H-3.2.2 Development of the land use/change data set of Indonesia

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Abstract In this research, the author has developed a database on land use/cover change of Indonesia and introduced a simple model simulating dynamic interrelationship between the change of land uses and socioeconomic system of human life. The model named "Constant Elasticity Dynamic Equilibrium Model of Land Use (CEDEq-LU Model)" is derived from the very basic relationship among land area, land productivity, production, and equilibrium condition of supply and demand for products. By using the last three decades of time-series data of Indonesia, the model significantly explains the interrelationship system dynamics with averaged coefficient of determination of about 99.6%.

Key words: constant elasticity dynamic equilibrium model, land use change, land policy simulation, sustainable development.

1 Introduction

Modeling land use changes is increasingly becoming a global concern. It is commonly understood that land use and human life are strongly inter-correlated. The dynamics of human life implies on land use dynamics. The dynamic of land uses may develop or threaten human welfare (Saefulhakim, 1994). Furthermore, subject to a relatively fixed total available land area, population growth, and economic development, land resource scarcity increase overtime. Hannon and Ruth (1994) conclude that model building is central to our understanding of real-world phenomena. Accordingly, modeling land use change means understanding how the future of our life in this earth, and in somehow also means preparing what should be done for the most possible better condition in the future.

Any society has own relative potential possibility for a sustainable development, depending upon how they manage resources they have (Saefulhakim, 1997b). The resources may be in terms of (see Pearce and Turner, 1990; Saefulhakim, 1997b):

(1) *Natural Capital* such as land resources which some are renewable (such as biological and related resources) and some are exhaustible (such as minerals and other non-biological resources);
(2) *Man-made Capital* such as infrastructure, tools, and facilities;
(3) *Human Capital* such as intellectual, managerial, and technical skills; and
(4) *Social Capital* such as social and public institutions, value, ethos, etc.

A community with highly dependent on exhaustible resources and without an appropriate care of a sound management of their renewable natural resources, man-made capitals, human capitals, and social capitals, their growth will rapidly reach the saturation value and collapse. Contrarily, when they have a good dynamic response on their resources limitation and a good dynamic preparation for their most possible sustainability, as assumed in the induced innovation model of Hayami and Ruttan (1987), they will grow at their most sustainable growth path.

2 Derivation of the CEDEq-LU Model

In a very elementary concept, in a closed system land use production function can be formulated by the following two equations in derivative forms:

$$\frac{\mathrm{d}q(i,t)}{q(i,t)\mathrm{d}t}=\frac{\mathrm{d}x(i,t)}{x(i,t)\mathrm{d}t}+\frac{\mathrm{d}y(i,t)}{y(i,t)\mathrm{d}t} \quad (1)$$

$$\sum_{i}\frac{\mathrm{d}x(i,t)}{\mathrm{d}t}=0 \quad (2)$$

Where:

$q(i,t)$: Quantity of output produced of i-th land use at time t

$x(i,t)$: Area of i-th land use at time t

$y(i,t)$: Productivity of i-th land use at time t (such as in terms of *yield* or *land rent*)

L : A fixed total available land area.

Assuming that the dynamic of supply of goods and services can be explained by the dynamic of output quantity produced by land uses, and *a constant elasticity model* (Gujarati, 1995) holds for their relationship, we can then write an equation of supply function as follow in derivative form:

$$\frac{\mathrm{d}Q_s(t)}{Q_s(t)\mathrm{d}t}=a_i\left(\frac{\mathrm{d}x(i,t)}{x(i,t)\mathrm{d}t}+\frac{\mathrm{d}y(i,t)}{y(i,t)\mathrm{d}t}\right)+\sum_{j\neq i}a_j\left(\frac{\mathrm{d}x(j,t)}{x(j,t)\mathrm{d}t}+\frac{\mathrm{d}y(j,t)}{y(j,t)\mathrm{d}t}\right) \quad (3)$$

Where:

$Q_S(t)$: Quantity of goods and services supplied by a society at time t

a_0 : Constant of supply

a_i : Elasticity of supply with respect to quantity of output produced of i-th land use (i denote a referenced land use)

a_j : Elasticity of supply with respect to quantity of output produced of j-th land use (j denote land uses other than i).

Assuming that a constant elasticity model can also explain the dynamic of demand for goods and services, then we can write the following equation of demand function in derivative form:

$$\frac{\mathrm{d}Q_D(t)}{Q_D(t)\mathrm{d}t}=\sum_{k}b_k\left(\frac{\mathrm{d}C_f(k,t)}{C_f(k,t)\mathrm{d}t}+\frac{\mathrm{d}F(k,t)}{F(k,t)\mathrm{d}t}\right) \quad (4)$$

Where:

$Q_D(t)$: Quantity of society demand for goods and services at time t

b_0 : Constant of demand

b_k : Elasticity of demand with respect to k-th factor of demand

$D(k,t)$: Measurement of k-th demand factor at time t.

$F(k,t)$: Magnitude of k-th demand factor at time t

$C_f(k,t)$: Correction factor for k-th demand factor at time t.

Assuming equilibrium condition for supply and demand, a condition for a simultaneous interdependence among supply and demand factors (Gujarati, 1995), we can write as follows in a derivative forms:

$$a_i\left(\frac{dx(i,t)}{x(i,t)dt}+\frac{dy(i,t)}{y(i,t)dt}\right)+\sum_{j\neq i}a_j\left(\frac{dx(j,t)}{x(j,t)dt}+\frac{dy(j,t)}{y(j,t)dt}\right)-\sum_k b_k\frac{dC_f(k,t)}{C_f(k,t)}=\sum_k b_k\frac{dF(k,t)}{F(k,t)dt} \tag{5}$$

Here, let use the following notations for the elasticity:

$$\beta(i,k)=b_k/a_i,\alpha(i,j)=-(a_j/a_i) \tag{6}$$

Equation (5) can then be written as the following two equations:

$$\frac{dx(i,t)}{x(i,t)dt}=\sum_k\beta(i,k)\frac{dF(k,t)}{F(k,t)dt}+\sum_{j\neq i}\alpha(i,j)\frac{dx(j,t)}{x(j,t)dt}+\frac{d\theta(i,t)}{\theta(i,t)dt} \tag{7}$$

$$\frac{d\theta(i,t)}{\theta(i,t)dt}=\sum_k\beta(i,k)\frac{dC_f(k,t)}{C_f(k,t)dt}+\left(\sum_{j\neq i}\alpha(i,j)\frac{dy(j,t)}{y(j,t)dt}-\frac{dy(i,t)}{y(i,t)dt}\right) \tag{8}$$

Where:

$\theta(i,t)$: Aggregate level of society control on land use system dynamics (or aggregate effort of the society for their life sustainability, dynamically balancing their most possible supply and demand function)

$\beta(i,k)$: Elasticity of i-th land use with respect to k-th society demand factor

$\alpha(i,j)$: Elasticity of i-th land use with respect to the other j-th land use.

Equation (2), Equation (7), and Equation (8) are **the Basic Equation Set for the CEDEq-LU Model.**

3 Parameter Estimation and Simulation of the Model

For the purpose of parameter estimation and simulation of the CEDEq-LU Model, we integrate the basic equation set onto t, and the following land use system equation set and boundaries are resulted:

$$\ln x(i,t) = \sum_k \beta(i,k) \ln F(k,t) + \sum_{j \neq i} \alpha(i,j) \ln x(j,t) + \ln \theta(i,t) + \kappa(i) \quad (9)$$

$$\ln \theta(i,t) = \sum_k \beta(i,k) \ln C_f(k,t) + \left(\sum_{j \neq i} \alpha(i,j) \ln y(j,t) - \ln y(i,t) \right) \quad (10)$$

$$\sum_i x(i,t) = L \quad (11)$$

$$0 < \min(x(i)) \leq x(i,t) \leq \max(x(i)) < L \quad (12)$$

$$0 < \min(F(k)) \leq F(k,t) \leq \max(F(k)) \quad (13)$$

$$0 < \min(\theta(i)) \leq \theta(i,t) \leq \max(\theta(i)) \quad (14)$$

$$0 < \min(y(i)) \leq y(i,t) \leq \max(y(i)) \quad (15)$$

$$0 < \min(C_f(k)) \leq C_f(k,t) \leq \max(C_f(k)) \quad (16)$$

Where:

$\kappa(i)$: Constant of i-th land use, j is alias of i

min(.) : Lower boundary for the corresponding variable

max(.) : Upper boundary for the corresponding variable.

A constrained least square parameter estimation procedure was applied using GAMS - General Algebraic Modeling System. Due to data availability, in this first parameter estimation we used only time serial data of land use with 5 categories (FAOSTAT-PC: FAO, 1991), real gross domestic products (BPS, 1997), and population (BPS, 1997). The land use categories are (1) ARBL: Arable Land, (2) PCRP: Permanent Crops, (3) PPST: Permanent Pasture, (4) FORW: Forest and Woodland, and (5) URBL: Urban, Non-Agricultural, and Other Land. Actually, data for gross domestic products and population serially ranged from year 1960 to 1995. However, they are constrained by availability of land use data ranged only from year 1961 to 1989. Therefore, for only this purpose we use a same serial data for both i.e. from 1961 to 1989 (i.e.: 29 serial samples). Actually, in micro-economic theory (such as in Dahl and Hammond, 1977; Judge et. al, 1988), common factors of demand for goods and services are income level and price structure. In public spending (Pindyck and Rubinfeld, 1991), population size is also considered a significant factor. However, here for simplicity, we assume that real gross domestic products and population are the most significant aggregate proxy variable for the demand factors.

For simulation purpose, we set baseline for the dynamics of magnitude of demand factors, $F(k,t)$, to follow the saturating growth model (Crammer, 1991) as follow:

$$\frac{dF(k,t)}{dt} = \eta(k) F(k,t) (\omega(k) - F(k,t)) \quad \text{While} \quad \lim_{t \to \infty} F(k,t) = \omega(k) \quad (17)$$

Where:

t : tTime

k : k-th category of demand factors

$F(k,t)$: Size of k-th demand factor at time t

$\omega(k)$: Saturation value (ceiling parameter, resource limits) of k-th demand factor

$\eta(k)$: Growth parameter of k-th demand factor

$a(k)$: Logistic growth constant of the k-th demand factor

$b(k)$: Logistic growth rate of the k-th demand factor.

Quasi-Newtonian nonlinear parameter estimation procedure was applied for parameter estimation of the saturating growth model using data of real gross domestic products and population serially ranged from year 1960 to 1995. For the simulation we set two scenarios as follows:

Until when the dynamics of land uses will be able to support economic development of Indonesia if there were no further significant improvement of social efficiency and land use productivity? (i.e. set $\theta(i,t)$ = 1, find optimal solution for $F(k,t)$)

How much land use productivity improvement (under land suitability constrains) will be needed to ensure a sustainable socioeconomic development? (i.e. set $C_f(k,t)$ = 1, find optimal solution for $y(i,t)$)

4 Results and Discussion

4.1 Parameters Estimates: Characteristics of Land Use and Socioeconomic Dynamics in the Past Three Decades of Indonesia

Results of parameter estimation for the CEDEq-LU Model are summarized in Table 1 and for the Saturating Growth Model in Table 2.

Table 1 :Parameter Estimates of the CEDEq.-LU Model

Land Use	Elasticity with Respect to: Land Use					Demand Factor		Constant	RSq.
	ARBL	PCRP	PPST	FORW	URBL	GDP	POP		
ARBL	1.000	9.009	1.162	-3.324	-0.316	-0.065	-1.248	-21.191	99.99981
PCRP	0.071	1.000	-0.174	0.133	-0.032	0.008	0.142	6.557	99.62387
PPST	1.049	-8.576	1.000	3.729	0.460	0.061	1.179	10.095	99.9868
FORW	-0.239	1.420	0.094	1.000	-0.184	-0.009	-0.189	5.149	99.99917
URBL	-2.014	15.674	1.725	-7.376	1.000	-0.110	-2.146	-8.482	100

Notes:
ARBL Arable Land (unit: thousand ha)
PCRP Permanent Crops (unit: thousand ha)
PPST Permanent Pasture (unit: thousand ha)
FORW Forest and Wood Land (unit: thousand ha)
URBL Urban, Non-Agricultural, and Other Land (unit: thousand ha)
GDP Real Gross Domestic Products (unit: billions Rp)
POP Population size (unit: thousand persons)
RSq. Coefficient of Determination (unit: percent)

The models are significantly fit to data of the past three decades land use and socioeconomic dynamics in Indonesia. The models fit to the data with coefficient of determination (R^2) of more than 99%. This means that unexplainable data variability is less than 1%. Therefore, parameter estimates of the models are good enough to explain main characteristics of land use and socioeconomic dynamics of Indonesia particularly for the past three decades.

From Table 1 (elasticity matrix) we can see how many percent area of a certain land use (row variable) will change when area of another land use (column variable), real GDP, or population changes one percent. As an example, from ARBL row and POP column we can see that a percent of population growth in the past three decade implied in conversion of arable land by about 1.25 percent. Moreover, from URBL row and ARBL column we can see that a percent conversion of arable land was followed by about 2% area expansion of urban and non-agricultural land. Another example, from URBL row and POP column we see that a percent of population growth implied in conversion of urban, non-agricultural and other land by about 2.15 percent. This later phenomenon is likely not reasonable. However, this is because of too broad categorization. Actually, the conversion is neither for urban and nor for non-agricultural land, but for other land such as uncultivated swampy land. Current example for this phenomenon is development of one million hectares swampy peat land to agricultural land in Central Kalimantan (1997). From Bogor case, GDP and population growth are linearly correlated with expansion of land for housing and industrial establishment with correlation coefficient of 0.99 and 0.86 respectively. As a general figure of land use change phenomena got from Table 1 are as follows:

(1) Economic and population growth directly and indirectly induced (or be induced by) change of land uses particularly arable land, permanent crop, urban and non-agricultural land;
(2) Main source of arable land expansion (food crop development, etc.) is from conversion of forest land and other land especially uncultivated swampy (peat) land;
(3) Main source of permanent crop land expansion (plantation development, etc.) is from conversion of permanent pasture land including *alang-alang* (*Imperata cylindrica*);
(4) Main source of urban & non-agricultural land (development of urban housing, transmigration settlement, industry, mining, etc.) is from conversion of arable land and forest/wood land.

Table 2: Parameter Estimates of the Saturating Growth Model

	Parameters	GDP	POP
1	Saturation Value	294567	498393
2	Logistic Growth Constant	-6.80480	-1.46463
3	Logistic Growth Rate	0.06106	0.02917
4	RSq.	99.8455	99.9240

Notes:
GDP Real Gross Domestic Products (unit: billions Rp)
POP Population size (unit: thousand persons)
RSq. Coefficient of Determination (unit: percent)

4.2 Simulation under the Scenario 1: Indonesia Socioeconomic Crisis in the Beginning of the 21st Century

Results of model simulation under the scenario 1 are summarized in Figure 1 and Figure 2. Figure 1 shows population projection up to the 21st century in Indonesia with different models, scenarios, i.e.:

(1) the Saturating Growth Model,
(2) the CEDEq - LU Model without significant improvement of land use productivity and social efficiency,
(3) Average of (1) and (2),
(4) Projection by the Government of Indonesia, and
(5) Projection by the World Bank.

It is shown that up to year 2003 both models/scenarios estimate the same population size. However, since then the Saturating Growth Model shows the highest estimate while the CEDEq-

LU Model shows the lowest estimate. Results of projections by the Government of Indonesia and by the World Bank are approximately same as average value of projections by the Saturating Growth Model and the CEDEq-LU Model. These phenomena tell us that if there is no further improvement of land use productivity and social efficiency, population carrying capacity of Indonesia's resources will only grow until year 2003. Since then, the population carrying capacity will not significantly grow and population of Indonesia will never reach 250 million persons. However, with a medium optimistic projection, population of Indonesia will grow as estimated by the Government of Indonesia and the World Bank.

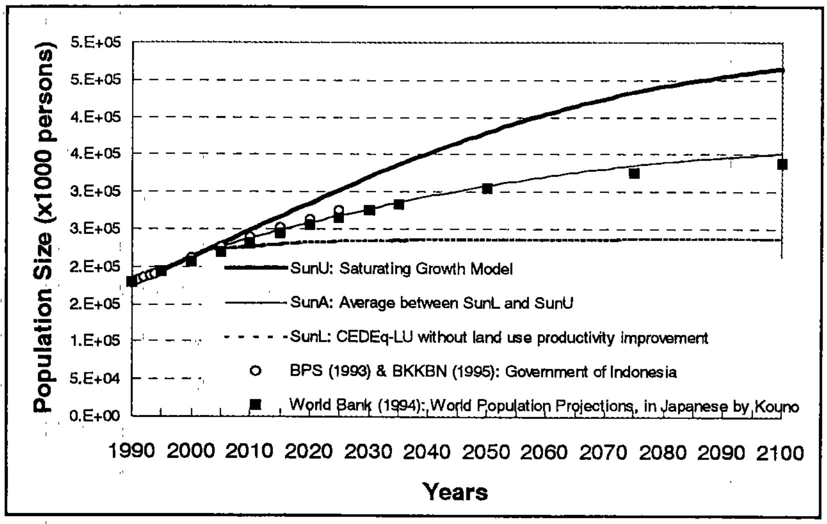

Fig. 1 Popluation projections by various scenarios

Figure 2 shows economic growth projection up to the 21st century in Indonesian with different modes/scenarios. Up to year 2006 Indonesian economy is estimated by both models to grow with average growth rate of about 6% a year. However, if there is no further improvement of land use productivity and social efficiency, from year 2006 the economy will set down to the level of year 1997. The problem will be more critical when the social efficiency and the land use productivity are significantly degrading as happening in the current Indonesian economic crisis. Saefulhakim (1998) shows that the current economic crisis in Indonesia is caused by many factors especially related to cumulative causation process of productivity and efficiency degradation, such as leveling-off in rice productivity and incremental capital-output ratio (ICOR) since 1984.

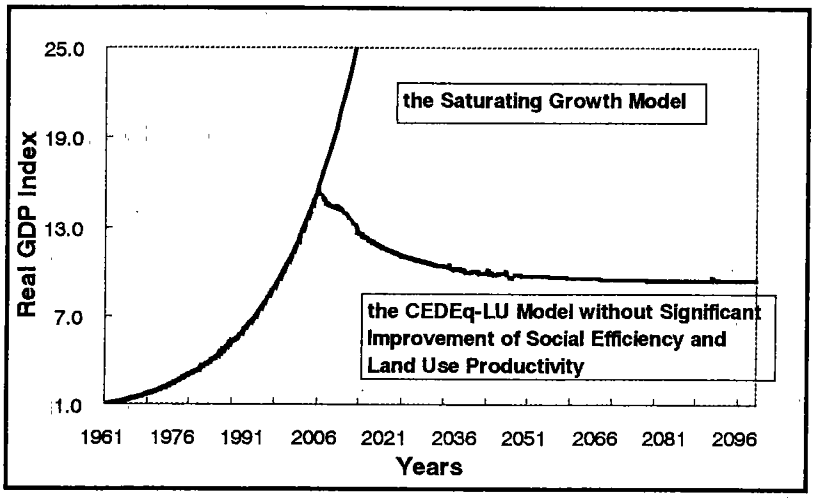

Figure 2 GDP projections

4.3 Simulation under the Scenario 2: Land Use Productivity Improvement Rate Necessary for Maintaining Sustainable Socioeconomic Development in Indonesia

Results of model simulation under the scenario 2 are summarized in Figure 3 and Figure 4. These figures show how land uses in Indonesia to be changed in order to match with:

(1) Economic and population growth as projected using the Saturating Growth Model, i.e. maximum possible economic growth and population carrying capacity; and

(2) Land suitability constrains.

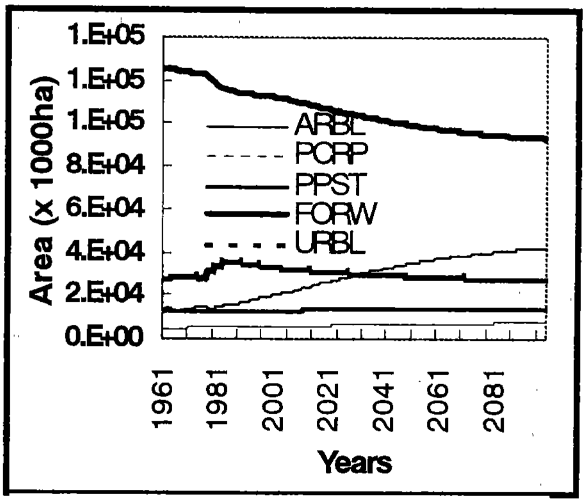

Fig.3 Land use projection under scenaio 2

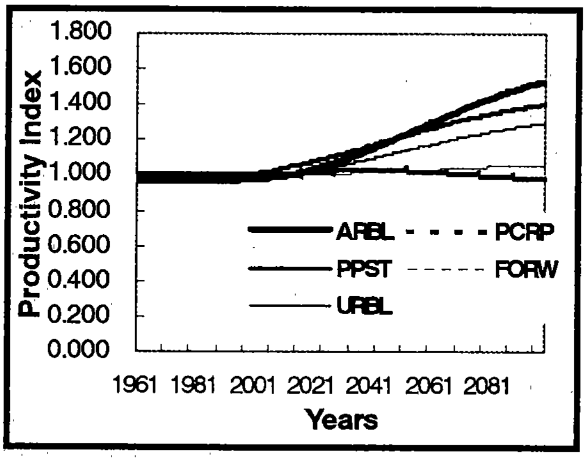

Fig. 4 Required land productivity

As a general conclusion from the figures, we can say that as far as policy is measured in terms of land uses, in order to achieve the most possible sustainable development, Indonesia has at least to do the followings:

(1) Area of arable land should be increased significantly. For that, it will be necessary to convert some of convertible forest and the currently uncultivated swampy land.

(2) Land use productivity should be increased significantly particularly for arable land, permanent pasture, urban land, and non-agricultural land. For that, we have to set up better policies and actual programs concerning namely land use intensification, land use conversion control, land resource rehabilitation, land resource conservation, land consolidation, etc. (see Saefulhakim, 1994, 1996, and 1997a; Saefulhakim and Nasoetion, 1994 and 1996; Saefulhakim, et al., 1997; Geo, 1997).

5 Conclusion

The above research results can be summarized as follows:

(1) It was introduced a simple model simulating dynamic interrelationship between the change of land uses and socioeconomic system. The model is named the CEDEq-LU (Constant Elasticity Dynamic Equilibrium Model of Land Use). The model fit to actual data with highly significant coefficient of determination.

(2) Economic and population growth directly and indirectly induced (or be induced by) change of land uses particularly arable land, permanent crop, urban and non-agricultural land

(3) Main source of arable land expansion (food crop development, etc.) is from conversion of forest land and other land especially uncultivated swampy (peat) land;

(4) Main source of permanent crop land expansion (plantation development, etc.) is from conversion of permanent pasture land including *alang-alang* (*Imperata cylindrica*);

(5) Main source of urban and non-agricultural land expansion (development of urban housing, transmigration settlement, industry, mining, etc.) is from conversion of arable land and forest/wood land.

(6) Indonesian economy has a potential growing capacity up to about 95 times real GDP of year 1997. Population supporting capacity is about 2.5 times population of 1997. Therefore, Indonesia has potentiality to increase the current status of income per capita up to approximately 40 times.

(7) However, if there is no further improvement of land use productivity and social efficiency, population carrying capacity of Indonesia's resources will only grow until year 2003, and from year 2006 the economy will set down to the level of year 1997. The problem will be more critical when the social efficiency and the land use productivity are significantly degrading as happening in the current Indonesian economic crisis.

(8) In terms of land policy, in order to achieve the most possible sustainable development, Indonesia has at least to:

   (1) Significantly increase area of arable land with a care conversion of some convertible forest and the currently uncultivated swampy land, and

   (2) Significantly improve land use productivity, particularly for arable land, permanent pasture, urban land, and non-agricultural land.

References

1. BKKBN (1995). **Some Implications of Indonesia Population Growth in the Second Long Terms Development Era.** The Office of State Ministry of Demography, National Coordinating Agency of the Family Planning. Jakarta. (*In Indonesian*)
2. BPS (1993). **Population Projection of Indonesia by Provinces 1990-2025**. Central Bureau of Statistics of Indonesia (BPS), Jakarta. (*In Indonesian*)
3. BPS (1997). **BPS Online DataBase 1997**. Central Bureau of Statistics of Indonesia (BPS), Jakarta.
4. Crammer, J. S. (1991). **An Introduction to the Logit Model for Economists**. Edward Arnold, A Division of Hodder & Stoughton, London.
5. Dahl, Dale C., and Jerome W. Hammond (1977): **Market and Price Analysis, the Agricultural Industries**. McGraw-Hill Book Co., New York.
6. Food and Agriculture Organization, FAO (1991): **AGROSTAT-PC Version 1.1: Computerized Information Series.** FAO, Rome.
7. Geo, Laode (1997): **A Study on Investment Policy for Soil & Water Conservation and Land Use Arrangement in the Upper Cimanuk Watershed, West Java**. Ph.D. Dissertation of Regional and Rural Development Planning Study Program, Bogor Agricultural University (IPB), Bogor. (*In Indonesian*)
8. Gujarati, Damodar N. (1995). **Basic Econometrics**. Third Edition. McGraw-Hill, Inc., New York.
9. Hannon, Bruce, and Matthias Ruth (1994). **Dynamic Modeling**. Springer-Verlag New York Inc., New York.
10. Hayami, Yujiro, and Vernon W. Ruttan (1987). **Agricultural Development: An International Perspective.** Revised ed., Baltimore, Maryland: The Johns Hopkins University Press.
11. Judge, G. G., W.E. Griffiths, H. Lutkepohl and T. C. Lee (1988). **Introduction to the Theory and Practice of Econometrics**. Second Edition. John Wiley, New York.

12. Mori, Shunsuke (1996): *MARIA - Multi-regional Approach for Resource and Industry Allocation model - and its First Simulations*. **In** Akihiro Amano (ed.): **Global Warming, Carbon Limitation and Economic Development.** Center for Global Environmental Research, National Institute for Environmental Studies, Environment Agency of Japan, Tsukuba.
13. Nijkamp, Peter (1986). **HandBook of Regional and Urban Economics, Vol. I: Regional Economics**. Elsevier Sci. Pub., Amsterdam.
14. Pearce, David W., and Kerry Turner (1990). **Economics of Natural Resources and The Environment**. Harvester Wheatsheaf. New York.
15. Pindyck, Robert S., and Daniel L. Rubinfeld (1991). **Econometric Models and Economic Forecasts**. McGraw-Hill, Inc. New York.
16. Puu, Tonu (1997). **Mathematical Location and Land Use Theory: An Introduction.** Springer-Verlag, Berlin.
17. Saefulhakim, R. Sunsun (1994): **A Land Availability Mapping Model for Sustainable Land Use Management**. Ph.D. Dissertation of Regional Planning Laboratory, Graduate School of Agriculture, Kyoto University, Kyoto.
18. Saefulhakim, R. Sunsun (1996): **A Study on Effectiveness of Land Use Conversion Control Policy Institutions**, Case Study of Bali, Java, and South Sumatra. Monograph of Land Resources Development Planning Laboratory, Department of Soil Sciences, Faculty of Agriculture, Bogor Agricultural University (IPB), Bogor. (*In Indonesian*)
19. Saefulhakim, R. Sunsun (1997a): *Conceptual Framework for Spatial Planning and Rural Area Development*. **Journal of Regional and Urban Planning**, Vol.8, No.1, January 1997. Center for Regional and Urban Development, Bandung Institute of Technology (ITB), Bandung
20. Saefulhakim, R. Sunsun (1997b). **Socioeconomic Aspects of an Optimal Land Use Model for the Upper Cimanuk Basin**. Inception Report, Cooperative Research Work of Research Institute of Bogor Agric. Univ. (IPB) and the World Bank. (*In Indonesian*)
21. Saefulhakim, R. Sunsun (1998). **Spatial Arrangement for Rural Areas, Agriculture Development, and Irrigation Infrastructure**. Paper presented in the National Expert Forum for Designing the Government Regulation on Rural Spatial Arrangement. Jakarta, January 21-22, 1998. The National Coordinating Agency for Spatial Arrangement (BKTRN). (*In Indonesian*)
22. Saefulhakim, R. Sunsun, Dyah R. Panuju, and Lutfi I. Nasoetion (1997): **Land Ownership/Holding, Land Consolidation, and Land Use Arrangement Policy Model for Sustainable Agribusiness Development.** Monograph of Land Resources Development Planning Laboratory, Department of Soil Sciences, Faculty of Agriculture, Bogor Agric. Univ. (IPB), Bogor. (*In Indonesian*)
23. Saefulhakim, R. Sunsun, and Lutfi I. Nasoetion (1994): **Rural Land Use Management for Economic Development.** Paper presented at the Seminar on Agricultural Land Use Management, Organized by Asian Productivity Organization (APO), Tokyo 8th-18th November 1994.
24. Saefulhakim, R. Sunsun, and Lutfi I. Nasoetion (1996): *Irrigated Paddy Land Conversion Control Policy.* **Proceeding of National Forum on Soil and Agroclimatic Research Communication.** Center for Soil and Agroclimatic Researches, Bogor. (*In Indonesian*)
25. Saefulhakim, R. Sunsun, T. Kitamura, and S. Kobayashi (1992): *Factors Affecting Rural Occupations and Land Use, A Multivariate Approach Using Correspondence Analysis*. **Indonesian Journal of Tropical Agriculture**, Vol. 4, No. 1, pp. 1-10.
26. Sapp, Stephen G., and Wendy J. Harrod (1989): *Social Acceptability and Intention to Eat Beef, An Expansion of the Fishbein-Ajzen Model Using Reference Group Theory*. **Rural Sociology**, Vol. 54, No. 3, pp. 420-438.
27. Shigemi, Kouno (1996). **World Population Projections, '94/95: Estimates and Projections with Related Demographic Statistics**. Maruzen, Co. Ltd. Tokyo. **(In Japanese)**
28. World Bank (1994). **World Population Projections, 1994-95 Edition: Estimates and Projections with Related Demographic Statistics**. World Bank, Washington DC.