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IMPACTS OF ECONOMIC DEVELOPMENT AND POPULATION GROWTH ON AGRICULTURAL LAND CONVERSION IN JOGJAKARTA: A DYNAMIC ANALYSIS

Joko Mariyono
University of Gunung Kidul at Wonosari, Jogjakarta; and
PhD Candidate in Economics at Crawford School of Economics and Government
The Australian National University, Canberra
E-mail: mrjoko28@yahoo.com; joko.mariyono@anu.edu.au

Rika Harini
Faculty of Geography, Gadjah Mada University, Jogjakarta
E-mail: harini_rika@yahoo.co.id

Nur K. Agustin
Centre for Agricultural, Socioeconomic and Policy Studies, Bogor
E-mail: nung_agustin@yahoo.com

ABSTRAK

Luas lahan pertanian cenderung berkurang karena dialihfungsikan untuk keperluan lain sebagai akibat dari pembangunan ekonomi regional. Kajian ini bertujuan untuk menganalisis alih fungsi lahan di Jogjakarta dengan menggunakan model dinamis dengan memasukkan variabel ekonomi, demografi dan infrastruktur. Panel data yang digunakan dalam kajian ini dikumpulkan dari lima wilayah selama kurun waktu 1979-2000.

Estimasi dilakukan dengan panel regresi. Hasilnya menunjukkan bahwa lahan pertanian di Jogjakarta berubah secara dinamis dan menuju pada keadaan yang stabil. Lahan sawah akan tetap ada, sedangkan lahan kering kemungkinan akan dikonversi ke lahan sawah dan untuk kepentingan lainnya. Lahan sawah akan dicetak sebagai akibat naiknya pendapatan daerah. Tekanan penduduk terhadap lahan kering jauh lebih besar daripada terhadap lahan sawah.

Kata kunci: *alih fungsi lahan pertanian, pembangunan ekonomi, pertambahan penduduk, model dinamis, regresi panel*

INTRODUCTION

Agricultural land conversion has two major adverse impacts: ecological and economic impacts. Ecologically, the agricultural land conversion leads to decrease in carrying capacity of lands. Irianto (2004) highlights agricultural land conversion has potential impact on reduction in ground water production and flood. For example, flood in Jakarta is mainly caused by agricultural land conversion in Bogor (Ashari, 2003). Moreover, loss of water resource is highly costly because water resource has high total economic value (Usman, 1991). Agricultural land conversion also leads to loss of aesthetics (Soetisna et al., 1992) because agricultural landscape provides natural services such as amenity, clean air, and biodiversity. In many countries, environment is of high priority concern of the country's development. The increasing awareness of people on the environmental issues encourages several researchers to study the environmental effects of agricultural activities partly because agriculture has different characteristics from those of other industries regarding its environmental effects. One of the characteristics is its spatial conservatory which provides a beautiful landscape and friendly environment that create amenities for the citizens.

Economically, agricultural land conversion does not only impact on agricultural productions; but also leads to loss of agricultural jobs for both former and land owners and agricultural wage workers; loss of agricultural investments such as irrigation, institutions and other infrastructures; and negative environmental consequences (Firman, 1997). In fact, agricultural sector provides most jobs in rural area (Hill, 2000; Soekartawi, 1994). The implication is that there will be huge quantity of opportunity cost resulting from agricultural land conversion.

Once the lands are converted to other non agricultural purposes, it will never back to the original agricultural lands. As a result, there is permanent decrease in total production of agricultural outputs. Ironically, the national demand for foods is steadily increasing along with the steady rise in population growth. However, Indonesian agricultural production still faces classical problems such as shortage of water in dry season, lack of fertilisers during early planting season, and agricultural land conversion. The two first problems have temporary impact, but the last problem has permanent impact on rice production.

The fact that agricultural land conversion has various permanent impacts on production of rice, ecology, and socio-economics of rural life, it is important to study agricultural land conversion. This paper aims to examine the land conversion using a dynamic model, and to determine factors influencing the speed of land conversion. A theoretical frame work of land conversion and mathematical model will be built and data set on agricultural land will be used to test empirically. Results of empirical test will be discussed.

LITERATURE REVIEW

The inevitable consequence of economic development is agricultural land conversion. The rate and determinants of agricultural land conversion varies in terms of both spatial and temporal aspects. Studies on agricultural land conversion are somewhat of interest because the determinants of agricultural land conversion stem from many factors including economic, social, and cultural factors.

In Indonesia, it has been predicted that in 2020 there is around 9.3 million hectares of paddy field needed for fulfilling demand for rice at national level. But, now there is only 8.1 million hectares of paddy field available, which is around 45 % in Java and Bali. The problem is that the quantity of land is not increasing over time, but it is steadily decreasing (*KOMPAS-DAILY*, 2005). Because of different source of data, the exact rate of daily agricultural land conversion is still debatable. It is reported that the rate of agricultural land conversion in Java and Bali is around 45,000 hectares a year (PEMDA-DIY, 2006). A study by Pakpahan et al., (1993) mentions that rate of agricultural land conversion in four provinces of Java is around 23,140 hectares per year. By using data from *Badan Pertanahan Nasional*, Husodo (2003) states that agricultural land converted to housing and industrial area in Java is 81,176 hectares during the period 1994-1999.

Agricultural land conversions in Java have been considered the most serious issue. This is because the island is a rice bowl. Many studies summarised Ashari (2003) show that wetland conversion in Java is influenced by structural changes, economic growth, geographic and demographic factors. Kustiawan (1997) specifically mentions that agricultural land conversion in northern coastal Java occurs due mainly to internal and external factors, and government policies. Firman (1997) sums up that wetland conversion in northern regions of West Java is largely triggered by domestic and foreign investments in the manufacturing, finance and service sectors. In addition, political factors are more dominant than other factors, because many actors and institutions have involved in the land conversion in those regions.

In micro scale, the main reason of wetland conversion is geographical factors. When wetland is located in an industrial area, the value of land will be high such that the owners sell the land (Syafa'at et al., 1995). In addition, Rusastra et al., (1997) support the fact that the owners will purchase wetland in other places which is cheaper.

In economic point of views, agricultural land conversion is mainly influenced by the value of agricultural products relative to value of non agricultural ones. The value of agricultural products can be represented by farmer exchange rate. When farmer exchange rate is low, there is no incentive for farmers to retain agricultural practices as a generator of income (Ashari, 2003). Husodo (2003) points out that continual decrease in farmer exchange rate is one fundamental problem that needs to be seriously handled. Mariyono (2006) econometrically confirms that farmer exchange rate and regional income are the main economic factors influencing agricultural land conversion. Farmer exchange rate affects directly the conversion from agricultural land to other businesses, whereas regional income indirectly influences the conversion. Regional income leads to increase in built areas converted from agricultural land. The other factors that trigger agricultural land conversion are population growth and transportation infrastructures. More populated area needs more land for housing and other economic activities. Additionally, decentralisation is likely to accelerate the process of wetland conversion (*Dewan Ketahanan Pangan* (=Food Security Council), 2002).

Land conversion does not only happen in food crop sub-sector. In fisheries, Tajerin (2005) studies conversion of brackish land in East Java. By using an econometric model, the study shows that brackish land conversion is mainly affected by rapid development of region, urbanisation and migrations. In estate crops, Asni (2005) carries out a study on land conversion in Labuhan Batu North Sumatra using multiple regressions. The study shows that significant factors influencing land conversion in estate crops are level of education, income, and saving.

Most studies on Indonesian agricultural land conversion above use normative and descriptive analyses, and a only some of them employ static econometric approaches. None of them uses dynamic models of land conversion such that the rate of agricultural land conversion and the end of the episode have not been understood well. This present study tries to analyse agricultural land conversion using dynamic model to provide better understanding on the rate of change and the prediction of long run movements.

METHOD OF RESEARCH

Model specification. In food crop sub-sector, agricultural land can be broadly grouped into dryland and wetland. Wetland refers to "sawah" which is irrigated with either technical or simple irrigation systems and rain fed. Dryland refers to "tegalan" which is usually non-irrigated land. Both kinds of land are potential to be converted to other purposes, despite the fact that in a certain economic and social reasons both kinds of land are convertible from one to another (Mariyono, 2006).

Related to agricultural land conversion, there is a statement that when certain land has been converted to other non agricultural purposes, it will be followed progressively by other land nearby. The progression of conversion from one year to consecutive year could be slow or fast, and at the final movement is dependent on economic and other factors.

This study uses a system of first order linear autonomous differential equations (Hoy et al., 2001), which represents a simultaneous movement in the quantity of dryland and wetland. Since the agricultural land conversion occurs along with economic development, the dynamic system equations are formulated as:

$$\dot{D}_L = \delta_0 + \delta_1 D_L + \delta_2 W_L + \delta_3 F + \delta_4 R + \delta_5 P + \delta_6 I + \delta_7 M + \delta_8 B + \delta_9 S \quad \ldots(1)$$

$$\dot{W}_L = \beta_0 + \beta_1 D_L + \beta_2 W_L + \beta_3 F + \beta_4 R + \beta_5 P + \beta_6 I + \beta_7 M + \beta_8 B + \beta_9 S \quad \ldots(2)$$

where D_L and W_L is respectively quantity of dryland and wetland at time *t*,

$\dot{W}_L \equiv \frac{dW_L}{dt} \approx \frac{\Delta W_L}{\Delta t}$ and

$\dot{D}_L \equiv \frac{dD_L}{dt} \approx \frac{\Delta D_L}{\Delta t}$ is respectively rate of change in quantity of dryland and wetland in one year, *F* is farmer exchange rate, *R* is length of asphalted road, *P* is population level, *I* is regional income, *M*, *B* and *S* are dummy variable for municipal area, district of Bantul, and district of Sleman respectively and δ_i, β_i for i=0,1,...,9 are coefficients to be estimated. The base of comparison of location is agricultural land in Gunung Kidul and Kulon Progro which is considered non-urban areas because they have no direct border with the municipal area. The economic, demographical and geographical factors are included in the system to avoid the system from suffering bias of omitting relevant variables (Gujarati, 2003).

Farmer exchange rate is defined as an index resulting from a ratio of the price received by farmer to the price paid by farmer (Supriyati, 2004). When the index is getting greater, agricultural products are more valuable, and vice versa. Consequently, farmers tend to shift their agricultural business to other business if the farmer exchange rate declines.

Population, it can give a pressure to agricultural lands to be converted to housing and other purposes. The higher population regions will need more land for housing. It is likely that when population goes up, agricultural lands will decline.

Road, it can boost the value of lands including agricultural lands that have access to road. This is because more economic activities will be created; and subsequently it will be profitable to convert the agricultural lands to other profitable businesses.

Regional income, it can stimulate an increase in built areas. This is because more economic activities occur, and need more space for creating other businesses as regional income increases.

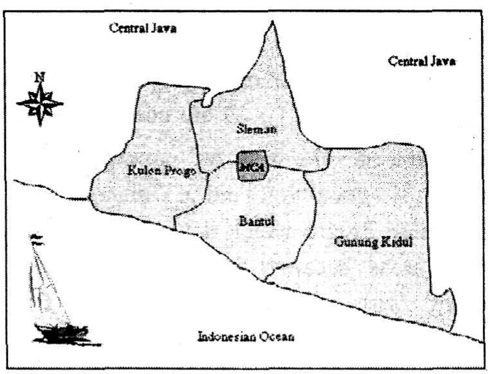

Figure 1. Area of Jogjakarta Province

Location, it is an intrinsic factor that influences the value of lands. If the lands are close to central business area, the land will have high economic value. As shown in Figure 1, two regions: Sleman and Bantul are close to municipal area, which is the central business area. It is likely that the rate of land conversion in those regions is greater than that in others.

Dynamic movement. By following Hoy et al. (2001), the agricultural land conversion can be mathematically expressed a system of first order linear differential equations with constant coefficient as follow:

$$\dot{D}_L = (\delta_0 + \overline{C}) +_1 \delta_1 D_L + \delta_2 W_L \quad ....(3)$$

$$\dot{W}_L = (\beta_0 + \overline{C}_2) + \beta_1 D_L + \beta_2 W_L \quad ....(4)$$

where

$$\overline{C}_1 = \hat{\delta}_3\overline{F} + \hat{\delta}_4\overline{R} + \hat{\delta}_5\overline{P} + \hat{\delta}_6\overline{I} + \hat{\delta}_7\overline{M} + \hat{\delta}_8\overline{B} + \hat{\delta}_9\overline{S},$$

$$\overline{C}_2 = \hat{\beta}_3\overline{F} + \hat{\beta}_4\overline{R} + \hat{\beta}_5\overline{P} + \hat{\beta}_6\overline{I} + \hat{\beta}_7\overline{M} + \hat{\beta}_8\overline{B} + \hat{\beta}_9\overline{S},$$

the hat ($\wedge$) over the coefficient represents the estimated values, and the bar (–) over the variables represents the average values. Equation (3) and (4) are called the first order autonomous linear differential equation. The equations show that the quantity of wetland (and dryland) converted to (from) one another is dependent on the existing quantity of dryland and wetland. This means that the quantities of land dynamically change and will stop changing when $\dot{W}_L$ and $\dot{D}_L$ are equal to zero. This is called a steady state condition. In a matrix form, the system dynamic equation can be expressed as:

$$\begin{bmatrix} \dot{D}_L \\ \dot{W}_L \end{bmatrix} = \begin{bmatrix} \delta_1 & \delta_2 \\ \beta_1 & \beta_2 \end{bmatrix} \cdot \begin{bmatrix} D_L \\ W_L \end{bmatrix} + \begin{bmatrix} \delta_0 + \overline{C}_1 \\ \beta_0 + \overline{C}_2 \end{bmatrix} \quad (5)$$

Let define matrix $A = \begin{bmatrix} \delta_1 & \delta_2 \\ \beta_1 & \beta_2 \end{bmatrix}$.

The determinant of matrix A is $|A| = \delta_1 \cdot \beta_2 - \delta_2 \cdot \beta_1$ and the trace of matrix A is $tr(A) = \delta_1 + \beta_2$. The characteristic roots (λ_1, λ_2) for the system equation are found by solving $\begin{vmatrix} \delta_1 - \lambda & \delta_2 \\ \beta_1 & \beta_2 - \lambda \end{vmatrix} = 0$ for λ, that is,

$$\lambda_1, \lambda_2 = \frac{tr(A) \pm \left(tr(A)^2 - 4|A|\right)^{1/2}}{2} \quad .....(6)$$

The stability of the system is determined by the signs of λ_1 and λ_2 resulting from β_1, β_2, δ_1 and δ_2 which follows theorems below.

Theorem 1: The dynamic system of equations will be stable and converges to the steady state if $\lambda_1, \lambda_2 < 0$ resulting from $|A| > 0$ and $tr(A) < 0$. This means that from any starting point, the change of dryland and wetland will be zero; and the level of dryland and wetland converge to certain points.

Theorem 2: The system will be unstable and diverges from steady state if $\lambda_1, \lambda_2 > 0$ resulting from $|A| > 0$ and $tr(A) > 0$. This means that if there is a shock disturbing the system, the level of dryland and wetland will move away from the steady state level, and will never move back to the level.

Theorem 3: The system will be in saddle point if $\lambda_1 > 0$ and $\lambda_2 < 0$; or $\lambda_1 < 0$ and $\lambda_2 > 0$ resulting from $|A| < 0$. This means that there is a certain path leading to movements of both dryland and wetland toward the steady state level.

Data collection and location. This study uses the case of Jogjakarta province at which development of infrastructure and development of areas have been rapidly progressive, in spite of the fact that agricultural land conversion in Jogjakarta is the least in terms of volume compared with other provinces in Java (Pakpahan et al., 1993; Husodo, 2003). This development is supposed to trigger agricultural land conversion to non-agricultural purposes.

The data are compiled from a number of sources including the Annual Report of the Provincial Agricultural Office, and statistical data published by the Provincial and District Statistical Offices. This study that consists of data collection, data database management, data transformation and econometric analysis is carried out in 2005. There is no need to apply a certain method of sampling since this study use secondary time series data. The data used in this study comprise five regions in a twenty two-year period 1979 to 2000, in which there was rapid infrastructural development. Definition and unit measurement of data to analyse are expressed in Table 1.

Table 1. Definition and Measurement of Variables

Variable	Definition	Measure
Wetland (W_L)	Quantity of irrigated and rain-fed area planted with rice and other secondary crops	hectare
Dryland (D_L)	Quantity of non-irrigated area	hectare
Farmer exchange rate (*F*)	Ratio of price received by farmer to price paid by farmer	index
Population (*P*)	Number of residents	people
Road (*R*)	Length of asphalted road covering new and existing roads	kilometre
Regional Income (*I*)	Quantity total regional income in a year.	million
Municipal Area (*M*)	Location of municipal area	dummy
Bantul (*B*)	Location of Bantul district	dummy
Sleman (*S*)	Location of Sleman district	dummy

Estimation and analysis. This study estimated parameters in equation (1) and (2) by using an econometric method. Panel generalised least square was used to account for any problems of heteroskedasticity between panel and autocorrelation within panel (Greene 2003).

Stability of the dynamic system equation was analysed with qualitative approach using a phase diagram (see Hoy et al 2001). Testable hypotheses in this study were formulated as:

H_0: $\delta_1 = \delta_2 = \cdots = \delta_9 = 0$; and

$\beta_1 = \beta_2 = \cdots = \beta_9 = 0$

H_1:at least one of δ_i and β_i not equal to zero for i=1,2,…,9

H_0 will be rejected if Likelihood Ratio (*LR*) is greater than χ^2 at, at least, 10% significant level. Likelihood ratio is formulated as:

$$LR = 2(LL(H_1) - LL(H_0)) \qquad \ldots\ldots(7)$$

Where $LL(H_1)$ is the estimated value of log-likelihood for H_1 and $LL(H_0)$ is the estimated value of log-likelihood for H_1. If H_0 is rejected, rate of agricultural land conversion is influenced by variables included in the model.

RESULTS AND DISCUSSION

Let first descriptively analyse the rate of change in land conversion for both dryland and wetland, which is represented by the value of $\dot{Dryland}$ and $\dot{Wetland}$ given in Table 2.

The important information provided in Table 2 is standard deviation of each variable is relatively high, meaning that there enough variation is such variable for econometric estimation. It is remarkable that the quantity of wetland in municipal area, Bantul and Sleman decrease, but it is not the case in Gunung Kidul and Kulon Progo. The rate of wetland conversion in Sleman is 346.55 hectares a year, which the highest in Jogjakarta. But the quantity of dryland in those regions increases. On the other hands, the quantity of dryland in Gunung Kidul and Kulon Progo decreases, but the quantity of wetland increases.

Table 2. Average Value of Variables

Regions		Obs	Mean	Sdt. Dev.	Min	Max
Province	Farmer exchange rate	20	107.32	9.27	96.30	131.10
	Regional income	20	2167328	1922938	187268	5286367
Municipal area	Road	20	217	28	167	271
	Population	20	438051	31863	381452	490433
	Ẇetland	20	-21.20	34.54	-92	84
	Wetland	20	357.90	140.49	165	584
	Ḋryland	20	81.35	186.29	-112	719
	Dryland	20	2408	511.58	1468	3085
Bantul	Road	20	1138	533	384	1715
	Population	20	704558	41133	638851	769663
	Ẇetland	20	-78.65	88.30	-321	0
	Wetland	20	17320.55	490.25	16559	18013
	Ḋryland	20	78.65	115.9162	-123	388
	Dryland	20	33332	534.07	32528	34126
Sleman	Road	20	1219	574	545	2247
	Population	20	752282	52381	662856	838628
	Ẇetland	20	-346.55	502.57	-2079	30
	Wetland	20	26267	1880	24291	30414
	Ḋryland	20	29	286.03	-575	560
	Dryland	20	5641	380	5207	6255
Gunung Kidul & Kulon Progo	Road	40	708	361	176	1306
	Population	40	565132	147763	403260	739259
	Ẇetland	40	20.95	165.19	-294	483
	Wetland	40	9338	1540	7020	11043
	Ḋryland	40	-75.43	7061.03	-20507	35067
	Dryland	40	50127	34794	9441	95937

Source: author's analyses

The rate of conversion is affected by the quantity of land and other factors. The effects of such factors on land conversion are given in Table 3, showing that dryland and wetland conversion is significantly estimated.

For the case of dryland, the result suggests that the rate of conversion is significantly affected by all independent variables, except dummy variable for municipal area. The negative constant means that the quantity of dryland falls at constant rate of 18,560 hectares a year, keeping other factors unchanged. Farmer exchange rate, length of road and regional income significantly exacerbate the rate of fall in quantity of dryland. But population leads to reduction in the conversion. In Gunung Kidul and Kulon Progo, the rate of conversion is faster than that in Bantul and Sleman, but, it is not different from that in municipal area.

Table 3. Estimates Dynamic System for Dryland and Wetland

Independent variable	Dependent var.: $\dot{D}_L$		Dependent var.: $\dot{W}_L$	
	Coefficient	z-ratio	Coefficient	z-ratio
Constant	-18560	-3.83***	3614	4.43***
Dryland	-0.2433	-5.30***	-0.0001	-0.07ns
Wetland	0.6224	4.09***	-0.2334	-4.39***
Farmer exchange rate	-27.75	-1.60*	0.0934	0.07ns
Length of road	-1.1428	-2.94**	-0.1085	-3.07**
Population	0.0508	4.81***	-0.0024	-3.58**
Regional income	-3.84E-04	-3.63**	1.87E-05	1.97**
Municipal area	759	0.59ns	-2510	-4.45***
Bantul	-14670	-4.59***	2149	4.18***
Sleman	-29364	-4.90***	4088	4.00***
$\chi^2(9)$		38.01***		36.51***
Log-likelihood		-849.165		-611.005
Observation		100		100

Note: ns) not significant; *) significant at 90% confidence interval;
**) significant at 95% confidence interval;
***) significant at 99% confidence interval.

For the case of wetland, there is a different episode. The result suggests that the rate of conversion is significantly affected by all independent variables, except dryland and farmer exchange rate. Farmer exchange rate does not effect significantly. This is because it possibly takes a moment to have impact on the land conversion. Farmers will not convert wetland immediately as farmer exchange rate is getting worse, and they expect that the exchange rate will be better afterwards. The positive constant means that quantity of wetland increases at constant rare of 3,614 hectares a year. Length of road and population reduce the rate of growth, but regional income accelerates the growth. Rate of increase in wetland in Kulon Progo and Gunung Kidul is lower than that in municipal area; but it is higher than that in Bantul and Sleman. It seems that dryland and wetland are convertible because the same factors have different impacts on both dryland and wetland conversions. The dynamic motion of both lands is qualitatively represented by a phase diagram in Figure 2.

At the steady state, the isoclines for which $\dot{D}_L = 0$ and $\dot{W}_L = 0$ are respectively:

$$D_L = \frac{1}{0.2433}\left(0.6224W_L - 18650 + \overline{C}_1\right) \quad \ldots(8)$$

$$W_L = \frac{1}{0.2334}\left(3614 + \overline{C}_2\right) \quad \ldots..(9)$$

where

$$\overline{C}_1 = \hat{\delta}_3\overline{F} + \hat{\delta}_4\overline{R} + \hat{\delta}_5\overline{P} + \hat{\delta}_6\overline{I} + \hat{\delta}_7\overline{M} + \hat{\delta}_8\overline{B} + \hat{\delta}_9\overline{S},$$

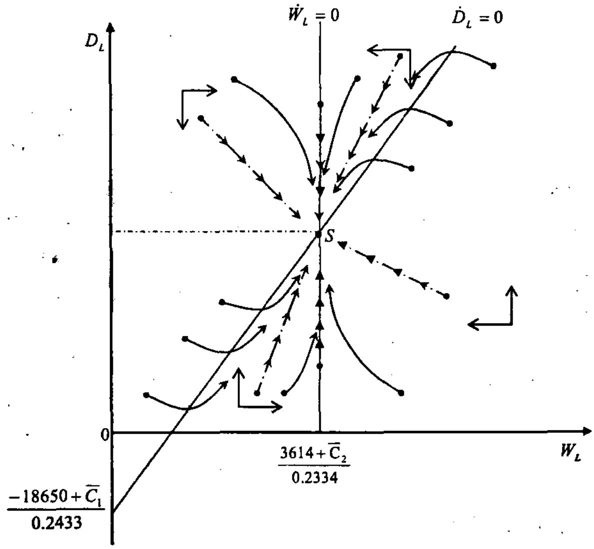

Figure 2. Phase Diagram

$$\overline{C}_2 = \hat{\beta}_3\overline{F} + \hat{\beta}_4\overline{R} + \hat{\beta}_5\overline{P} + \hat{\beta}_6\overline{I} + \hat{\beta}_7\overline{M} + \hat{\beta}_8\overline{B} + \hat{\beta}_9\overline{S},$$

the hat ($\wedge$) over the coefficient represents the estimated values, and the bar (–) over the variables represents the average values. The estimations suggest that $\partial\dot{D}_L/\partial W_L > 0$, meaning that $\dot{D}_L > 0$ or D_L increases $(\uparrow)$ when the quantity of wetland is greater than the value of which $\dot{D}_L = 0$ (located on the right-hand side of the isoclines for $\dot{D}_L = 0$); and $\dot{D}_L < 0$ or D_L decreases $(\downarrow)$ when the quantity of wetland is less than the values of which $\dot{D}_L = 0$ (located on the left-hand side of the isoclines for $\dot{D}_L = 0$). Likewise, the estimations suggest that $\partial\dot{W}_L/\partial W_L < 0$, meaning that $\dot{W}_L < 0$ or D_L decreases $(\leftarrow)$ when the quantity of wetland is greater than the values of which $\dot{W}_L = 0$ (on the right-hand side of the isoclines for $\dot{W}_L = 0$); and $\dot{D}_L > 0$ or D_L increases $(\rightarrow)$ when the quantity of wetland is less than the value of which $\dot{W}_L = 0$ (on the left-hand side of the isoclines for $\dot{W}_L = 0$). The motions of D_L and W_L are represented by the arrows on a plane of D_L and W_L.

It is clear that the system is stable. For any starting point, the motion converges to the steady state point *S*. Refers to the **Theorem 1**, it confirms that

$|A| = (-0.2433 \,.\, -0.2344)-(0.6224 \,.0) > 0$

and $tr(A)=(-0.2433-0.2344)<0$.

From equation (9), the steady state level of W_L will be

$$\frac{3614+\overline{C}_2}{0.2334} = 15484 + 4.28\cdot\overline{C}_2 \text{ hectares,}$$

because W_L is independent of D_L. Substituting this expression into equation (8) will give the steady state level for D_L, that is,

$-37043 + 4.11 \cdot \overline{C}_1 + 10.96 \cdot \overline{C}_2$ hectares. The steady state level of W_L is determined by $\overline{C}_2$ which is dependent on length of road, population and regional income. Length of road and population lead to a higher steady state level of wetland; in contrast, regional income leads to a lower one.

Dryland has a different story. It could be the case that the steady state level of D_L will be negative (or zero in economic sense). It seems that dryland will be converted to wetland. For example, when the regional income increases, the growth rate of wetland rises, and simultaneously, the rate of reduction in dryland increases faster. In the case of length of road, rate of reduction in dryland is more than ten times of rate of reduction in wetland. The policy maker should pay attention to which the steady state value is prevented from being zero by controlling the number of population and the length of road. Since population has opposite impact, the only sensible action is to control the length of road.

CONCLUSION

Agricultural land conversion is inevitable along with economic development and demographical changes. In Jogjakarta, length of road, population, regional income and farmer exchange rate are the main factors affecting agricultural land conversion. Accounting for those factors and interdependency between dryland and wetland, it is indicates that the wetland is created and dryland converted at constant rate. The rate of dryland conversion is much higher than the rate of wetland creation. Regional income and population have opposite effect on change in both dryland and wetland. Length of road has the same impact; but the magnitudes of both impacts are different.

Despite the inevitable agricultural land conversion, it is unnecessary to worry about it. This is because the dynamic model indicates that in the long run, the wetland agriculture in Jogjakarta will not disappear, although the dryland will likely to evaporate from Jogjakarta because it will be converted to wetland and other purposes as a consequence of economic development and population growth. Since the wetland is expected to be more productive, it is reasonable that the quantity of wetland will increases.

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