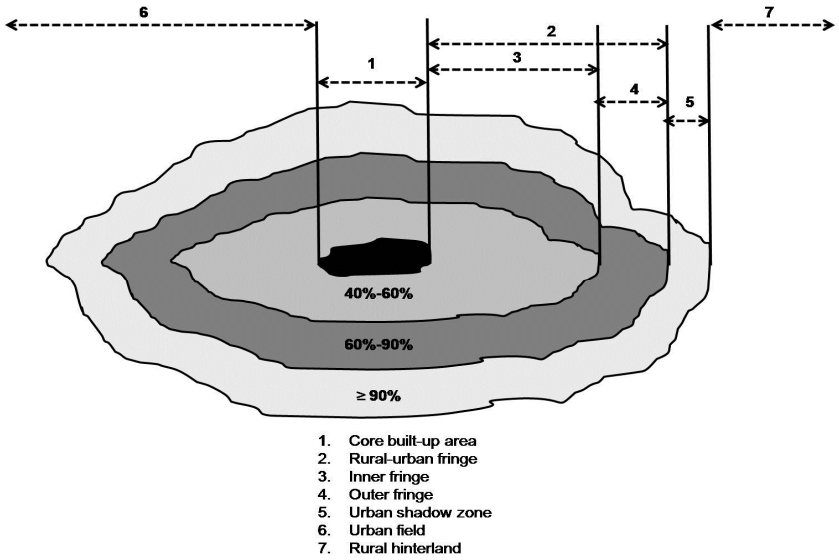

Fig. 5 Combination model [18,19]

Morphological identification of cities in the study area entailed dividing the grid area of the city based on observations of cells of each area of 4 hectare. Each of these observation cells count the ratio of land to produce cells belonging to the category of inner fringe, outer fringe and urban shadow zone. Then, in order to know the administrative area of the three categories above, the urban fringe areas are grouped into the same administration. To combine square grid and distance bands, we used Geographic Information System software (ArcGIS 9.3), and ArcMAP.

For the construction of the grid, we utilise pre-existing secondary data such rates 400mx400m. After that, we divided into 200mx200m. Then, we proceed with giving the name of each cell: the horizontal giving the

name using letters “A,B,C” and the vertical using the number “1,2,3”. After the cells are completed, we create an overlay (INTERSECT) with the ‘base map’, so that the grid cell can be fused with the ‘base map’ (Fig. 6).

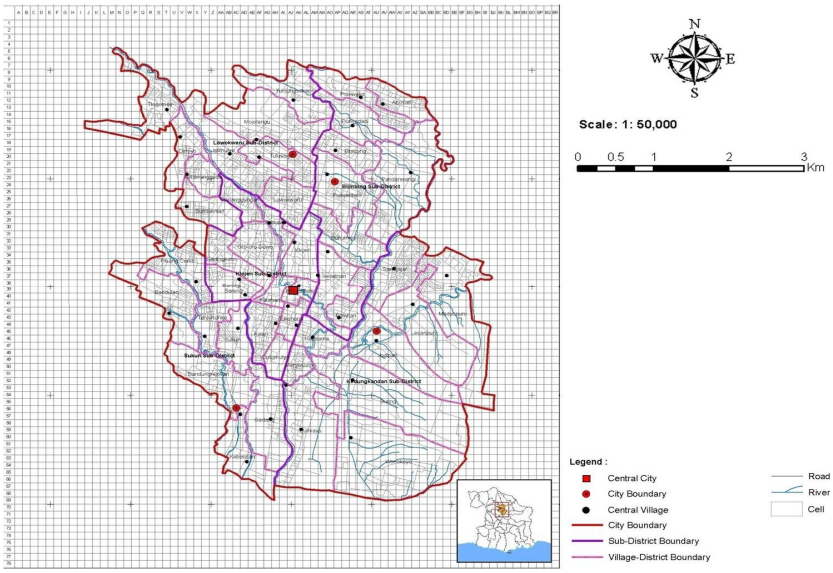

Fig. 6 Observation cells in the study area

The results for the three years were compared, with the purpose of identifying the land use type changes that had occurred over the 20-years period.

The present study selected four sub-districts and 23 villages, which have a total area of about 8164.33 hectare. In 2010, there were 816,637 inhabitants (Statistic of Malang City, 2010). The study area located between 112.06° to 112.07º (East longitude) and 7.06°- 8.02º (South latitude). The study area has a topography that is most flat (96.3%) with slope 0 per cent to 15 per cent and a height of 380 meters to 667 meters above sea level (Fig. 7).

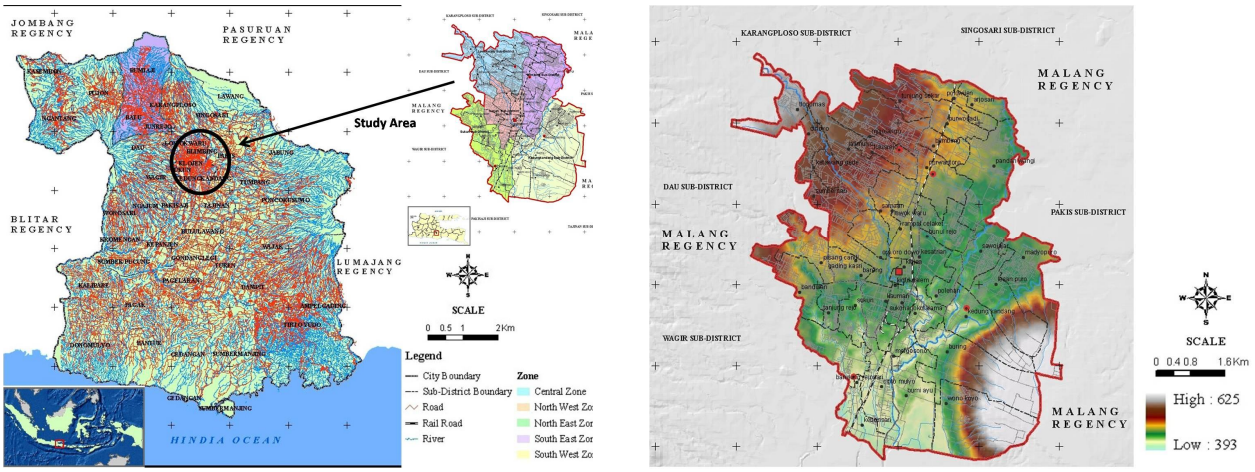

Fig. 7 The location of the study area and Digital elevation model of the study area

RESULTS AND DISCUSSION

Rural-urban land use model

We examined the land-use changes in each area by considering the percentage change in each land use. We made overlay land use with the grid cells of urban-rural land use model to obtain the pattern of land use changes in inner, outer and urban shadow zones.

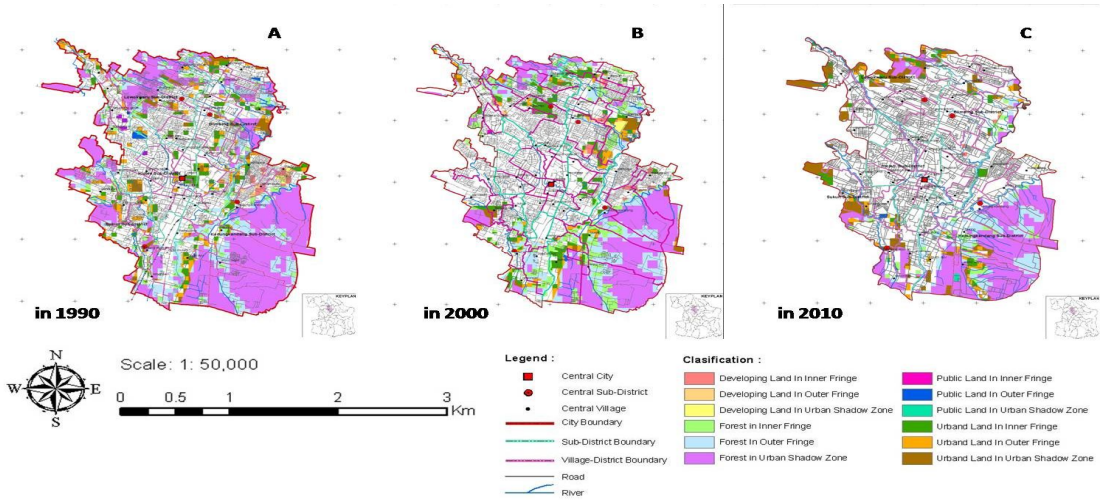

Fig. 8 The pattern of land use type changes in the rural-urban fringe area based on rural-urban land use model

Fig. 8 shows that the pattern of land use type changes in inner fringe, outer fringe and urban shadow zone leapfrogs. From 1990 to 2010, the total of land-use types changed. Forest and farmland (F) decreased to 60.70 per cent. In contrast, urban land (U) increased around 20.39 per cent in 2000 and decreased to 34 per cent in 2010. Public land (P) decreased around 3.44 per cent in 2000 and that increased around 6 per cent in 2010 (Table 2).

Table 2 Percentage of land-use types in the rural-urban fringe area based on urban-rural land use model, spatial structure model, and combination model

Model	Period	Land-use types								Total (ha)
		Forest/Farmland		Urban-land		Public-land		Developing-land		
		(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)	
Urban-rural land use model	1990	2778.88	57.16	1374.05	28.26	414.43	8.52	294.43	6.06	4861.79
	2000	1713.78	43.17	1654.25	41.67	400.19	10.08	201.89	5.09	3970.11
	2010	1092.2	39.94	1097.3	40.12	424.18	15.51	121.12	4.43	2734.8
Spatial structure model	1990	2656.05	36.95	2698.94	37.55	1357.61	18.89	475.61	6.62	7188.52
	2000	1981.89	27.57	3356.01	46.69	1461.42	20.33	389.20	5.41	7188.52
	2010	982.28	13.66	4155.48	57.81	1772.36	24.66	278.40	3.87	7188.52
Combination model	1990	733.70	58.76	441.73	35.38	59.46	4.76	13.74	1.10	1248.63
	2000	338.78	37.12	488.89	53.57	73.50	8.05	11.40	1.25	912.57
	2010	90.71	13.39	514.68	75.97	68.98	10.18	3.10	0.46	677.47

The total of the rural-urban fringe area is 2734.8 hectare or 33.50 per cent of the total area of the city. According to the classification, the dominance of the first area is the urban shadow zone of 1707.96 hectare or 20.92 per cent of the city, and the inner fringe area is the smallest at 367.23 hectare or 4.50 per cent of the city (Table 3).

The rural-urban fringe area changes for 1990, 2000, and 2010. From 1990 to 2010, the outer fringe and urban shadow zone decreased, while the inner fringe increased in 2000 but it decreased in 2010. This happened because some parts of the inner fringe changed to the urban area in 2010 (Fig. 9).

Table 3 Identification of rural-urban fringe area based on urban-rural land use model, spatial structure model, and combination model 2010

No.	Category of morphology		Area	
			(ha)	%
URBAN-RURAL LAND USE MODEL				
I	Urban area		5429.53	66.50
II	Rural-urban fringe area			
	1	Inner fringe	367.23	4.50
	2	Outer fringe	659.61	8.08
	3	Urban shadow zone	1707.96	20.92
	Total of rural-urban fringe		2734.8	33.50
Total of the City			8164.33	100.00
SPATIAL STRUCTURE MODEL				
I	Built-up area		882.50	10.81
II	Rural-urban fringe area			
	1	Inner fringe	3715.16	45.50
	2	Outer fringe	3473.36	42.54
	Total of rural-urban fringe		7188.52	88.05
III	Urban shadow zone		92.81	1.14
Total of the City			8164.33	100.00
COMBINATION MODEL				
I	Urban area		5045.55	61.80
II	Rural-urban fringe area			
	1	Inner fringe	320.88	3.93
	2	Outer fringe	356.59	4.37
	Total of rural-urban fringe		677.47	8.30
Total of the City			8164.33	100

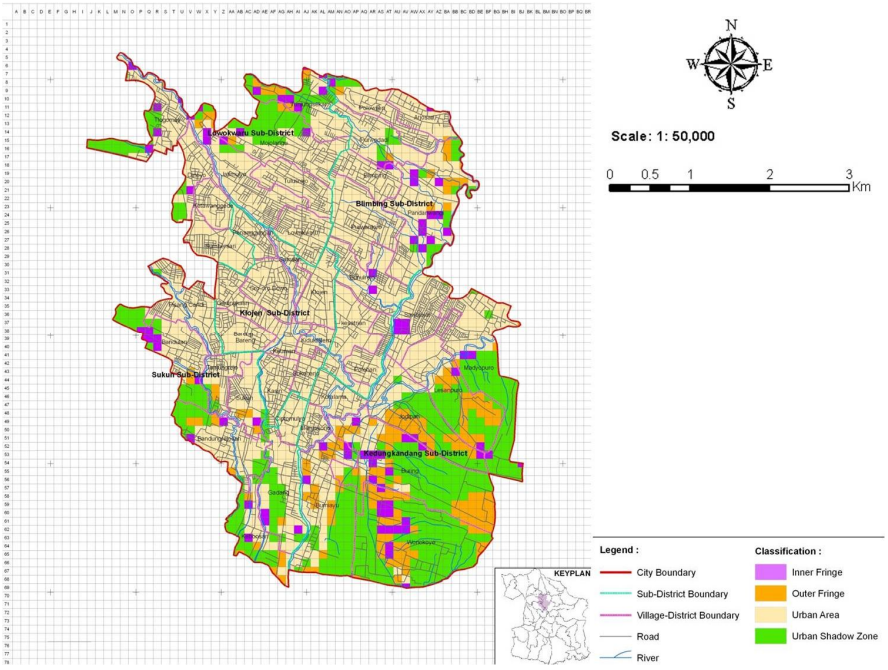

Fig. 9 Rural-urban fringe area based on urban-rural land use model

Spatial structure model

Fig. 10 illustrates that the pattern of land use types in the inner fringe, outer fringe and urban shadow zone is concentric. From 1990 to 2010, the total of land-use types changed. Forest and farmland (F) decreased around 63.02 per cent. In contrast, urban-land (U) and public-land (P) increased around 53.97 per cent and 30.55 per cent (Table 2).

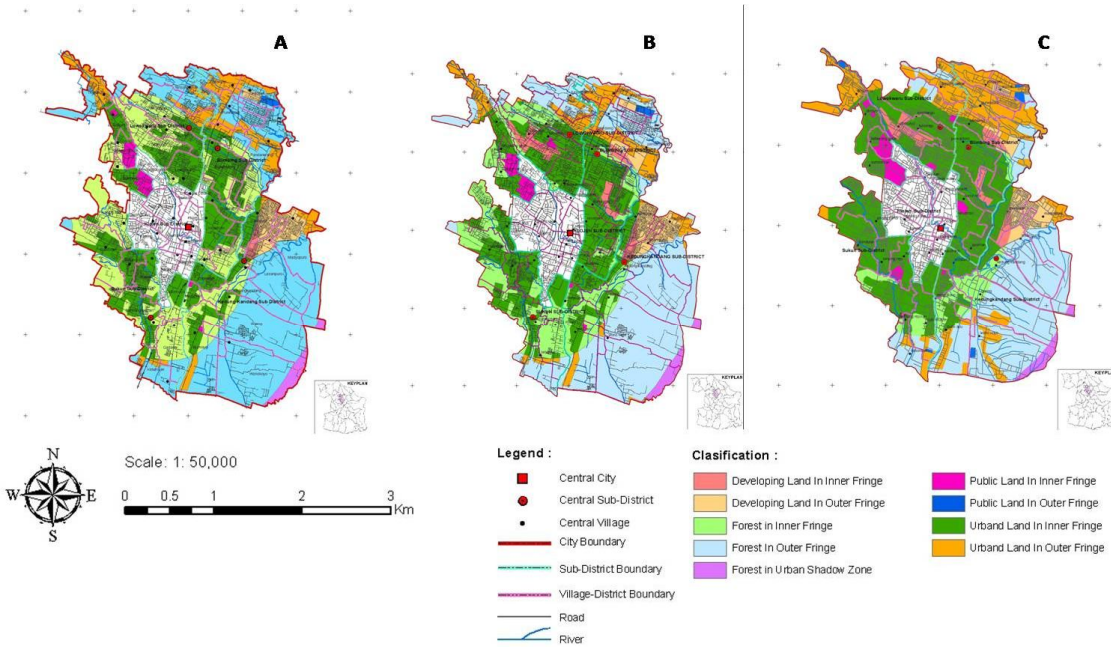

Fig. 10 The pattern of land use type changes in the rural-urban fringe area based on spatial structure model

The total of rural-urban fringe area based on spatial structure model is 7188.52 hectare or 88.05 per cent of the total area of the city. According to the classification, the dominance of the first area is the inner fringe of 3715.16 hectare or 45.50 per cent of the city, and the smallest area is the urban shadow zone with 92.81 hectare or 1.14 per cent of the city (Table 3).

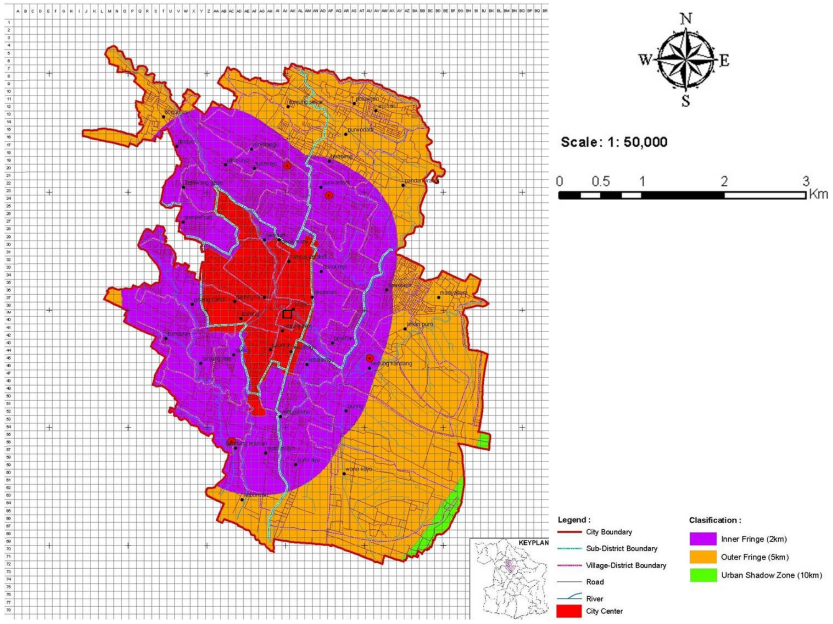

Fig. 11 Rural-urban fringe area based on spatial structure model

This model is divided into three parts. Firstly, the inner fringe covers the area around 2 km from the city center; secondly, the outer fringe covers the area around more than 2 km and up to 5 km from the city center; and thirdly, the urban shadow zone covers the area around more than 10 km from the city centre (Fig. 11).

Determination of the distance of the inner fringe, outer fringe, and urban shadow zone towards the city center in each city depends on the radius of the city. We still use grid cells in this model to calculate the total area of each rural-urban fringe category by villages.

Combination model

The pattern of land use types is concentric in the inner fringe, outer fringe and urban shadow zone (Fig. 12). From 1990 to 2010, the total of land-use types changed. Forest and farmland (F) decreased around 87.64 per cent. In contrast, urban land (U) and public land increased around 14.70 per cent and 29.47 per cent (Table 2).

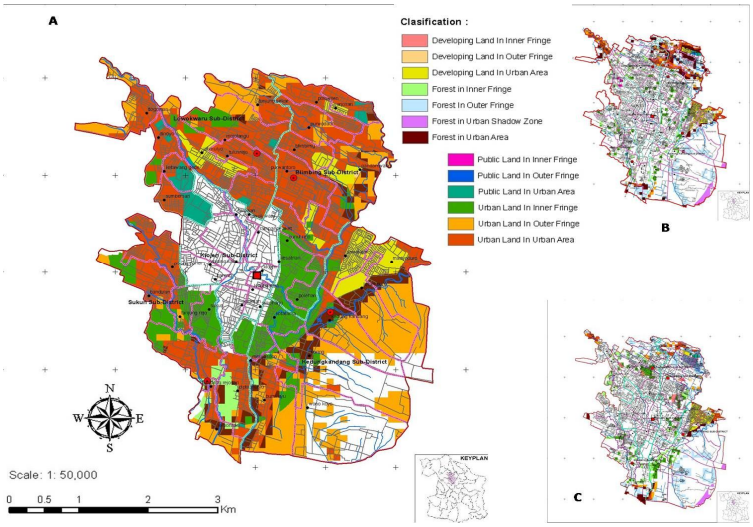

Fig. 12 The pattern of land use type changes in the rural-urban fringe area based on combination model

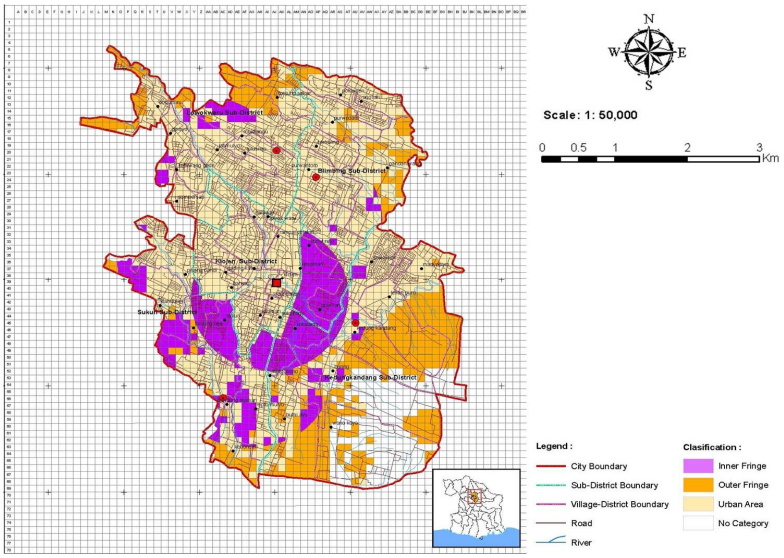

Fig. 13 Rural-urban fringe area based on combination model

The total of rural-urban fringe areas is 677.47 hectare or 8.30 per cent of the total area of the city. According to the classification, the dominance of the first area is the outer fringe area of 356.59 hectare or 4.37 per cent of the city, and the smallest area is inner fringe area of 320.88 hectare or 3.93 per cent of the city (Table 3 and Fig. 13). This model divided into 3 parts: urban area, inner fringe, and outer fringe.

Comparative analysis between three models in the rural-urban fringe area

We have demonstrated quantitatively that there are differences in large amounts of the rural-urban fringe area in three models. The total of rural-urban fringe area based on urban-rural land use model is 2734.8 hectare or 33.50 per cent of the total area of the city. Meanwhile, the total rural-urban fringe area based on

spatial structure model is 7188.52 hectare or 88.05 per cent of the total area of the city. Then, the total rural-urban fringe area based on combination model is 677.47 hectare or 8.30 per cent of the total area of the city. This can be seen in Table 4.

Table 4 Percentage of rural-urban fringe area 2010 based on three models

No.	Model	Total of rural-urban fringe area	
		(ha)	(%)
1	Urban-rural land use model	2734.80	33.50
2	Spatial structure model	7188.52	88.05
3	Combination model	677.47	8.30

Fig. 14 illustrates that the location of inner, outer, and urban shadow zone on each model is different. The location of inner, outer and urban shadow zone in urban-rural land use model tends to be spread throughout the region (Fig. 9). We can find the location of the urban shadow zone close to the city centre. In contrast, some parts of the inner fringe are located far from the city centre, close to rural areas. It is questionable.

As shown in Figure 11, the total area of the inner fringe is the biggest at around 3715.16 hectare or 45.50 per cent. The smallest area is the urban shadow zone with 92.81 hectare or 1.14 per cent. This situation is different with the urban-rural land use model. In this model, the total area of the urban shadow zone is the biggest around 1707.96 hectare or 20.92 per cent (Figure 9). The spatial structure model determines urban fringe area location based on the distance to the city centre. We all know that each city in the world has a different radius and, therefore, we must determine the distance of the urban fringe area to the city centre according to the radius of each city. This model is idealistic.

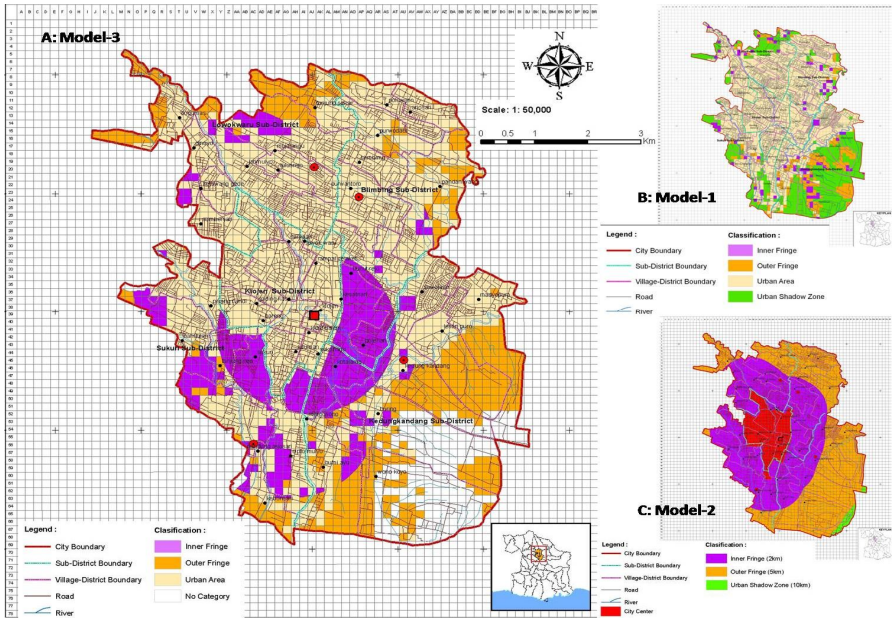

Fig. 14 Rural-urban fringe area based on rural-urban land use model, spatial structure model, and combination model

In combination model, rural-urban fringe area location is determined by the proportion of urban land use functions, residential properties and the proportion of agricultural land use. It was also calculated based on the distance bands and square grid. Fig. 13 illustrates that the location of rural-urban fringe area (inner and outer fringe) is more balanced and reasonable than the other two models. The outer fringe is the biggest area in this model at around 356.59 hectare or 4.37 per cent. Then, the smallest area is the inner fringe.

Land use type changes of the three models are shown in Fig. 15 and table 2. Land use type in each model changed. Forest and farmland in each model decreased. Urban-land and public land increased. In contrast, urban land in the rural-urban land use model decreased in 2010 (Fig. 14b). This is a weakness of the rural-urban land use model. Furthermore, the total of rural-urban fringe area in the rural-urban land use model and combination model decreased (Fig. 14a and Fig. 14b). In contrast, the total rural-urban fringe area in the spatial structure model did not change (Fig. 14c). This is a weakness of the spatial structure model.

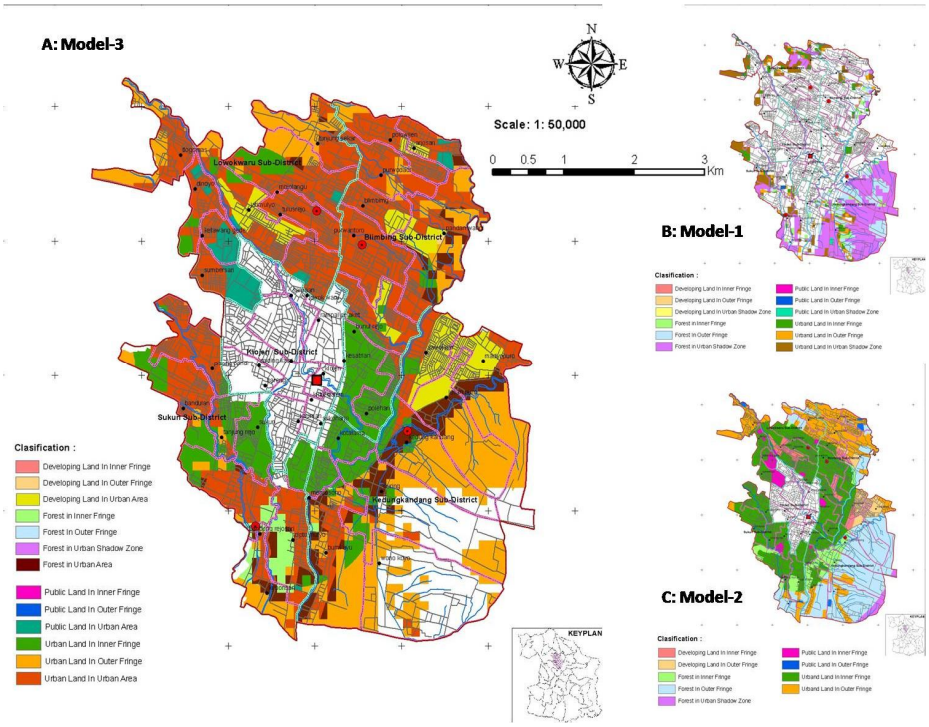

Fig. 15 Land use type changes based on three models

It should be underlined that the best model should meet the following requirements:
(1) The total area of rural-urban fringe should be decreased
(2) Urban-land and public-land should be increased
(3) Forest and farmland should be decreased
(4) No changing domination area in connection with location of inner, outer and urban shadow zone

In the rural-urban land use model, the total area of forest and farmland dropped from 57.16 per cent to 39.94 per cent. The domination area is the urban shadow zone. Urban-land and public-land increased in 2000 and decreased in 2010. The dominant area changes between the inner fringe and outer fringe. It shows that this model is questionable. It resembles a sprawl. In the spatial structure model, the total area of forest and farmland decreased from 36.95 per cent to 13.66 per cent. Urban land increased from 37.55 per cent to 57.81 per cent. In this model, the weakness lies in the total area of the rural-urban fringe not changed (Table 2). The combination model is better than others. The dominant area of forest and farmland in this model is the outer fringe. Then the dominant area of urban-land and public-land is the inner fringe. There is no change in dominant area in each land use type from 1990 to 2010 (Table 2 and Table 5).

To prove that the combination model is better than the others two models, we analysed land-use type changes related to location of rural-urban fringe area in detail. We choose Pandanwangi village in detail (Table 6).

Table 6 shows that the combination model (model-3) is better than the two other models because it is able to meet all four criteria that have been determined with regard to how to identify rural-urban fringe area location. The weakness of the urban-rural land use model (model-1) is the decrease in the total area of urban land in the rural-urban fringe. Furthermore, the weakness of the spatial structure model (model-2) is that the total area of the rural-urban fringe does not change in any period.

Table 5 Percentage of land-use types changes in the rural-urban fringe area based on three models

Model	Percentage of land-use type changes (%)											
	Forest and farmland (F)			Urban land (U)			Public land (P)			Developing land (D)		
	1990	2000	2010	1990	2000	2010	1990	2000	2010	1990	2000	2010
Urban-rural land use model	57.16	43.17	39.94	28.26	41.67	40.12	8.52	10.08	15.51	6.06	5.09	4.43
Spatial structure model	36.95	27.57	13.66	37.55	46.69	57.81	18.89	20.33	24.66	6.62	5.41	3.87
Combination model	58.76	37.12	13.39	35.38	53.57	75.97	4.76	8.05	10.18	1.10	1.25	0.46

Table 6 Percentage of land-use types changes in Pandanwangi by three models for 1990, 2000 and 2010

Classification	Urban-rural land use model (Model-1)						Spatial structure model (Model-2)						Combination model (Model-3)					
	'90		'00		'10		'90		'00		10		'90		'00		'10	
	F	U	F	U	F	U	F	U	F	U	F	U	F	U	F	U	F	U
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
IF	57	43	60	28	40	41	81	19	29	56	5	65	79	21	48	37	2	95
OF	65	34	74	19	51	39	61	39	50	41	36	55	68	32	63	36	33	66
USZ	0	17	33	21	52	48	0	0	0	0	0	0	0	0	0	0	0	0
UF	74	26	57	23	48	43	68	32	42	46	25	59	74	26	54	37	19	80
Total of UF	269.38		266.32		107.94		398.25		398.25		398.25		398.25		345.27		183.03	

CONCLUSIONS

The rural-urban fringe area is an important area for a city, other than the city centre. If the city centre is insufficient for the urban population, then, of course the target of urban development will move to the rural-urban fringe. It is difficult to trace boundaries of rural-urban fringe areas clearly because of mixing of urban and provincial properties in an area once. We investigate this problem by comparing result and interpretation of three models with the same data using GIS function. Identification of rural-urban fringe area in each model is different.

The results show that there are differences large amounts of rural-urban fringe areas in three models. The location of inner, outer, and urban shadow zone on each model is different. The location of inner, outer and urban shadow zone in urban-rural land use model tends to be spread throughout the region. We can find the location of the urban shadow zone close to the city centre. In contrast, some parts of the inner fringe are located far from city centre, close to the rural area. It is often questionable. In addition, the urban-rural land use model has a weakness: urban-land in the rural-urban fringe area is unstable. Furthermore, the spatial structure model determines the rural-urban fringe area location based on the distance to the city centre. We all know that each city in the world has a different radius and, therefore, we must determine the distance of rural-urban fringe area to the city centre according to the radius of each city. This model is idealistic. On the other hand, the weakness of the spatial structure model is the total area of rural-urban fringe does not change in each period.

The combination model is an appropriate model to identify rural-urban fringe area location compared with the other two models because the rural-urban fringe area location (inner fringe and outer fringe) is more balanced and reasonable than the other two models. The combination model can meet the four requirements related to identification of rural-urban fringe area location. The authors hope that this study will give a new model that can be used by planners to identify rural-urban fringe area location. It is important for rural-urban planning if we want to make an appropriate concept and strategy to anticipate urban developments in the rural-urban fringe area.

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REFERENCES

1. Yunus, H.S. 2000. *Spatial structure of cities*. Indonesian National Business Publisher, Surabaya.
2. Himiyama, Y. 1994. The land use/cover change programme in Japan: a review and proposal, Geogr. Rev. Jpn, 67, 63-75.
3. Himiyama, Y. 1998. Land use/cover changes in Japan: from the past to the future, Hydrol, Process, 12.
4. Hoshino, S. 2001. Multilevel modeling on farmland distribution in Japan, *Land Use Policy*. 18, 75-90.
5. Verbist, B., Putra, A.E.D., Budidarsono, S. 2005. Factors driving land use change: Effects on watershed function in a coffee agroforestry system in Lampung, Sumatera. *Agric. Syst*. 85, 254-270.
6. Budi, S.W., Surjono, Harnen, S. The Influence of Trip Attraction on the Road's LOS at Traditional Market Land Use. *JAEBS*. 2: 92-96 (2012)

7. Rustiadi, E., Kitamura, T. 1998. Analysis of land-use changes in city suburbs: A case study on some subdistricts of the Bekasi Area of West Java, Indonesia. *J. Rural Plan. Assoc*. 17, 20-31.

8. Braimoh, A.K., Onishi, T. 2007. Spatial determinants of urban land use change in Lagos, *Land Use Policy*. 24, 502-515.

9. Smith, T.L. 1937. The population of Lousiana: Its composition and changes. *Lousiana Bulletin*. 293.

10. R. A. Kurtz., Eicher, J.B. 1958. Fringe and suburbs: A Confusion of Concepts. *Social Force*. 37, 32-37.

11. Schnore, L.F. 1957. Satellites and Suburbs. *Social Force*. 36, 121-127.

12. Robin, J. Pryor. 1968. Defining the Rural-Urban Fringe. *Social Force*. 47: 202-215

13. Yunus, H.S. 2001. *Land use change in suburban area, a case study of Yogyakarta suburban. Dissertations, Faculty of Geography*, Gajahmada University, Yogyakarta.

14. Bryant, C.R., Russwurm, L.H., McLellan, A.G. 1982. *The City's Countryside: Land and its Management in the Rural-Urban Fringe*. Longman, London

15. Russwurm, L. H. 1975a. Land policies across Canada: thoughts and viewpoints. *Battle for Land Conference Report*. Community Planning Association of Canada, Ottawa

16. Russwurm, L. H. 1975b. Urban fringe and urban shadow. *Urban Problems (rev. edn)*. 148-64

17. INRS (Institut National de la Recherche Scientifique). 1973. I'Agriculture, Office de planification et de development du Quebec and Universite du Quebec, Montreal.

18. Agustin, I.W., Kubota, H. 2010. A New Combination Model to Identify Location of Urban Fringe Area, *Procedings of Sustain 2010*, Kyoto, 11-12 December, pp. 170-182, Japan.

19. Agustin, I.W., Kubota, H. 2012. An Appropriate Strategy to Anticipate Fringe-Settlements Development in the Rural-Urban Fringe Area. *J. Basic Appl. Sci. Res*. 2(10), pp 10612-10619.