AN ECONOMIC EVALUATION OF MULTIFUNCTIONAL ROLES OF AGRICULTURE DEVELOPMENT IN INDONESIA: CASE STUDY AT CITARUM WATERSHED, WEST JAVA

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ABSTRAK

Sektor pertanian dalam arti luas tidak hanya merupakan kegiatan produksi dan kemudian menjual suatu produk, pertanian juga menghasilkan diinginkan dan tidak diinginkan hasil sampingan atau positif dan negatif eksternalitas. Hasil sampingan atau eksternalitas negatif, misalnya bisa dalam bentuk residu pestisida yang turut hanyut dalam aliran permukaan, erosi tanah dan lainnya yang telah menjadi topik penelitian sejak lama. Sedangkan eksternalitas positif yang disediakan oleh sektor pertanian hanya akhir-akhir ini menjadi sasaran penelitian terutama dalam analisa ekonomi. Penelitian ini dimaksudkan untuk mengevaluasi dan secara ekonomi menilai multi-fungsi pembangunan pertanian di Indonesia dengan mengambil kasus DAS Citarum. Penelitian ini dilaksanakan di tiga wilayah DAS Citarum yaitu bagian hulu di Kabupaten Bandung, wilayah tengah di Kabupaten Cianjur dan bagian hilir di Kabupaten Karawang, Jawa Barat. Metode Pengganti Biaya (Repalcement Cost Method, RCM) telah digunakan untuk mengestimasi nilai moneter dari multi-fungsi pertanian di tiga wilayah DAS Citarum tersebut. Hasil penelitian menunjukkan bahwa total nilai ekonomi dari sembilan komponen RCM yang dihitung adalah sekitar USD 3,98 M/th. Nilai tersebut tersebar di wilayah hulu, tengah dan hilir masing-masing sekitar USD 1,67 M/th, USD 2,28 M/th dan USD 2,73 M/th.

Kata Kunci: Evaluasi Ekonomi, Peranan Banyak Fungsi, Pembangunan Pertanian

INTRODUCTION

One my trapped into too narrow focus on agriculture because it is not just the production and sale of commodities. Agriculture also produces many intended and unintended positive and negative by-products, or externalities, that are not accounted for in markets. Farm producers do not bear all the cost associated with agricultural production, such as soil erosion, water depletion, surface and groundwater pollution, deforestation, loss of wildlife habitat, and chemical misuse and contamination.

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On the other hand, they do not reap all the benefits of recreational amenities, open space, and dam as flood control as well as for irrigation that my produced.It is also possible to overlook the fundamental changes that were required for the effective adoption of the new technology in a large nation such as Indonesia. Some of positive externalities, such as maintenance of open space as well as reforestation of upstream area are tangible while others, such as symbolic value of preserving the farming heritage, are more abstract. Many of the externalities have characteristic of public goods, they are non-rival and at least partially non-excludable. Without government intervention, rural disseminates may be over provided and rural amenities under provided.

Agricultural development in Indonesia is believed has multi-functional to the benefit of people engage in this sector. However it also has multi-externalities either positive or negative impact to the social, economy, biophysical, as well as environment safety. Luck of positive externalities understanding of agricultural development has lead to the large conversion of highly productive land such as paddy land to non-agricultural purpose. This, in turn create serious challenge to the food security and to other related aspect such as: unemployment, environment, social unrest etc. On the other hand, various studies related to the negative impact of modern agriculture have been carried out. Nevertheless, the results of these studies in fact are very importance as a basis to develop more environmentally friendly agriculture.

Agriculture and rural areas play a variety of roles. These include flood prevention, the conservation of water resources, landslide prevention, and the preservation of recreational amenities. Although governments will need further discussion on a number of issues regarding how to maintain these multiple functions, it is clear that they should be incorporated into the administrative framework.

In general, multifunctional roles are created by external economies of agriculture and rural areas. In other words, these multifunctional roles have the characteristics of by-products from agricultural production. Moreover, these functions have the characteristic of a public good, i.e. everyone uses them without excluding any person who does not pay. Therefore, the beneficiaries of these functions pay little attention to the farmers who provide them.

Since multifunctional roles are formed by external economies and have the characteristics of public goods, if the supply of these functions depends on the market mechanism, efficient resource allocation will be hindered due to "market failure". As a result, these functions will not be supplied as and when they are needed.

Objective

The research objective is to provide policy-makers with specific insights, tools and information with which to analyze the various role of agriculture within their societies and from which to make informal policy decisions in pursuit of sustainable agriculture and rural development in Indonesia.

Expected Outputs

1. A methodology for identification, qualification and analysis of the roles of agriculture, and the analysis of related policy options;
2. Case study-based analytical finding on the roles of agriculture in Indonesia;
3. A synthesis of major findings on the roles and their policy implications, including how their importance and the policy actions.

RESEARCH METHODOLOGY

Theoretical Framework

Various classification of economic value of agricultural land but in general this value can be divided into two groups such as: (1) *user values* or often called as *personal use values*. These values can be produced through actual exploitation of land and its products then grouped into two classifications that is *direct use values* and *ecological function values*. Direct use values consisted of two groups according to output that can be marketed (*marketed output*) such as crops yield, livestock, woods and output that cannot be marketed or *unpriced benefits*. (2) *Intrinsic values,* which is computed as a proxy of benefit that is obtained from non-exploitation or actual benefit. For example, sustaining crops species that can be used as medical crops for diseases that may occur in the future. At present these crops may have no economic value but in the future could be very useful for the benefit of human being. Replacement Cost Method (RCM) will be exercised to analyze the environmental role of agriculture development in Indonesia, especially Citarum river basin case study.

In RCM, goods and services traded on the market are substituted for the functions to be valued. The functions are then evaluated according to the market prices of these goods and services. This method has two advantages. Firstly, it is possible to evaluate each function separately, and secondly, the evaluation is easy to understand, since goods and services are used instead of functions (Nishizawa and Yoshida 2001).

In 1972, the Forestry Agency of Japan first introduced this method in order to evaluate the multifunctional roles of forestry. Since then, this method has been applied mainly to the multifunctional roles of paddy fields. In RCM, it is assumed that differences in amenities in residential areas are reflected in land prices and wages (Nishizawa and Yoshida 1991). The description of RCM is mostly following the experience of Nishizawa and Yoshida 2001. They have successfully exercised this method to estimate the monetary value of the multifunctional roles of agriculture and rural areas particularly at hilly and mountainous areas in Japan.

Location

Primary data related to *marketed output* were collected at 12 villages, which is consisted of four villages belong to upstream area of Citarum in Bandung District, two villages in Purwakarta District and four villages at Cianjur District that belong to at middle stream, and two villages at down stream area, which is located in Karawang District. Two villages are selected from each area, which are differentiated according to the most dominant type of irrigation system, main commodities, and natural resource damage due to floods, drought or landslide.

Respondents were purposively selected for various level of region such as province, district, sub-district as well as village level. Respondents are divided into groups that is (1) policy makers at provincial, district, and sub-district level, and village leader; and (2) farmer groups, farmer and young people at villages. Not less than 25 farmers are purposively selected in each village. Interview is conducted following focus group discussion (FGD) using semi-structural questionnaire.

Secondary data were also collected in this study that include: (1) value of public investment such construction of Dam and system to control landslide, erosion, flood and construction of irrigation facilities; (2) number of agro-tourist, irrigated land, rice and secondary crops production, damage due to natural disaster, solid and liquid waste, organic and non-organic waste etc; and (3) technical parameter of land as a result of research such as rate of erosion, sedimentation, absorption of SO_2 and NO_2 by agricultural land and other related information. Secondary data are collected from *Perum Jasa Tirta I*, Provincial Agency for Development Planning (Bappedda), Provincial Agricultural Office, Office of Public Work and Irrigation, National Land Agency (BPN), Provincial Office of Central Bureau of Statistic (BPS), Office of Social Affair, Office of Human Settlement and Regional Infrastructure, Office of Tourism, Office of Environmental Sustainability, Central Research Institute for Soil and Agro climate and University.

Data Analysis

The application of RCM on the other hand, basically the replacement cost is predicted through the contribution of agricultural land with respect to the expected environmental services. All related values of multi functional role of agriculture will be converted to US$, which is equal to Rp 8,800 per $1.0 according to exchange rate in February 2003. In this study, the analysis is conducted for three areas of Citarum river basin such as upstream, middle stream, and down stream. The total area covered at each area is drown from various references such as: (1) Center Research and Development for Soil and Agro climate in Bogor, (2) Provincial Office of Public Work and Irrigation in

Bandung, (3) National Land Agency, (4) West Java Assessment Institute for Agricultural Technology in Bandung. Those data, which are not available during the study especially air pollution is then calculated as a proportion of each area of Citarum river basin in accordance with those maps mentioned above.

In the computation value of each component of RCM, data on investment such as: (1) budget for construction of prevention and control Dam and its network system to control erosion, landslide, and flood was not; and (2) budget for construction of rice filed, terracing, and other public investment, which is not funded by *Perum Jasa Tirta I* is not included in the calculation. The amount of this investment maybe substantially big but it needs special effort to collect this data. Therefore, this constraint will become one of the limitations of this study.

a. Function of Flood Prevention

Due to effect of gravitation rainwater at *catchments area* will flow to downstream through the river. During heavy rainy season (October – February) the excessive rainfall water use to cause flood at downstream area of Citarum. To reduce the opportunity of flood at this area, and then need to constructed flood control dam so that water retention could minimize it's occurred. However, the investment cost for this purpose is expensive, but water detention at paddy field or other agricultural land could reduce the cost.

Paddy fields surrounded by ridges temporarily store water at times of heavy rain, and discharge it gradually into downstream rivers and surrounding areas. In this way, they prevent or mitigate the damage, which might otherwise be caused by floods. Upland fields, on the other hand, store rainwater temporarily in porous soil formed by cultivation, preventing sudden run-off and helping to prevent flooding. This role played by agricultural land is called the water retention function. Evaluation of the water retention capacity of paddy fields (except for those in low-lying flatlands) and the temporary water retention capacity of paddy fields in low-lying flatlands (near buildings which benefit from the drainage they provide) is based on the cost of constructing a dam, which would fulfill the same function of water control.

Therefore, *water retention capacity* of agricultural land to control flood can be calculated based on depreciation cost and maintenance cost of Dam that control water supply. Thus, the economic value of paddy field in its function to control flood can be estimated using the following equation.

$$NPB = A_1 \text{ x } (B+C) + A_2 \text{ x } (B + C) \quad (7)$$

where

NPB = value of flood control function of paddy filed ($/ha/year)

A_1 = Effective water retention capacity of non-paddy field land (m3)

A_2 = Effective water retention capacity of paddy filed land (m3)

B = Depreciation cost of Dam for volume of water retention ($\$/m^3$)

C = Maintenance cost of Dam volume of water retention ($\$/m^3$)

b. Function of Water Retention

Water drawn from rivers to irrigate paddy fields penetrates into the soil, and eventually drains away and returns to the rivers. Some of this water contributes to the stabilization of flow regimes, while some of the rest penetrates deep into the ground and becomes part of the groundwater reserves. The soil of paddy fields and similar areas also absorbs rainwater at times when they are not being irrigated. This reusable water in the soil and subsoil is evaluated as the function of conserving the water resources of fields used for paddy and crop fields.

The economic value of its capacity to maintain water flow stability and re-use for irrigated water and flow back to the river can be calculated using an approach, which is based on yearly depreciation cost, maintenance cost of irrigated Dam, and volume of ground water supply from paddy filed can be calculated based on the differentiation of price of ground water and surface water (Government own Drinking Water Firm). The economic value of agricultural land especially paddy filed for water retention is then calculated using the following equation.

$$NKS = A \times (B+C) + [D_1 \times (E + F_1) \times G_1] \quad (8)$$

where

NKS = value of water retention at paddy filed ($/ha/year)

A = water flow for paddy filed (m^3/s)

B = depreciation cost of irrigated Dam ($\$/m^3/s$)

C = maintenance cost of irrigated Dam ($\$/m^3/s$)

D = Volume external ground water that in use (m^3)

E = irrigated water retention capacity of paddy filed ($m^{3)}$

F1 = rainfall water retention capacity of paddy filed ($m^{3)}$

G_1 = price differentiation between ground and surface water ($/m3)

c. Function of Prevention of Soils Erosion

In the process of crop cultivation, levees are repaired and organic materials are added to the soil. This leads to an increase in the bulk density of soil, while the ground surface is gradually smoothed and flattened. Both these effects reduce loss of soil by water and wind erosion. However, if cultivated fields are abandoned and left fallow, soil is likely to be lost. In other words, soil erosion can be prevented by the cultivation of farmland.

The volume of soil conserved (i.e. the difference in the volume of soil lost from cultivated farmland and the volume of soil lost from abandoned farmland) is estimated, and given a monetary value based on the cost, which would be incurred by constructing a dam to filter and retain sediments.

Rain water heat the ground and flows from upstream down to the down stream area and finally to the sea. The rain water flows in two ways such as run off water and ground water. Run off water mostly caused erosion that flows away surface soil, witch is usually fertile soil. The volume of this soil erosion is determined by level of run off, slope, and vegetation in there. Erosion processes some times also caused flood due to heavy sedimentation at the river. To minimize this process therefore, there should be constructed erosion control network and removal as much as possible sedimentation at down stream area. In fact, paddy filed with terracing system at sloppy area is plies significant role to reduce erosion. Therefore, the economic value of paddy filed in its roles to lessen erosion can be approached using its capacity in this role. The value can be calculated based on the following equation.

$$NPER = (A1 - A2)*SDR*(B+C)*LS \quad (9)$$

where

NPER	=	paddy field economic value to lessen erosion ($/ha/year)
A1	=	Estimated erosion rate of non paddy field land (m3/ha/year)
A2	=	Estimated erosion rate of paddy field land (m3/ha/year)
SDR	=	Sediment Delivery Rate
B	=	Depreciation cost of Dam per volume of sediment ($/m^3/year)
C	=	Maintenance cost of Dam per volume of sediment ($/m^3/year)
LS	=	paddy filed area (ha)

d. Function of Landslide Prevention

In the process of rice cultivation, paddy fields form shallow plates filled with water. Irrigation water constantly permeates into the soil, thereby maintaining a steady level of groundwater. However, if paddy fields are abandoned, the ground will crack, and the capacity to maintain a steady groundwater level will be reduced. As a result, the groundwater level may rise sharply at times of heavy rain, leading to landslides. Small-scale landslides on abandoned paddy fields tend to be overlooked, so that sequential large-scale landslides become more likely. Thus, landslides can be prevented through the continuous cultivation of paddy fields.

Construction of paddy field, which is designed either level or terracing with permanent boundary is believed has capacity to avoid or at least minimize landslide. The estimated value of landslide that can be reduced by growing various crops at paddy field is calculated according to average benefit and lost. The economic value of paddy field in controlling landslide is calculated by the following equation.

$$NPTL = (A1 - A2) * B \qquad (10)$$

where

NPTL	=	Value of landslide control by paddy field ($/ha/year)
A1	=	Number of landslide occurrence at non-paddy filed land
A2	=	Number of landslide occurrence at paddy filed land
B	=	Average lost in each landslide occurrence ($/year)

e. Function of Waste Disposal

Daily activities of households always produce unwanted product like waste that could pollute environment and air. Similarly, industry and livestock rising also pollute air with its bed smell and produce by-products that contaminated the environment. Microorganisms in cultivated soil use organic materials as a food source, and eventually reduce them to their mineral form, which can be directly used by plants. Organic wastes such as food residues and human wastes can thus be returned to fields as compost. This differs from disposing of wastes as landfill. Organic materials returned to the fields are recycled and used by crops as part of the global circulation of materials. Thus, cultivated farmland receives organic wastes, thereby reducing final disposal costs.

To minimize this pollution to the environment and air, is then needed a process of waste disposal so that it can be useful for human being. For example, this polluted waste can be processed to yield organic fertilizer or recycling to have new product that useful for daily households' activities. However, this effort need cost process by-product to produce mainly organic fertilizer such as manure and compost.

Assume that price of compost and manure is a proxy of cost need to process waste then the roles of paddy field to reduce environmental pollution can be approached using value of manure and compost used is paddy field farming. On the other hand, effort to prevent the conversion of agricultural land of non-agricultural purposes is accounted could reduce waste pressure to the environment. Therefore, the economic value of agricultural land can be estimated according to waste disposal and control of solid waste pollution to the environment using the following equation.

$$NWD = (A \times B \times C) + (C \times D \times E) \tag{11}$$

where

NWD = Value of Waste Disposal ($/ha/year)

A = Volume of organic fertilizer applied at paddy field (ton/ha)

B = Price of Organic fertilizer, which is estimated based on cost of processing ($/ton)

C = Area of paddy field (ha); Assumed that paddy filed is not producing by-product that polluted the environment, or it produce zero waste.

D = Volume of waste that produced by non-paddy field land (ton/ha)

E = Processing cost of non-paddy filed land use ($/ton)

f. Air Pollution Reduction

Daily industry activities and automotive movement produce wasted gas that any time can cause air pollution. In order to reduce this type of air pollution, then some amount is needed to carry out a certain process to remove or at least lessen each component of wasted waste that can affect human health. Gases such as SO_2 and NO_2 are the main two types of gases that can be absorbed by paddy crops. This crop can absorb SO_2 and NO_2 at a volume of about 9.67 kg/ha and 13.64 kg/ha per year (Yoshida, 2001). These two types of gas approximately weighing about 10% for each unit of active carbon (Irawan, 2002). Therefore, if price of active carbon is known then value of paddy field to control air pollution caused by SO_2 and NO_2 can be estimated through this following equation.

$$NPU = (Volgas/0.10 \times HAR)/LS \tag{12}$$

where

NPU = the economic value of paddy filed in controlling air pollution due to wasted gas ($/ha/year)

Volgas = volume of wasted gas that is absorbed by paddy filed (ton)

Total Volgas = (9.67 + 13.64) kg/ha/year x LS

HAR = price of active carbon (Rp/ton)

LS = Area of paddy filed land (ha)

g. Rural Amenities for Recreation and Relaxation

Paddy field with terracing system and green crops growing along the year provide beautiful views to all visitor or newcomer to the rural area. Most of visitors that are coming to the rural area mainly to enjoy the natural and inartificial view of agricultural land. Therefore, the roles of paddy filed to provide *rural amenities for recreation and relaxation,* could not be directly measure and marketed. However, the economic value of paddy field for this function can be approached using the following amenities equation.

$$NRA = (A \times B \times C \times D) + (E \times F \times G \times H) \tag{13}$$

where

NRA = Economic value of rural amenities ($/ha/year)

A = Total tourist that need recreation (person/year)

B = Proportion of tourist that come to the rural area (%)

C = Correction coefficient of proportion of tourist to use agriculture as their object for recreation (%)

D = Expenses of visitor ($/person/year)

E = Total number of people going to the rural area (person/year)

F = Proportion of people come back to the village at rural area (%)

G = Proportion of people come back to the village at rural area due to agricultural reasoning (%)

H = Expenses to go back to the village at rural area ($/person/year).

h. Reducing Urbanization

Process of urbanization is migration of rural people to the urban area historically always created various social problems in their new homeland. The migration process is generally influenced by *full-factor* such as higher wage rate at urban area and *push-factor* like limited job opportunity at rural area. If agricultural land at rural area continuously decline due to population pressure then job opportunity will be more and more limited and unemployment increases. Therefore, need special effort to protect agricultural and reduce the speed of land conversion for non-agricultural purposes. The existence of agricultural land at rural area on the other hand, could reduce number of rural people migrate to urban area. In other words, it could provide more job opportunity at rural area however, varied according to land quality, type of crops grown by farmer. Therefore, the economic value of agricultural land to lessen social problems due to urbanization can be approached using the following equation.

$$NURB=(LPxNTK) \quad (14)$$

Where

NURB = value of reducing urbanization process ($/ha/year)

LP = area of paddy filed land (ha)

NTK = value of agricultural worker absorption ($/ha/year)

i. Estimated Economic value of Marketed Product

Farmer grows various crops at agricultural land such as paddy, secondary crops, vegetable, and fruit. Economic value of agricultural land is approached using average yield per hectare multiply by its respective price and harvested area, which can be written as the following equation.

$$NMP_i = \sum_{1}^{n} (P \times Q) * LP \quad (15)$$

i = 1, 2, 3…….,n = type of crop grown

where

NMP = economic value of marketed products ($/ha/year)

P = price of each product ($/ton)

Q = Productivity (yield/ha) of each crop (ton/ha)

LP = harvested area (ha).

RESULTS AND DISCUSSION

Area of Citarum river basin is accounted for about 748,460 ha, which is consisted of 257,586 ha belong to upstream; 415,689 ha represents middle upstream and about 456,995 ha at down stream area (Table 1). Total area of human settlement and industrial zone is ranging from 5.99% to 9.56% of the total area of Citarum river basin. Meanwhile, mixed crops farm land and human settlement is accounted between 16.48 % and 26.98%, and agricultural land dominated the area of Citarum, which is between 67% and 73%. Furthermore, rice field is about 26% of the total area of Citarum, therefore, agricultural land non-rice field is then counted about 40% which include mixed crops farm land, tea plantation, rubber plantation, dry land, forest, dam and mangrove.

Three big Dams have been constructed at Citarum river basin that can store water for drinking water, flood and erosion, water energy electric. These dams are: (1) Saguling at upstream area, (2) Cirata at middle stream and (3) Jatiluhur at down stream area of Citarum. Data on investment cost, storing capacity, developed water flow, depreciation cost, annual maintenance cost and external ground water use of these three Dams are summarized in Table 2.

Jatiluhur Dam is the biggest water catchments Dam in West Java with investment cost about USD 0.94 billion. Two other Dams such as Saguling and Cirata are relatively small with investment cost about USD 0.19 billion and USD 0.25 billion. However, although Saguling is the smallest Dam but it depreciation cost is the highest that reach about USD 3.82 million/year. On the other hand, maintenance cost of Jatiluhur Dam is recorded the highest that is about USD 16.72 million/year. These three Dams are the main supplier of irrigated water for rice farming in West Java, but it also become water based agro-tourism destination in this province. Water electric powers also a part of the function of these Dams to supply Java and Bali. Therefore, sustaining land resources especially at upstream and middle stream to remain vegetated should enhance multi-functionality of these Dams.

Table 1. Area of Citarum River Basin According to Land Use 2001 (ha).

No.	Land use	Up Stream	Middle Stream	Down Stream	Citarum
1	Irrigated land with slope≤ 8%	49,145 (19.08)	71,219 (17.13)	74,101 (16.21)	142,467 (19.08)
2	Irrigated land with slope> 8%	27,033 (10.49)	44,955 (10.81)	47,739 (10.45)	57,518 (7.68)
3	Tea plantation	7,807 (3.03)	10,790 (2.60)	10,790 (2.36)	10,971 (1.47)
4	Rubber plantation	0 (0)	1,608 (0.39)	3,037 (0.66)	7,767 (1.04)
5	Dry land	41,868 (16.25)	68,827 (16.56)	69,010 (15.10)	116,753 (15.60)
6	Mixed crops land	42,453 (16.48)	96,287 (23.16)	111,427 (24.38)	201,898 (26.98)
7	Human settlement & industrial zone	24,633 (9.56)	27,092 (6.52)	27,355 (5.99)	46,159 (6.17)
8	Bush and idle land	1,544 (0.60)	19,349 (4.65)	29,374 (6.43)	52,571 (7.02)
9	Forest	58,522 (22.72)	62,177 (14.72)	63,358 (13.86)	68,655 (9.17)
10	Conserve forest	0 (0)	3,448 (0.88)	3,448 (0.75)	5,445 (0.73)
11	Dam	4,581 (1.78)	9,937 (2.39)	17,356 (3.80)	17,356 (2.32)
12	Mangrove	0 (0)	0 (0)	0 (0)	20,900 (2.79)
	Total	257,586 (100)	415,689 (100)	456,995 (100)	748,460 (100)

Source: Central Research Institute for Soil and Agro climate (2001).

Table 2. Investment Cost and External Ground Water Use at Three Dam at Citarum River Basin, West Java 2003.

No	Item	Saguling	Cirata	Jatiluhur
1	Investment cost of Dam construction (USD)	191,112,669	250,423,497	935,596,371
2	Life Time Dam (Year)	50	90	270
3	Depreciation Cost of Dam (USD/Year)	3,822,253	2,782,483	3,465,172
4	Life Storing Capacity (Water/Sediment) (M3/Year)	15,650,000	34,507,984	76,451,149
5	Annual Maintenance Cost Of Dam (USD/Year)	1,500,000	1,420,454	16,719,144
6	Developed Water Flow of Paddy Field (m3/s)	81	101	195
7	Depreciation Cost of Water of an Irrigating Dam Per Developed Water Flow (USD/m3/s)	47,188	27,549	17,770
8	Annual Maintenance Cost of the Dam Per Developed Water Flow (USD/m3/s)	17,873	13,574.	82,753

9	Volume External Ground Water Utilized (m3)	319.87	217.67	230.31

Source: Perum Jasa Tirta II (2002) and PT. Pembangkitan Jawa dan Bali (2002), analyzed.

a. Function of Flood Prevention

Due to effect of gravitation rainfall at *catchments area* will flow to downstream through the river. During heavy rainy season (October – February) the excessive rainfall water use to cause flood at downstream area of Citarum. To reduce flood at this area, is then needed construction of flood control dam so that water retention could minimize it's occurred. However, the investment cost for this purpose is expensive, but water detention at paddy field or other agricultural land could reduce the cost. The economic value of agricultural land resource at Citarum river basin is presented in Table 3. This table shows that the economic value of such land is accounted for about USD 83 million at upstream, USD 47 million at middle stream and USD 116 million at downstream area. In average based on these three areas of Citarum, the economic value of land is about USD 83 million.

Table 3. Estimated Economic Value of Aricultural Lnd in Its Role as Flood Prevention at Citarum River Basin, West Java (2003).

No	Item	Up Stream	Middle Stream	Down Stream	Citarum
1	Non-paddy field area (Ha)	175,370.00	299,695.00	335,334.00	1,233,368.00
2	Paddy field area (Ha)				
	a. Under 8 %	48,312.00	71,219.00	74,101.00	176,559.00
	b. Up 8 %	32,607.00	54,134.00	57,667.00	69,361.00
	Total	80,919.00	125,353.00	131,768.00	245,920.00
3	Water retention capacity of non-paddy field area	0.096	0.094	0.094	0.095
4	Water retention capacity of paddy field[1]				
	a. Under 8 %	0.095	0.095	0.095	0.095
	b. Up 8 %	0.093	0.093	0.093	0.093
	Average of water retention capacity of Paddy field	0.094	0.094	0.094	0.094
5	Depreciation cost of Dam[2] (USD/Year)	3,822,253.38	2,782,483.30	3,465,171.74	3,356,636.14
6	Annual maintenance cost Of Dam[2] (USD/Year)	1,500,000.00	1,420,454.55	16,719,144.08	6,546,532.88
7	Life storing capacity[2] (m3/Year)	15,650,000.00	34,507,984.00	76,451,149.00	42,203,044.33
8	Effective water retention capacity of non-paddy field (m3/Year)	168,355,200.00	281,713,300.00	315,213,960.00	255,094,153.33
9	Effective water retention capacity of paddy field (m3/Year)	76,063,860.00	117,831,820.00	123,861,920.00	105,919,200.00
10	Depreciation cost of water control Dam per volume of water stored (USD/m3)	0.244	0.081	0.045	0.123
11	Annual maintenance cost Of water control Dam per volume of water stored (USD/m3)	0.096	0.041	0.219	0.119
12	Value of flood control of non- paddy field (USD/Year)	57,254,251.26	34,311,581.06	83,221,484.62	58,262,438.980
13	Value of flood control of paddy field (USD/Year)	25,867,804.22	14,351,456.05	32,701,511.29	24,306,923.850
14	Total value (USD/Year)	83,122,055.48	48,663,037.11	115,922,995.91	82,569,362.830

Note: 1. Adopted from Fahmudin et.al (2002); 2. Data consisted of 3 big Dams such as: Saguling, Cirata and Jatiluhur. Other data such as investment on paddy field, terracing and its network for preventing and controlling flood. Exchange rate 1 USD = Rp. 8800.

b. Function of Water Retention

Paddy field also has capacity as a water retention field for a certain volume of water. The economic value of its capacity to maintain water flow stability and reuse for irrigated water and flow back to the river can be calculated using an approach, which is based on yearly depreciation cost, maintenance cost of irrigated Dam, and volume of ground water supply from paddy field can be calculated based on the differentiation of price of ground water and surface water.

Similar to a Dam, paddy field also has water retention capacity. Its economic value of this function can be calculated using equation 2 and the result is presented in Table 4. The economic value of paddy field at upstream of Citarum is accounted for about USD 5.27 million/year, USD 4.15 million/year at middle stream, and USD 19.6 million/year at down stream. Meanwhile, overall average of economic value of this paddy field is about USD 26 million/year.

Table 4. Estimated Economic Value of Agricultural Land in Its Function as Water Retention at Citarum River Basin, West Java 2003.

No.	Item	Up Stream	Middle Stream	Down Stream	Citarum
1	Developed Water Flow of Paddy Field (m3/s)	81	101	195	377
2	Depreciation Cost of Water of an Irrigating Dam Per Developed Water Flow (USD/m3/s)	47,188.31	27,549.34	17,770.11	30,835.92
3	Annual Maintenance Cost of the Dam Per Developed Water Flow (USD/m3/s)	17,873.65	13,574.16	82,753.49	38,067.10
4	Volume External Ground Water Utilized (m3)	319.87	217.67	230.31	255.95
5	Rate of Fostering Ground Water Supply from Paddy Field Irrigation	0.091	0.091	0.091	0.091
6	Rate of Fostering Ground Water Supply from Rain Water On Paddy Field	0.094	0.094	0.094	0.094
7	Difference Price of tap water and ground Water (USD)	0.085	0.073	0.078	0.079
8	Value (USD)	5,270,026.27	4,153,477.57	19,602,107.69	25,976,444.02

Exchange rate: 1 USD = Rp. 8800.00

This finding indicates that if conversion of fertile paddy field land to non-agricultural uses could not be controlled then people will lost about USD 26 million per year. This implies that there must me a special effort to maintain paddy field land in it roles as water retention function to avoid further bigger economic lost and environmental degradation.

c. Function of Soil Erosion Prevention

Rainfall water heat the ground and flows from upstream down to the down stream area and finally to the sea. The rainfall water flows in two ways such as run off water and ground water. Run off water mostly caused erosion that flows away surface soil, witch is usually fertile soil. The volume of this soil erosion is determined by level of run off, slope, and vegetation in there. Erosion processes some times also caused flood due to heavy sedimentation at the river. To minimize this process therefore, there should be constructed erosion control network and removal as much as possible sedimentation at down stream area. In fact, paddy field with terracing system at sloppy area is plies significant role to reduce erosion.

Terracing system paddy field both at upstream, middle, and down stream has capacity to lessen erosion. The result of analysis is presented in Table 5. The result shows that the economic value of paddy field capacity to lessen erosion is accounted about USD 6.5 million/year at upstream, and about USD 2.0 million/year at middle and down stream area respectively. In aggregate, this value for all paddy field at Citarum river basin reach not less than USD 6.59 million/year.

Table 5. Estimated Economic Value of Agricultural Land in Its Function to Lessen Erosion at Citarum River Basin, West Java 2003.

No	Item	Up Stream	Middle Stream	Down Stream	Citarum
1	Non-paddy field area (ha)	175,370.00	299,695.00	335,334.00	1,233,368.00
2	Paddy field area (ha)				
	a. Under 8 %	48,312.00	71,219.00	74,101.00	176,559.00
	b. Up 8 %	32,607.00	54,134.00	57,667.00	69,361.00
	Total	80,919.00	125,353.00	131,768.00	245,920.00
3	Estimated volume of soil erosion at non-paddy field[1] area (ton/ha/year)	54.810	19.062	11.732	21.256
4	Estimated volume of soil erosion at paddy field[1] (ton/ha/year)	1.330	1.400	1.450	1.393
5	Construction cost of Dam[2] (USD)	191,112,669.00	250,423,497.00	935,596,371.00	1,377,132,537.00
7	Life storing capacity of Dam for sediment[2] (m3/year)	15,650,000.00	34,507,984.00	76,451,149.00	126,609,133.00
8	Construction Cost per M3[2] (USD/m3)	12.21	7.26	12.24	10.88
9	Sediment delivery rate	8.06	8.06	8.06	8.06
10	Value of soil erosion control of paddy field (USD/M3)	6.64	2.19	1.28	2.46
11	Total value (USD/Year)	6,556,649.98	1,993,365.15	2,057,107.67	6,591,846.22

Note : 1. Adopted from Fahmudin et.al, 2002
2. Source of data: Perum Jasa Tirta II, West Java. Data cover three big dam such as Saguling, Cirata dan Jatiluhur.
Other data such as investment cost of paddy field construction; cost of terracing, and cost of dam construction for flood control and its network are not included in the calculation due to unavailability of data.
Exchange rate 1 USD = Rp 8,800.00.

d. Function of Landslide Prevention

The estimated value of paddy field in it roles to prevent landslide along Citarum river basin is presented in Table 6**.** Based on this estimation, the economic value of paddy field at upstream area is about USD 1,049.62/ha/year, USD 377.28/ha/year at middle stream and about USD 434.21/ha/year at downstream area. Meanwhile the overall average value is accounted about USD 656.78 /ha/year.

Table 6. Estimated Economic Value of Paddy Field Roles in Preventing Landslide at Citarum River Basin, West Java 2003.

No.	Item	Up Stream	Middle Stream	Down Stream	Citarum
1	Total Area Potential of Landslides Accident (ha)	256,289.00	425,048.00	467,102.00	748,460
2	Paddy field land (ha)				
	a. Under 8 %	48,312.00	71,219.00	74,101.00	176,559.00
	b. Up 8 %	32,607.00	54,134.00	57,667.00	69,361.00
	Total	80,919.00	125,353.00	131,768.00	245,920.00
3	Estimated Number of Potential of Landslides[1]	0.0951	0.0964	0.1017	0.0992
4	Estimated Number of Landslides of paddy field[1]	0.0236	0.0284	0.0311	0.0252
5	Cost of Losses Per Landslides[2]	17,784.09	16,534.09	14,232.95	16,183.71
6	Value of Preventing Landslides (USD/Year)	399,642,194.41	618,616,430.80	617,799,732.63	1,101,302,386.67
7	Value of Preventing Landslides (USD/Ha/Year)	4,938.79	4,935.00	4,688.54	4,478.30

Note: 1. The number is calculated based on the frequency of landslide accidents within last 10 years multiplied by ratio between area of landslide and area that potential to have landslide.
2. Data that obtained from CBS is then validated at the field level through focused group interview. Exch rate 1 USD = Rp. 8800

e. Function of Waste Disposal

Daily activities of households always produce unwanted product like waste that could pollute environment and air. Similarly, industry and livestock rising also pollute air with its bed smell and produce by-products that contaminated the environment. To minimize this pollution to the environment and air, is then needed a process of waste disposal so that it can be useful for human being. For example, this polluted waste can be processed to yield organic fertilizer or recycling to have new product that useful for daily households' activities. However, this effort need cost process by-product to produce mainly organic fertilizer such as manure and compost.

Assume that price of compost and manure is a proxy of cost need to process waste then the roles of paddy field to reduce environmental pollution can be approached using value of manure and compost used is paddy field farming. On the other hand, effort to prevent the conversion of agricultural land of non-agricultural purposes is accounted could reduce waste pressure to the environment.

The result of analysis showed that three main source of waste at Citarum river basin are: (1) livestock rising and fish processing, (2) City waste (households, market, etc), and (3) non-agricultural industry. Volume of each source is 2.0 million ton/year, 26.76 million ton/year and 5.67 million ton/year respectively. Yearly total waste at this area is accounted for about 34.47 million ton/year (Table 7).

Table 7. Average Volume of Non-Organic Solid Waste at Citarum River Basin in a Period of (1996 – 2000).

No	Source of waste	Ton/year
1	Livestock rising and fisheries processing	2,043,720.00
2	City waste	26,755,910.00
3	Non-industrial processing	5,669,650.00
	Total	34,469,280.00

Source: Bapedal and Bapedalda, West Java 1996 – 2000 (analyzed)

In order to find data on volume of organic fertilizer used at paddy field, face to face interview was carried out at 9 Sub-Districts along the Citarum river basin such as Soreang, Rajamandala, and Kertasari Sub-District in Bandung District; Cihea and Ciranjang Sub-District in District of Cianjur; Wanaraja and Jatiluhur Sub-District in Purwakarta District; and Jatisari and Tempuran Sub-District in Karawang District. Table 8 shows that volume of organic fertilizer application at paddy field, waste processing cost, and waste of activities from non-paddy field land. Average application of organic fertilizer at paddy field is still very low, that is about 1.44 ton/ha/year. Meanwhile, the processing cost of organic waste at “SM” foundation in District of Bekasi is accounted about USD 6.21 per ton.

In the case of solid non-organic waste processing cost at one of the processor interviewed in Bogor District is about USD 6.77/ton, which is mostly industrial waste recycling. Meanwhile, non-paddy field land use at Citarum river basin also produce quite big volume of waste such as home industry, city waste, market, and households’ waste. These activities yield waste about 64.11 ton/year.

Table 8. Volume of organic fertilizer applied at paddy field, processing cost of organic waste, waste of non-paddy field land, and processing cost non-organic solid waste at Citarum river basin, West Java 2003.

No.	Item	Value
A.	Organic waste	
1.	Average volume of manure and compost applied at paddy field (ton/ha/year)[1]	1.44
2.	Processing cost of organic waste to produce manure and compost (USD/ton/year)[2]	6.21
B.	Industrial, human settlement and City waste	
3.	Volume of solid waste (ton/year)[3]	34,469,280.00
4.	Ratio volume of waste to area of non-paddy field land (ton/ha/year)[4]	64.11
5.	Waste processing cost (USD/ton/year)[5]	6.77

Source:
1. Primary Data (analyzed)
2. "SM" foundation, Bekasi (analyzed)
3. Taken from Table 8
4. Volume of non-organic waste divided by area of agricultural land that use for non-paddy field such as industry, human settlement, public market, offices etc.. Paddy field is assumed not produce waste that can pollute the environment or zero waste.
5. Data collected from various waste processor in Bogor District (reformulated)

Meanwhile, Table 9 shows the economic value of paddy field in its roles in recycling organic waste as manure and organic fertilizer. In this calculation is assumed that paddy field does not produce polluted waste to the environment or zero waste farming activities.

The economic value of paddy field for this function is accounted for about USD 3.20 million/year at upstream area, USD 3.80 million/year at middle stream, and not less than USD 2.83 million/year at down stream area of Citarum river basin. In aggregate, the economic value of paddy field in reducing organic waste pollution to the environment is accounted about USD 4.11 million/year. In addition, the total economic value of organic and non-organic waste disposal that produce organic fertilizer and other products that useful for human being is about USD 700 million/year at upstream, USD 711 million/year at middle stream, and about USD 932 million at down stream with an average of about USD 991 million/year for all Citarum river basin.

f. Function of Air Pollution Reduction

Daily industry activities and automotive movement produce wasted gas that any time can cause air pollution. In order to reduce this type of air pollution, then some amount is needed to carry out a certain process to remove or at least lessen each component of wasted waste that can affect human health. Gases such as SO2 and NO2 are the main two types of gases that can be absorbed by paddy crops. This crop can absorb SO2 and NO2 at a volume of about 9.67 kg/ha and 13.64 kg/ha per year (Yoshida, 2001). These two types of gas approximately weighing about 10% for each unit of active carbon (Irawan, 2002).

Table 9. Estimated Economic Value of Agricultural Land Function in Organic Waste Disposal and Reduction of Solid Waste Environment Pollution at Citarum River Basin, West Java 2003.

No.	Item	Up Stream	Middle Stream	Down Stream	Citarum
A.	Paddy Field				
1	Paddy field land (ha)				
	a. Under 8 %	48,312.00	71,219.00	74,101.00	100,120.00
	b. Up 8 %	32,607.00	54,134.00	57,667.00	57,158.00
	Total	80,919.00	125,353.00	131,768.00	157,278.00
2	Amount of Organic fertilizer applied at paddy field ((ton/ha/year)[1]	2.10	1.68	1.20	1.44
3	Total Amount of Organic fertilizer applied at paddy field (ton/year)	169,929.90	210,593.04	158,121.60	225,693.93
4	Organic waste processing cost (USD/ton/year)[2]	18.75	17.94	17.89	18.19
5	Value of Waste Disposal (org. fertilizer) (USD/Year)	3,186,185.63	3,777,512.66	2,829,118.85	4,106,090.70
B.	Industrial waste, settlement and City waste				
1	Non-paddy field land (ha)	175,370.00	299,695.00	335,334.00	537,620.00
2	Paddy field land (ha)	80,919.00	125,353.00	131,768.00	157,278.00
3	Total amount of solid waste (ton/year)	15,297,583.01	18,006,575.23	23,430,937.22	34,469,280.00
4	Ratio of solid waste to non-paddy field land (ton/ha/year)	87.23	60.08	69.87	64.11
5	Solid waste processing cost (USD/ton/year)[3]	98.75	93.94	100.89	97.86
6	Total economic value	697,035,870.42	707,498,221.46	928,921,365.79	986,800,389.54
C.	Total value of organic and solid waste	700,222,056.05	711,275,734.12	931,750,484.65	990,906,480.24

Source : 1. Data are collected from face to face interview with farm households.
2. Data collected from “SM” Foundation in Bekasi District
3. Data taken from various non-organic waste processors in Bogor, Bandung, Purwakarta and Bekasi District and all are in West Java, 2002.

Activities of industry and automotive at Citarum river basin could produce wasted gas about 1.87 million ton of SO_2 per year and about 8.52 million ton per year of NO_2 (Table 10). The main source of SO_2 is processing industry that can produce about 1.23 million ton per year in average, while NO_2 is mainly yielded by mobile sources such as motorcycle, car, truck, bus etc. Based on equation (6) capacity of paddy field to absorb SO2 and NO2 is about 9.72 kg/ha/year and 13.64 kg/ha/year respectively.

Meanwhile survey data showed that the price of active carbon at present is about USD 137.10 per ton. Volume of polluted SO2 and NO2 is about 1.07 million ton and 3.87 million ton per year at upstream area of Citarum. Meanwhile at middle and down stream area the volume of these gas is about 1.12 and 4.04, and 1.73 and 5.48 million ton per year respectively. In aggregate, the volume of these polluted gas at Citarum is about 3.92 and 14.16 million ton per year.

The estimated economic value of paddy field in it roles to lessen air pollution due to wasted gas such as presented at Table 11 is about USD 10 million/year at upstream, about USD 15 million/year at down stream and about USD 24 million/year at downstream area and for all Citarum is counted for about of 74 million/year.

Table 10. Average Volume of Wasted Gas SO_2 and NO_2 in Period of 1996 – 2000 at Citarum River Basin, West java, 2003.

No	Source of GAS	SO_2 (ton)	NO_2 (ton)
1	Processing Industry	1.230.417,00	239.447,00
2	Moving sources	636.803,00	8.278.440,00
	Total	1.867.220,00	8.517.887,00

Source: Bapedal and Bapedalda 1996 – 2000, West Java Province.

Table 11. Estimated Economic Value of Paddy Field in Reducing Air Pollution at Citarum River Basin, West Java 2003.

No.	Item	Up Stream	Middle Stream	Down Stream	Citarum
1	Non-paddy field are (ha)	175,370.00	299,695.00	335,334.00	1,233,368.00
2	Paddy field area (ha)				
	a. Under 8 %	48,312.00	71,219.00	74,101.00	176,559.00
	b. Up 8 %	32,607.00	54,134.00	57,667.00	69,361.00
	Total	80,919.00	125,353.00	131,768.00	245,920.00
2	Volume of pollutant SO2 (Kg/Year)[1]	1,071,500,219	1,118,698,082	1,731,065,037	3,921,263,339
3	Volume of pollutant NO2 (Kg/Year)[1]	3,868,073,991	4,038,456,433	5,483,661,541	14,155,607,676
3	Absorption Capacity of paddy field for SO2 (Kg/Ha/Year)[2]	9.72	9.72	9.72	9.72
4	Absorption Capacity of paddy field for NO2 (Kg/Ha/Year)[2]	13.64	13.64	13.64	13.64
5	Price of active carbon (USD/Kg)[3]	0.25	0.21	0.30	0.26
6	Total value (USD)	10,345,058.59	14,916,637.50	23,737,582.55	73,817,282.44

Note: 1. Data based on Table 10 then distributed according to region of Citarum and in line with source of pollutant
2. Adopted from Yoshida (2001)
3. Data are collected from direct interview with distributor and trader in Bandung, Purwakarta, Cianjur and Karawang District 2003.

g. Function of Rural Amenities for Recreation and Relaxation

Paddy field with terracing system and green crops growing along the year provide beautiful views to all visitor or newcomer to the rural area. Most of visitors that are coming to the rural area mainly to enjoy the natural and inartificial view of agricultural land.

The result of interview indicates that there is a non-marketed product of paddy field that cannot be directly measured. Among other benefit are (1) object for recreation and refreshing, (2) tradition of going back to the village during holly day, (3) media for development of harmonize relation among neighbors and mutually inclusive work (*gotong royong*), (4) reduction of urbanization, (5) sustainability of local culture and tradition, (6) provide beautiful view, (7) media for education to have better understanding about environment sustainability, and (8) other multiplier effect of activities at paddy field.

From the total people come to the rural area at Citarum river basin, about 26.83% is identified as tourist and about 20.98% are related to agro-tourism. Saguling Dam is visited by about 21.52% from the total agro-tourism, while Cirata and Jatiluhur Dam is visited by about 20.% and 21.43% respectively. A total expense of tourist at each area of agro-tourism is about USD 131.67/person/year at upstream area, USD 165.56/person/year and USD 171.36/person/year consecutively. Overall an average expense of tourist at Citarum river basin is about 156.19/person/year (Table 12).

Table 12. Parameters that are Used to Analyze Data about Visitor to Come to the Rural Area at Citarum River Basin According to Catchments Area, West Java 2003.

No.	Item	Dam Catchment's Area			Citarum
		Saguling	Cirata	Jatiluhur	
1.	Percentage of tourist visited rural area (%)	24.29	27.62	28.57	26.83
2.	Percent. tourist visited rural area related to agriculture (%)	21.52	20.00	21.43	20.98
3.	Tourist expenses (USD/person/year)	131.67	165.53	171.36	156.19
4.	Total number of people going to rural area (person/year)	129.415	212.774	254.003	422.217
5.	Percent. of people going back to the village at rural area (%)	11.39	16.19	19.30	15.63
6.	Percent. of people going back to the village at rural area due to agricultural reasoning (%)	13.92	12.38	16.96	14.42
7.	Expenses for going back to the rural area (USD/person/year)	122.07	135.06	104.80	120.64

Note : USD 1 = Rp 9117.5
Source: Primary data taken from Provincial office of tourism of (analyzed)

Meanwhile, expenses of people that are going back to the rural area during the normal day is about USD 120.64/person/year in average. Expenses according to region of Citarum, cost for coming home at rural area is the highest at middle stream that is about

USD 135.06/person/year, while going to upstream and down stream is about USD122.07/perso/year and USD 104.80/person/year respectively (Table 13).

The economic value of rural amenities at upstream area was the highest among three areas of Citarum that is about USD 26.8 million per year. This is understood since the view at upstream is more interesting compared with either middle or down stream. However, the economic value of rural amenities produced by paddy field land at middle and down stream area of Citarum is accounted for about USD24.2 million/year and USD 19.4 million/year consecutively. Meanwhile, overall average of economic value at Citarum is about USD 31.6 million/year.

Table 13. Estimated Economic Value of Paddy Field Land in it Roles to Sustain Social-Cultural Value to Attract People to Have Recreation and Relaxation at Citarum River Basin, West Java 2003.

No.	Item	Up Stream	Middle Stream	Down Stream	Citarum
1	Total Number of Tourist (Person/Year)	1,135,972	1,314,191	1,316,252	1,943,370
2	Proportion of Tourist to Rural Area (%)[1]	24.29	27.62	28.57	26.83
3	Correction Coefficient of A (%)	21.52	20.00	21.43	20.98
4	Expenses per Visit Per Person (USD/Person/Year)[2]	136.42	171.50	177.55	161.82
5	Number of Home Coming People Person[3]	417,002.38	337,934.83	254,003	422,217
6	Proportion of Home Coming People to Rural Areas (%)	36.71	25.71	19.30	27.24
8	Expenses Required for Homecoming (USD/Person/Year)[4]	122.07	135.06	104.80	120.64
9	Total Value (USD/Year)	26,785,321.58	24,186,058.43	19,444,651.06	31,576,503.57

Note: 1. Percentage of tourist visited rural area related to agriculture.
2. Result of interview with tourist that visited agro-tourism area such as Saguling, Cirata dan Jatiluhur, Gunung Mas, Puncak, Cipanas and Cianjur
3. Explored from interview with rural leader, village official and secondary from rural statistic, train terminal and bus terminal.
4. Result of interview with individual that going back to the rural area during the normal day.

h. Function of Reducing Urbanization

Process of urbanization is migration of rural people to the urban area historically always created various social problems in their new homeland. The migration process is generally influenced by *full-factor* such as higher wage rate at urban area and *push-factor* like limited job opportunity at rural area. If agricultural land at rural area continuously decline due to population pressure then job opportunity will be limited and unemployment increases. The existence of agricultural land at rural area on the other hand, could reduce number of rural people migrate to urban area.

Agricultural land has proven that substantially contribute to the absorption of excessive rural labor force. At upstream area of Citarum for example, the economic value of agricultural to reduce urbanization through labor absorption is accounted about USD 369.38/ha/year. Meanwhile at middle and down stream area the value is about USD 370.06/ha/year and USD 503.68/ha/year respectively with an average of about USD 414.37/ha/year. Meanwhile, the total value of agricultural land in relation to this role is accounted about USD 94.67 million, 157.29 million, and 324.68 million at upstream, middle and down stream area consecutively for an average of 324.68 million per year (Table 14).

i. Estimated Economic value of Marketed Product

Citarum river basin covered six districts in West Java where Bandung is the largest with area about 39.6% of the total area followed by Karawang (22.39%), Cianjur (17.47%), Purwakarta (8.89%), Bekasi (6.78%) and Bogor (4,87 %). Agricultural land is the largest area of Citarum and known as the main production area of food crops and vegetable. Therefore, agriculture is the main sector in this area and one of the largest contributors to the national food production.

Table 14. Estimated Economic Value of Paddy Field Land in it Roles to Reduce Urbanization at Citarum River Basin, West Java 2003.

No.	Item	Up Stream	Middle Stream	Down Stream	Citarum
1	Non-paddy field land area (ha)	175,370.00	299,695.00	335,334.00	537,620.00
2	Paddy field land Area (ha)				
	a. Under 8 %	48,312.00	71,219.00	74,101.00	176,559.00
	b. Up 8 %	32,607.00	54,134.00	57,667.00	69,361.00
	Total	80,919.00	125,353.00	131,768.00	245,920.00
2	Economic value of labor absorption (USD/ha/year)[1]	369.38	370.06	503.68	414.37
3	Total value (USD/year)	94,666,749	157,291,910	235,270,785	324,676,420

Note : 1 Multiplication between labors needed (maydays/ha) and labor wage.
Exchange rate: 1 USD = Rp. 8800.00

Seasonal commodities grown at Citarum river basin include wetland rice, up land rice, corn, cassava, chili, tomato, carrot, cabbage, onion, potato and other vegetable crops (Table 15). Most of these commodities are gown at wetland, dry land, and upland.

Meanwhile, area, yield, and production of each commodity grown at this area are presented at Table 16.

Productivity of wetland rice at Citarum is about 5 ton/ha in average. Cropping index per year varied according to type of irrigated land, which is range between 100-200 percent per year. In average, cropping index at Citarum river basin is assumed about 150 percent per year. Meanwhile, main crops grown at dry land are upland rice, secondary crops, and vegetable. In this study, is assumed that crops are grown at monoculture type of farming. For those vegetable crops that harvest is done for many times, however, in this case is assumed only three times until the last harvest.

Mixed cropping on the other hand, the crops grown by farmer is mostly mixed between annual crops and seasonal crops. In the calculation of economic value is assumed only annual crops especially fruit that has significant market value and other crops is ignored in the computation. Data on area of fruit are not available; therefore population is used in computation of production and economic value. Using crops placement, for example 10 x 10 m, the area con be estimated.

Other assumption is 30% of the existing annual crops (fruit) are in productive age since age of plants is varied across region of Citarum. The main fruit plants at this area are banana, jumbo, guava, avocado, jackfruit and rambutan, durian, mangostein. However the highest value is given by banana, avocado, durian, mango, and mangostein (Table 16).

Estimated economic value of marketed product at agricultural land from Citarum river basin area is presented at Table 17. The total value of commodities produced from this area is about USD 378 million/year at upstream, USD 752 million/year at middle stream, and about USD 846 million/year at down stream. In aggregate, the economic value of commodities marketed from this area is not less than USD 1.49 billion/year.

j. Estimated Economic Value of Multi-functional Roles of Agricultural Land at Citarum River Basin, West Java 2003

Finally, based on economic value of environmental services and value of marketed product, the economic value of nine function of land at Citarum river basin is about 3.98 billion per year (Table 18). This economic value of land at Citarum is distributed at upstream, middle, and downstream area, which is accounted about USD 1.67 billion/year, USD 2.28 billion/year, and USD 2.73 billion/year consecutively.

Out of this total value, about 36.74% is provided by marketed products like various commodities grown by farmers in this area. Meanwhile, about 73.26% of the total value is contributed by the economic value of land in conserving the environment. In other word, without conservation and reservation of agricultural land at Citarum river basin, this region will experience economic lost not lest than USD 2.65 billion/year.

Table 15. Harvested Area, Productivity, and Production of Commodities Grown at Various Type of Land at Citarum River Basin, West Java 2003.

No.	Commodity	Up Stream			Middle Stream			Down Stream			Citarum		
		Area (ha)	Yield (t/ha)	Prod (t/ha/yr)	Area (ha)	Yield (t/ha)	Prod (t/ha/yr)	Area (ha)	Yield (t/ha)	Prod (t/ha/yr)	Area (ha)	Yield (t/ha)	Prod (t/ha/yr)
1	W.land rice	76,178	10.60	807,548	116,174	10.38	1,205,494	121,840	10.61	1,292,454	199,985	10.53	2,105,524
2	Upland rice	30,852	2.29	70,574	62,665	2.39	149,769	69,919	2.49	174,262	120,335	2.39	287,593
3	Corn	3,594	2.75	9,864	7,299	2.62	19,125	8,144	2.39	19,440	14,016	2.58	36,219
4	Cassava	4,507	14.05	63,326	9,155	14.73	134,803	10,214	14.50	148,110	17,580	14.43	253,587
5	Soybean	720	1.19	853	1,462	1.16	1,697	1,631	1.11	1,815	2,807	1.15	3,237
6	Mungbean	324	0.87	283	658	0.99	652	734	1.03	756	1,264	0.96	1,219
7	Sweet potato	1,385	0.95	1,309	2,813	4.09	11,505	3,139	1.16	3,630	5,402	2.06	11,148
8	Peanut	2,444	1.20	2,939	4,965	1.18	5,881	5,540	1.16	6,419	9,534	1.18	11,268
9	L. onion	1,989	14.19	28,219	449	11.95	5,365		-	-	2,585	9.59	24,790
10	Onion	429	10.62	4,559	872	6.30	5,496	973	6.32	6,153	1,674	7.75	12,975
11	Potato	7,502	22.39	167,990	1,693	17.56	29,729		-	-	9,753	13.93	135,852
12	Cabbage	4,357	25.89	112,797	983	17.68	17,385		-	-	5,665	15.34	86,927
13	White carrot	1,523	21.09	32,115	344	12.29	4,225		-	-	1,980	13.74	27,205
14	Mustard wht	802	55.24	44,325	181	31.85	5,769		-	-	1,043	31.34	32,699
15	Strg.bean	619	10.10	6,252	1,258	9.30	11,701	1,404	7.80	10,948	2,416	9.07	21,900
16	Carrot	2,957	18.67	55,210	667	13.51	9,018		-	-	3,844	11.81	45,394
17	Bean	1,523	15.80	24,063	344	12.64	4,346		-	-	1,980	10.61	21,010
18	Bayam	802	6.60	5,294	181	7.63	1,383		-	-	1,043	5.90	6,154
19	Cucumber	619	19.96	12,363	1,258	16.65	20,945	1,404	11.78	16,532	2,416	16.13	38,964
20	Chili	986	13.00	12,810	2,002	9.79	19,604	2,234	4.52	10,090	3,844	9.10	34,991
21	Tomato	2,287	18.34	41,958	516	14.78	7,627		-	-	2,974	12.12	36,051
22	Age plant	827	15.55	12,856	187	11.29	2,106		-	-	1,075	10.98	11,798
23	Labusiam	372	51.15	19,054	84	33.04	2,778		-	-	484	29.62	14,345
24	Kangkong	817	10.86	8,880	184	9.79	1,805		-	-	1,063	9.86	10,480
25	Garlic		-	-	28	7.38	206	31	8.75	272	54	8.06	432
26	Red bean	494	10.40	5,138	1,003	6.09	6,105		-	-	1,926	5.50	10,588

Source: Sub-District Statistics at Each Region of Citarum (1999 – 2001) (Analyzed)

Table 16. Area, Productivity, Production of Commodities at Mixed Farming at Citarum River Basin, West Java 2003.

No	Commodity	Up Stream			Middle Stream			Down Stream			Citarum		
		Area (ha)	Yield (t/ha)	Prod (t/ha/yr)	Area (ha)	Yield (t/ha)	Prod (t/ha/yr)	Area (ha)	Yield (t/ha)	Prod (t/ha/yr)	Area (ha)	Yield (t/ha)	Prod (t/ha/yr)
1	Avocado	526.19	34.97	18,401	1,193.43	43.11	51,449	276.22	28.75	7,941	2,502.43	35.61	89,112
2	Orange	207.50	45.61	9,464	470.64	48.97	23,047	544.64	47.67	25,963	986.85	47.42	46,793
3	Durian	422.38	82.45	34,825	390.97	86.73	33,909	102.45	83.78	8,583	819.80	84.32	69,126
4	Duku	61.66	47.31	2,917	139.85	46.83	6,549	161.84	45.32	7,334	293.23	46.49	13,631
5	Guava	9,366.31	12.32	115,393	21,243.58	11.95	253,861	24,583.89	13.42	329,916	44,544.30	12.56	559,625
6	Mango	259.82	45.67	11,866	589.29	59.71	35,186	681.95	66.53	45,370	1,235.64	57.30	70,806
7	Pineapple	734.15	13.14	9,647	1,665.12	11.22	18,683	1,926.94	13.56	26,129	3,491.48	12.64	44,132
8	Papaya	1,899.11	18.78	35,665	4,307.33	20.23	87,137	4,984.61	19.71	98,247	9,031.77	19.57	176,782
9	Banana	27,856.82	17.21	479,416	63,181.62	18.92	1,195,396	73,116.19	19.22	1,405,293	132,481.47	18.45	2,444,283
10	Rambutan	372.14	39.82	14,818	844.03	40.18	33,913	976.75	42.22	41,238	1,769.80	40.74	72,102
11	Snake fruit	11.31	118.76	1,343	25.65	119.38	3,062	29.68	113.33	3,364	53.79	117.16	6,301
12	Sawo	67.79	32.08	2,175	153.76	36.72	5,646	177.93	40.21	7,155	322.41	36.34	11,715
13	Sirsak	205.98	69.89	14,396	467.17	72.89	34,052	540.63	71.05	38,412	979.58	71.28	69,821
14	Belimbing	126.84	30.31	3,844	287.68	36.18	10,408	332.91	29.06	9,674	603.22	31.85	19,212
15	Mangostein	83.32	109.12	9,092	188.98	135.21	25,552	218.70	125.66	27,481	396.26	123.33	48,871
16	Jackfruit	492.04	41.62	20,479	1,115.99	38.95	43,468	1,291.47	42.32	54,655	2,340.05	40.96	95,856
17	Sukun	9.45	73.31	693	21.43	69.82	1,496	24.80	71.22	1,766	44.94	71.45	3,211

Source: Sub-District Statistic at each region of Citarum (1999 – 2001) (analyzed)

Table 17. Economic Value of Marketed Product at Citarum River Basin, West Java 2003.

No.	Commodities	Upstream	Middle Stream	Down Stream	Citarum
1	Paddy field land (< 8%)	77,369,867	112,121,367	116,658,552	224,288,388
2	Paddy field land (> 8%)	35,465,453	58,977,895	62,630,313	75,459,694
3	Tea plantation land	4,891,310	6,760,245	6,760,245	6,873,646
4	Rubber plantation land	0	30,676	57,938	148,174
5	Dry land	73,954,001	150,211,185	167,600,903	288,449,904
6	Mixed crops land	186,437,658	422,856,401	489,345,604	886,660,313
7	Fresh water fish land	299,847	650,422	2,556,065	5,634,065
	Total	378,418,136	751,608,190	845,609,620	1,487,514,185

Table 18. Total Eeconomic Value of Agricultural Land at Citarum River Basin, West Java 2003 (USD/Year).

No.	Item	Upstream	Middle Stream	Down Stream	Citarum
A.	Value of marketed product	373,438,897.84	740,314,857.33	832,540,542.89	1,463,833,923.91
B.	Value of environment				
1	Flood control and prevention	83,122,055.48	48,663,037.11	115,922,995.91	82,569,362.83
2	Water retention	5,270,026.27	4,153,477.57	19,602,107.69	25,976,444.02
3	Soil erosion control	6,556,649.98	1,993,365.15	2,057,107.67	6,591,846.22
4	Landslides control	399,642,194.41	618,616,430.80	617,799,732.63	1,101,302,386.67
5	Waste disposal	700,222,056.05	711,275,734.12	931,750,484.65	990,906,480.24
6	Air purification	10,345,058.59	14,916,637.50	23,737,582.55	73,817,282.44
7	Rural amenity	26,785,321.58	24,186,058.43	19,444,651.06	31,576,503.57
8	Urbanization control	64,777,293.75	110,904,178.13	168,901,638.82	208,238,108.94
	Sub Total	1,296,720,656.10	1,534,708,918.80	1,899,216,300.97	2,520,978,414.93
C.	Total	1,670,159,553.94	2,275,023,776.13	2,731,756,843.86	3,984,812,338.83
D.	Percentage of marketed product	22.36	32.54	30.48	36.74

CONCLUSION AND POLICY IMPLICATION

Conclusion

1. The total value of commodities produced from this area is about USD 378 million/year at upstream, USD 752 million/year at middle and USD 846 million/year at down stream of Citarum. In aggregate, the economic value of commodities marketed from this area is not less than USD 1.49 billion/year.
2. Based on economic value of environmental services and value of marketed product, the economic value of nine function of land at Citarum river basin is about 3.98 billion per year. This economic value is distributed at upstream, middle, and downstream area, which is accounted about USD 1.67 billion/year, USD 2.28 billion/year, and USD 2.73 billion/year consecutively.
3. About 36.74% of total economic value of agricultural land at Citarum river basin is provided by marketed products like various commodities grown by farmers in this

area. Meanwhile, about 73.26% is contributed by the economic value of land in conserving the environment. Without conservation and reservation of agricultural land, this region will experience economic lost not lest than USD 2.65 billion/year.

Policy Implication

1. The sustainability of environmental resources in relation to agricultural land is not only the responsibility of government either Central, provincial or District government but is responsibility of all communities at upstream, middle, as well as down stream. Therefore, government should attract the maximum capacity of community to participate in each program lunched to protect the environment.
2. Economic value of the multi-functional roles of agricultural land at Citarum river basin has shown that 73.26% or about USD 2.65 billion from the total economic value is contributed by this function. In other words, the return to investment of preventing flood, soil erosion and landslide along Citarum river basin is very attractive. Therefore, government must put high priority to recover the beauty of Citarum for the benefit of next generation.
3. Given attractive positive economic value of multi-functional roles of agricultural development along Citarum river basin, Government as well as community at down stream area should become a part of investment target to rehabilitate the upstream and middle stream of Citarum.

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