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PAYMENT FOR ENVIRONMENTAL SERVICES APPROACH TO REDUCE FLOOD IN CILIWUNG WATERSHED

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ABSTRACT

Spatial planning has already been stipulated in Ciliwung Watershed, but its implementation is often not in line with the rapid development activities. To fulfill space demand, agricultural and forest areas are converted into open or built-up areas because the economic appreciation of forest and agricultural land is lower than that of open or built-up areas. Payment for Environmental Services (PES) is a tool designed to overcome environment mismanagement, which is beneficial for the lives of rural communities. PES should be considered in the formulation of spatial planning. This study was aimed to develop optimum land use pattern in reducing flood in Ciliwung Watershed, using PES approach. This study used a dynamic system approach, consisting of submodels for land use pattern change, runoff, value of farmland, upstream subsidy policy, population dynamics and environmental services. The results showed that the PES policy should be able to maintain the existence of paddy fields and dryland farming areas and to reduce runoff if it is implemented in the form of a guaranteed access to the market, and held in conjunction with efforts to prevent land conversion and to implement reforestation policies. The optimum land use pattern under this condition shall be reached in 2023, which consisted of 0.82% water bodies, 10.74% forest areas, 70.34 % built-up areas, 8.16% dryland farming areas, 4.97% grassland areas, 2.39% paddy fields areas and 2.58% open areas. This land use pattern can reduce runoff in Ciliwung River from 972.04 to 850 cm, and this level is considered to be flood-free. Communities living in the upstream areas are the most effective managers of the watershed.

Keywords: Ciliwung Watershed, environmental services payment, land use pattern

INTRODUCTION

Ciliwung Watershed has a strategic value since its entire downstream area is located in the Special Administrative Region of Jakarta (DKI Jakarta/ Jakarta Province), the capital of Indonesia. The upstream and midstream areas of Ciliwung Watershed are located in West Java Province, the most populous province. Development activities of various sectors along Ciliwung Watershed area, from upstream to downstream, are growing rapidly due to the influence of human activities in Jakarta Province. Severe flood is among various problems caused by this rapid development. Economic loss associated with this natural hazard significantly increased from IDR 9.8 trillion (USD 7 billion) in 2002 to almost IDR 20 trillion (USD 2 billion) in 2013, with an average annual loss around USD 321 million (Budiyono *et al.* 2015; Central Management of Citarum Ciliwung Watershed 2011; Kompas 2013).

The government's policy to control flood is still dominated by a structural policy such as forest and land rehabilitation activities, improving conservation structures in the form of catchment well, pond, check dam and gully plug. Flood control policy that is more dominated by a structural approach turns out to be inefficient (Fulazzaky 2014) and is not cost-effective for ecological improvement (Cui *et al.* 2009).

Kodoatie and Sjarief (2010) stated that many developed countries change the pattern of flood control to prioritizing non-structural method, which is later complemented with a structural approach. This approach will give better results in the long run.

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Spatial planning is one of the non-structural approaches to flood control (Kodoatie & Sjarief 2010), since inappropriate changes in land use and land management are the main cause of flood (Woube 1999). Landscape fragmentation is also a threat to the sustainability of the watershed because it may disturb the ecological balance (Molle *et al.* 2010). Those previous explanations provide a clear picture of the impact of land use change on water management (Wheater & Evans 2009). Spatial planning has already been stipulated in the municipal/city spatial planning (Rencana Tata Ruang Wilayah, RTRW), but its implementation is often not in line with the rapid development activities, including in Ciliwung Watershed. Increased demand for space is driven by the increase in population and the development of various economic sectors. Up to now, the demand for space is being fulfilled by converting agricultural and forest areas into open areas or built-up areas. This happens because the economic appreciation of forest and agricultural land is lower than that of other uses.

The Government of the Republic of Indonesia has launched Integrated Water Resources Management (IWRM) program which is a development and management program of water, land and related resources, to maximize the economic and social welfares in a fairly manner without compromising the sustainability of ecosystems. One of the IWRM programs is the capacity building of Jakarta's flood management by reducing the rate of surface runoff and soil erosion in the upstream part of Ciliwung Watershed, through formulating a spatial planning for Bogor-Puncak-Cianjur areas (Fulazzaky 2014). However, the implementation of IWRM in Indonesia is still theoretical and has some limitations in its application (Fulazzaky 2014). Spatial planning patterns are now needed to describe the actual physical conditions to help analyze the physical potential in a comprehensive manner (Rustiadi *et al.* 2009), which will lead to the land use allocations in accordance with the condition and the capacity of regional resources and simultaneously meeting the needs of conservation and the economy.

Payment for Environmental Services (PES) is a tool designed to overcome environment mismanagement (Engel *et al.* 2008) and has potential to change people's behavior, so that they do not harm the environment. PES is beneficial for the lives of rural communities in developing countries (Jindal *et al.* 2007). PES should be considered in the formulation of spatial planning, because PES is an environmental services payment mechanism that can provide incentives to the communities for conservation activities that have been carried out. In this case, communities participating in the conservation of forests, land and water in the upstream areas are the sellers (incentive receivers) and communities or related agencies using water in the downstream areas are the buyers (incentive givers) (Fulazzaky & Gany 2009).

Previous studies on spatial planning formulation did not consider PES. Qi *et al.* (2011), for instance, prepared land use allocation using multi-objective function by minimizing sediment and maximizing water quality. Grindlay *et al.* (2011) integrated hydrological aspect and regional planning in the Segura River Basin, southeast Spain. Lin *et al.* (2009) developed a land use model for watersheds in Taiwan, by considering land conversion (CLUE-s model) and hydrological aspect (HEC-HMS).

As land use pattern is a part of spatial planning, this study was aimed to develop optimum land use pattern for Ciliwung Watershed in reducing flood in Jakarta by considering PES value.

MATERIALS AND METHODS

This research was conducted in Ciliwung Watershed located in West Java and Jakarta provinces. The upstream areas are located in Bogor Regency and Bogor Municipality; the midsteam areas are located in Bogor Regency, Bogor Municipality and Depok Municipality; while the entire downstream areas are located in most of Jakarta Province i.e. in Central Jakarta, West Jakarta and North Jakarta (Fig. 1).

This study used secondary data obtained from literatures, thesis, journal articles, reports, maps and statistical data obtained from Institut Pertanian Bogor (IPB/Bogor Agricultural University), Balai Pengelolaan Daerah Aliran Sungai Citarum Ciliwung (Central Management of Citarum Ciliwung Watershed/BPDAS Citarum Ciliwung), Kementerian Pekerjaan

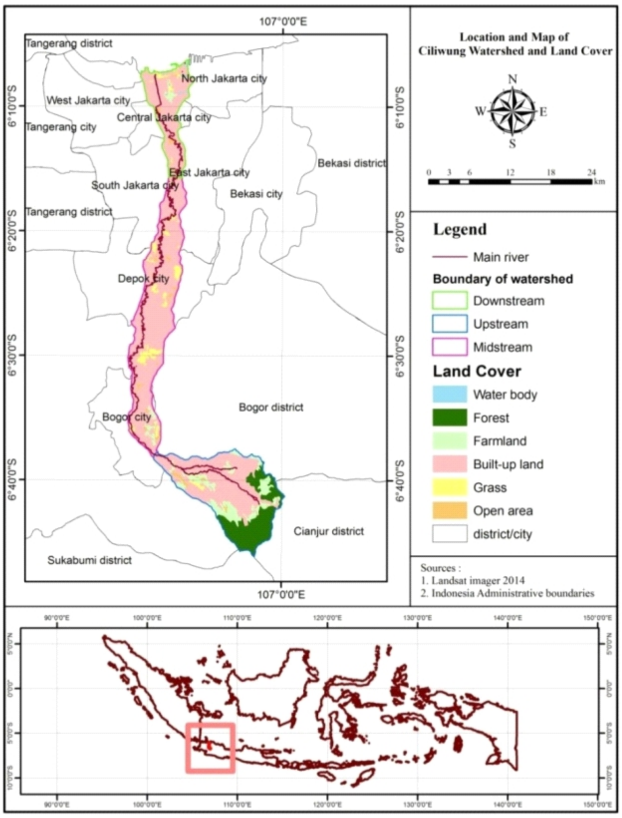

Figure 1 Research location

Umum (Ministry of Public Works) and Badan Pusat Statistik (Central Agency on Statistics/BPS).

This study used spatial and dynamic approach, and was divided into several stages, namely:

1. *Analysis of the dynamics in the changes of land use patterns*
   The data used in this study was Landsat 7+ETM satellite images in 1989, 2000, 2010 and 2014 which identified (interpreted) land use patterns in Ciliwung Watershed, using ArcGIS 10.1. The stages of land use interpretation were: 1. Geometric correction based on Ground Control Point (GCP); 2. Landsat image subset to determine the location of Ciliwung Watershed; 3. A composite band or combining several waves to obtain the best display; 4. Supervised classification through maximum likelihood classification; 5. Data transformation; and 6. Overlay image classification data from different years (Hadi *et al.* 2006). Based on image classification, land use in the upstream, midstream and downstream areas was classified into seven patterns which included water body, built-up areas, grassland, open areas, dryland farming, forest and paddy field areas. The purpose of this analysis was to produce multiple-year land use map to understand the process of land use patterns changes occurring in Ciliwung Watershed.
2. *Analysis of the relationship of each land use pattern and precipitation toward runoff*
   The relationship can be obtained using multiple regressions to obtain the coefficient of precipitation and various types of land use with runoff. In this study, the runoff is approached with water level of the river. Therefore, model used to analyze the relationship of each land use pattern and precipitation toward runoff is as follows:

$$Y_{it} = ax_{1it} + bx_{2it} + cx_{3it} + dx_{4it} + ex_{5it} + fx_{6it} + gx_{7it} + hx_{8it}$$

where:

Y = water level of the river (cm)
x_1 = precipitation (mm)
x_2 = water body (ha)
x_3 = built-up areas (ha)
x_4 = grassland (ha)
x_5 = open areas (ha)
x_6 = dryland farming (ha)

x_7 = forest (ha)

x_8 = paddy fields (ha)

$a, b, \ldots h$ = coefficients

i = the upstream, midstream and downstream areas

t = year (1989, 1990, 2000 and 2014)

3. *Analysis to formulate an optimum land use pattern by considering PES values*
   This analysis employed dynamic system analysis using Stella Program 9.1. The dynamic system analysis was conducted in several steps, i.e. 1. A need analysis - to identify the need of each stakeholder; 2. Problem formulation was prepared by evaluating resources limitations and conflicts of interests; 3. System identification - to give an overview of the relationship between factors that influence each other in relation to the system formation; 4. Dynamic model construction - to provide an overview of system form and behavior; 5. Simulation - to know the process within the system; and 6. Model validation - to know the validity of the model which was proven by the coherence of the model structure with real situation.

RESULTS AND DISCUSSION

Changes in Land Use Patterns

Ciliwung Watershed areas have become a densely populated area for a long time. Since 1989 the land use patterns have been dominated by built-up areas. Gunawan (2009) explained that Ciliwung is essential to human life since the beginning of the history of Indonesia. As time passed by, the number of people residing around Ciliwung River continue to grow and develop, up to now. This is why the communities' needs for housing and other facilities continue to grow until now. Based on analysis of land use patterns from 1989 to 2014, the built-up areas has increased from 25,433.93 ha (65.97%) in 1989 to 27,957 ha (72.52%) in 2014. Most land that can serve as water catchment areas have largely been reduced, and the biggest change occurred in dryland farming areas. In 1989, the dryland farming areas was 4,476.15 ha (11.61%) which decreased to 2,272.64 ha (5.89%) in 2014. The land use patterns from 1989 to 2014 are presented in Table 1.

Dryland farming areas are greatly reduced because the lands are owned by individuals, so that land conversion can be easily done. This arrangement is done because the economical benefit provided by agricultural land is lower than that provided by other uses. Land is considered only as a medium for agricultural production, while other land function as ecological balancer is often overlooked.

Meanwhile, the presence of paddy fields in the watershed areas have three major benefits i.e. 1. As a medium for paddy production; 2. As a buffer of environmental quality and ecological balancer; 3. Provide nutrients to ground water, maintain the river flow, reduce runoff and weather stabilization (Wu *et al.* 2001). Thus, a policy to preserve agricultural land is needed.

Table 1 Change of land use pattern in Ciliwung Watershed

Land use pattern	Year 1989		Year 2000		Year 2010		Year 2014	
	ha	%	ha	%	ha	%	ha	%
Water body	366.16	0.95	308.95	0.80	320.67	0.83	292.21	0.76
Built-up areas	25,433.93	65.97	25,673.99	66.59	26,066.72	67.61	27,957.00	72.52
Grassland areas	1,929.61	5.01	1,975.02	5.12	2,017.55	5.23	1,815.91	4.71
Open areas	945.08	2.45	1,004.81	2.61	926.69	2.40	996.86	2.59
Dryland farming areas	4,476.15	11.61	4,290.66	11.13	3,933.61	10.20	2,272.64	5.89
Forest areas	4,614.06	11.97	4,521.74	11.73	4,390.38	11.39	4,241.21	11.00
Paddy field areas	788.22	2.04	778.05	2.02	897.59	2.33	977.37	2.54
Total	38,553.21	100.00	38,553.21	100.00	38,553.21	100.00	38,553.21	100.00

Source : Landsat satellite image 1989, 2000, 2010 and 2014

Relationship between Land Use Pattern and Precipitation toward River Water Discharge

Land use patterns in the upstream, midstream and downstream areas are dominated by built-up areas which continue to grow until now. The increase in built-up areas occurred due to the conversion of water bodies, forest, agricultural land, paddy fields and open areas into housing and other facilities. Forest is present only in the upstream areas, while paddy fields exist in the upstream and midstream areas. The presence of forest, paddy fields and catchment areas affects the amount of river discharge. River runoff, represented by water level of river, showed that the runoff at locations closer to the downstream areas was getting higher. The increase in river discharge was due to the flow of the river from upstream to downstream areas and precipitation that occurred in each subwatershed. Data showed that the highest precipitation occurred in the downstream areas, while the lowest precipitation occurred in the midstream area (Table 2).

The main factor controlling hydrological process of watershed is precipitation. Part of rain flows into the river and is called runoff. Runoff takes place when the amount of precipitation exceeds the rate of water infiltration into the soil. Water infiltration rate is influenced by land use pattern. Runoff is a very important component in flood analysis. Flood occurrence is very sensitive to changes in land use. Therefore, it is important to observe relationship between land use patterns and precipitation toward runoff in determining the optimum land use pattern of the watershed.

Regression equation between precipitation, land use patterns and river water level is as follows:

$$Y_{it} = 0.155X_{1it} - 0.037X_{2it} + 0.086X_{3it} - 0.220X_{4it} - 0.110X_{5it} - 0.145X_{6it} - 0.09X_{7it} - 0.033X_{8it}$$

This regression equation showed that the higher the precipitation and the larger the built-up areas, the higher the river water level would be.

Coefficients of this regression equation indicated that the presence of grassland areas in Ciliwung Watershed had higher impact on lowering the river water level compared to other land use patterns.

This regression equation reaffirmed that land use patterns, except built-up areas, should be maintained because those patterns can reduce flood occurrence in downstream areas.

The R^2 value of the model is 76.8%, meaning that 76.8% of the river water level can be explained by the model, while the remaining percentage of other factors outside the model also have influence to the river water level.

Change of land use pattern occurs due to high population growth in Ciliwung Watershed areas. Increased population is followed by increased demand for land, housing and other facilities as built-up areas.

Table 2 Land use pattern, precipitation and river water level on each subwatershed

Year	Location	Water body (ha)	Built-up areas (ha)	Grassland (ha)	Open area (ha)	Dryland farming (ha)	Forest (ha)	Grassland (ha)	Precipi-tation (mm)	Water level (cm)
1989	Upstream	35.9	6,269.7	124.1	188	3,257	4,614.1	725.8	5,143	110
2000	Upstream	78.1	6,334.7	116.9	276.5	3,159	4,521.7	728.2	1,201	110
2010	Upstream	96.7	6,665.1	148.9	186.3	3,009	4,390.4	718	840	116
2014	Upstream	64.1	7,844.2	113.1	224.7	1,914	4,241.2	813.1	1,024	128
1989	Midstream	74.5	13,700.3	1,526.6	496.1	1,017	0	62.4	534	250
2000	Midstream	78.3	13,808.6	1,549.1	461.1	929.4	0	49.8	652	250
2010	Midstream	61	13,861.9	1,563.5	456	754.3	0	179.6	1,142	400
2014	Midstream	68.,8	1,4547	1,409.2	498.7	188.4	0	164.3	1,383	450
1989	Downstream	255.8	5,463.9	278.9	261	202.6	0	0	1,588	685
2000	Downstream	152.5	5,530.7	309	267.2	202.6	0	0	1,625	853
2010	Downstream	162.9	5,539.7	305.2	284.3	170	0	0	2,360	717
2014	Downstream	159.3	5,565.8	293.6	273.4	170	0	0	2,907	784

Source: Landsat satellite image 1989, 2000, 2010 and 2014; The Ministry of Public Work 1989, 2000, 2010 and 2014

Optimum Land Use Pattern by Considering PES Values

Population increase causes dynamic demand for space, which is followed by land conversion activities from agricultural land and forest areas into more or totally open areas. These open areas are more prone to high precipitation and cause floods in watershed areas.

As a system, land use patterns in upstream areas that are not in tune with the carrying capacity of the areas may cause floods in downstream areas. This condition is even worsened by inappropriate land use patterns in downstream areas which are resulted to floods in Jakarta.

Change of land use patterns decreases the economic value of water catchment areas to an even lower value than that of built-up areas.

Therefore, it is crucial to establish a policy that provides incentives to the upstream areas for preventing the changing of land use patterns into built-up areas, such as Payment for Environmental Services (PES).

Value of environmental services is based on the dynamic changes in population size. Therefore, the development of optimum spatial planning model is based on submodels for land use patterns change, river discharge/runoff, paddy field value, upstream subsidy policy, population dynamics and environmental services. *Systems thinking* of this optimum spatial planning model is presented in Figure 2.

Submodel for land use patterns change was established for the upstream, midstream and downstream areas. Land use patterns in the midstream and downstream areas indicated the

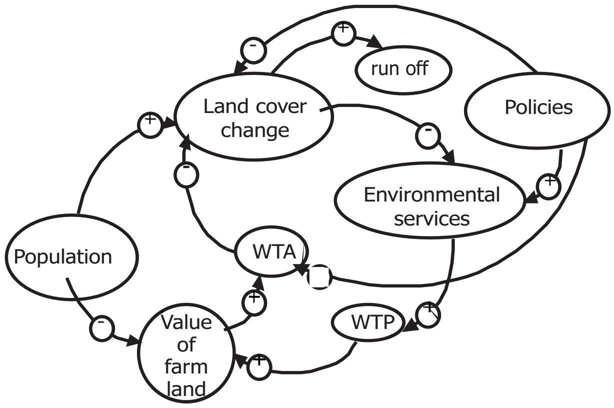

Figure 2 *Systems thinking* of the optimum spatial planning model

Tabel 3. Land use patterns change and the change direction in upstream areas between 1989 and 2014

		2014							
		Water body	Forest	Built-up area	Dryland farming	Grassland	Paddy field	Open area	Grand total
1989	Water body			7.53	27.98		0.43		35.94
	Forest		4,241	85.91	149.10		131.35	6.42	4,614.00
	Built-up area			6,205					6,269.70
	Dryland farming			1,555	1,661.30		1.45	38.36	3,257.10
	Grassland				11.02	113.10			124.12
	Paddy field			89.96			635.86		725.82
	Open area			8.05				179.90	187.97
	Grand total		**4,241**	**7,953**	**1,849**	**113.10**	**769.09**	**224.70**	**15,214**

Source: Landsat satellite year 1989 and 2014, analyzed nonexistence of forests and paddy fields (Table 2). Therefore, the optimum land use patterns were developed based on the changed land use patterns and the prediction of land use changes in the upstream areas. Between 1989 and 2014, there was a dominant increase of built-up areas from 6,269.7 ha in 1989 to 7,953 ha in 2014. The increase was due to the conversion of water bodies, forests and dryland farming areas into built-up areas. The largest land use pattern change occurred on dryland farming areas, from 3,257.1 ha in 1989 to 1,849 ha in 2014. The change was directed for 1,555 ha of built-up areas, 1.45 ha of paddy fields and 38.36 ha of open areas. The land use patterns change and the change direction in the upstream watershed areas between 1989 until 2014 are presented in Table 3, and used as a basis for developing submodel for land use patterns change (Fig. 3).

Runoff submodel was developed based on relationship between precipitation, land use patterns and water level (Fig. 4). The regression equation is:

$$Y_{it} = 0.155X_{1it} - 0.037X_{2it} + 0.086X_{3it} - 0.220X_{4it} - 0.110X_{5it} - 0.145X_{6it} - 0.09X_{7it} \ - 0033X_{8it}.$$

Value of farmland submodel was developed based on the value of paddy field and dryland farming production (Fig. 5). Value of paddy field production was approached with the value of paddy field production per ha multiplied by the price of grain. The value of dryland farming production was approached with its production value per ha multiplied by the unit price of dryland farming production.

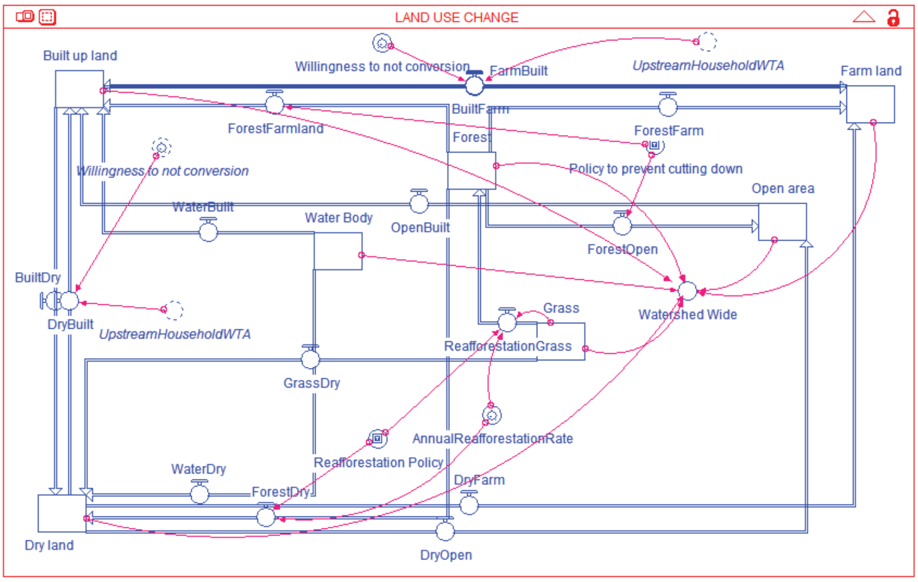

Figure 3 Submodel for land use change

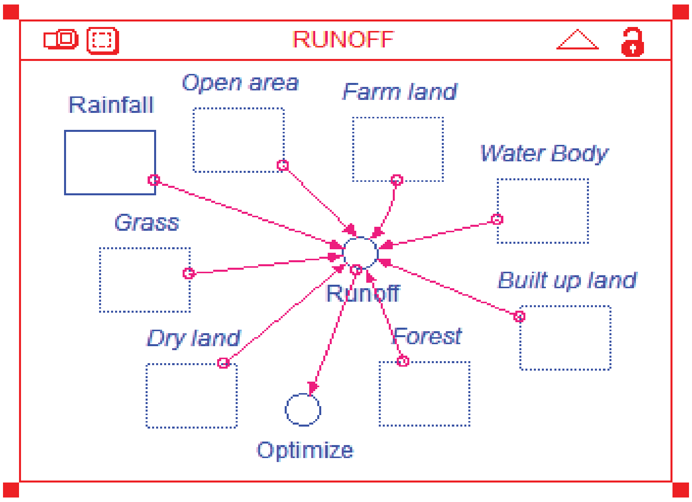

Figure 4 Runoff submodel

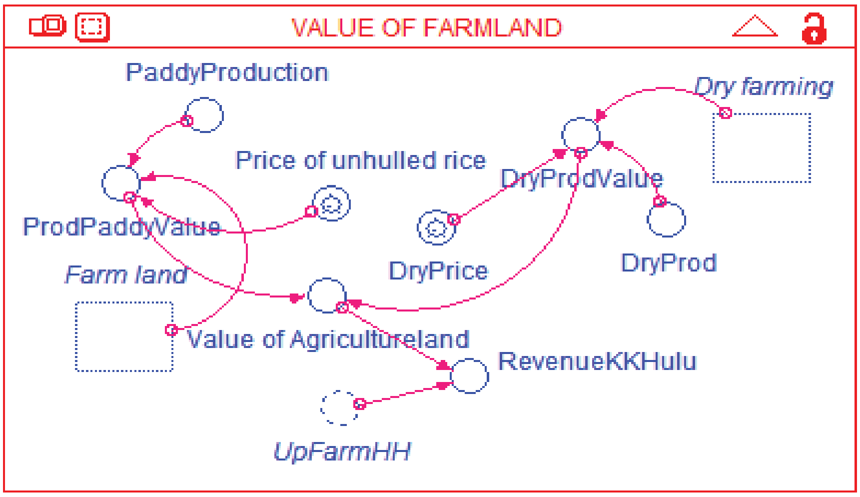

Figure 5 Value of farmland submodel

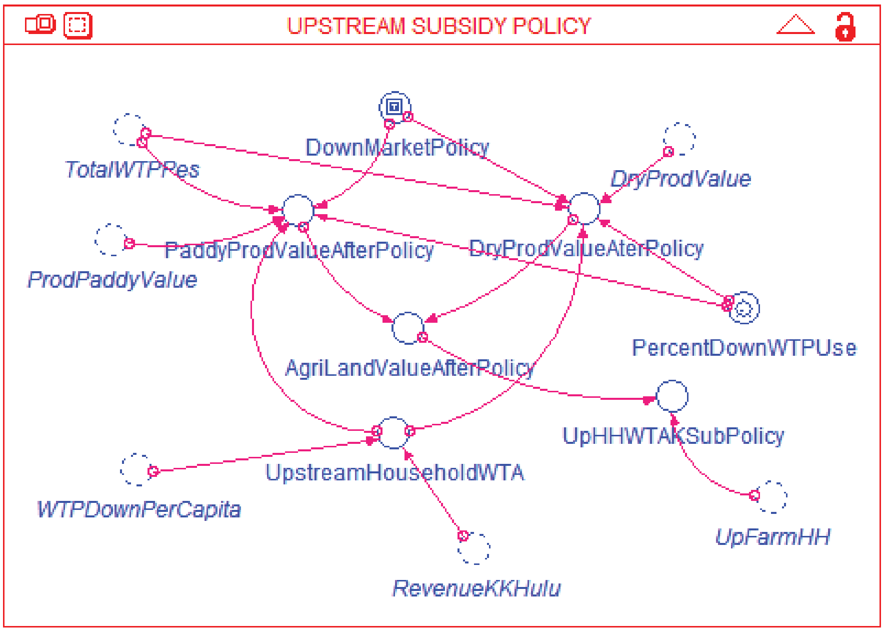

Figure 6 Upstream subsidy policy submodel

Upstream subsidy policy submodel (Fig. 6) was developed based on values of paddy field and dryland farming areas which were lower than those for other uses, characterized by the continuous conversion of paddy fields and dryland farming areas. In this case, the government should establish a policy to provide easy access for farmers in the upstream areas to market their agricultural products. This policy can overcome the high discrepancies between farmers' and market prices as a result of marketing chain cost. Another policy that can be possibly implemented is government subsidies to cover the marketing chain cost from the farmers to the market.

Population dynamics submodel (Fig. 7) was developed based on the assumption that the change of land use patterns in Ciliwung Watershed occurs due to high population growth. The increase of population causes an increase in land demand for housing and other facilities as built-up area.

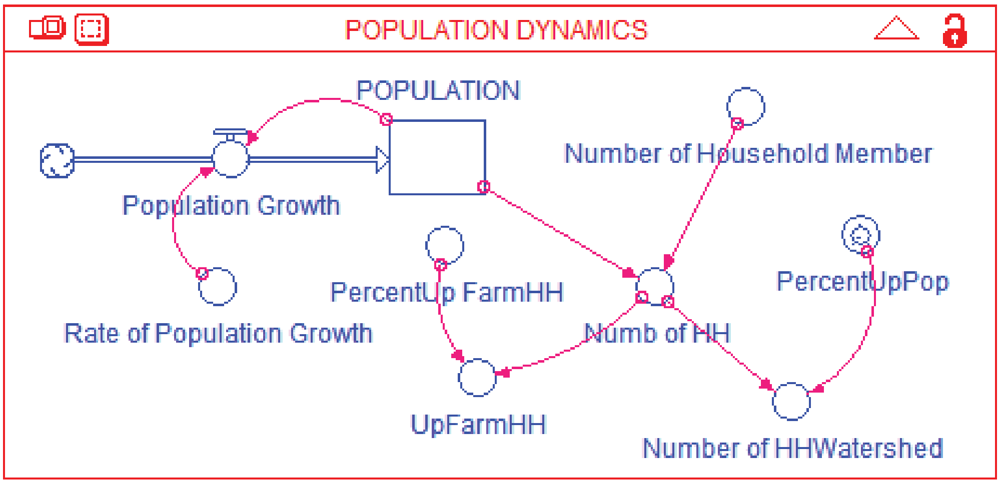

Figure 7 Population dynamics submodel

Environmental services submodel (Fig. 8) was developed based on the assumption that the reduction in land use patterns change would cause changes in the value of environmental services. Changes leading to an increase in built-up areas and a decrease in water catchment areas in the upstream areas would cause an increase in the runoff which contributes to flood occurrence in downstream areas (Jakarta). Law Number 32 Year 2009 on the Protection and Management of the Environment (UU PPLH) explains the mechanism of Payment for Environmental Services (PES) for both the beneficiaries and the providers of PES.

Environmental services submodel in this study used Contingent Valuation Method (CVM) to determine the amount of Willingness to Pay (WTP) from the surrounding society located in the Ciliwung Watershed for watershed protection.

The improvement of river quality using CVM involves three main stages: (a) identification of the goods and services to be evaluated; (b) construction of a hypothetical scenario; and (c) monetary value elicitation (Pearce et al. 2006). Among these three stages, Stage 2 (i.e. construction of a hypothetical scenario) is the critical one, since it directs how the respondent will react to hypothetical policy scenarios. This stage involves three elements: (a) change in watershed policy; (b) description of the hypothetical payment; and (c) determination of the payment method.

The policy scenarios in this study were developed under flood and non-flood scenarios.

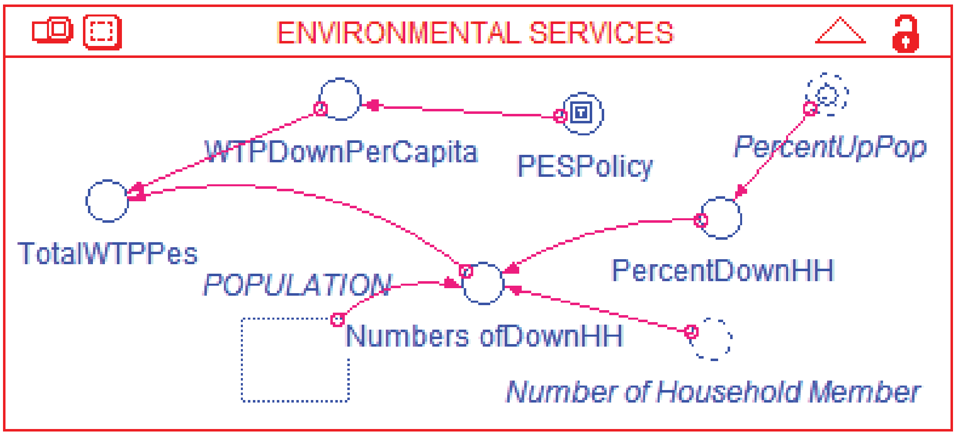

Figure 8 Environmental services submodel

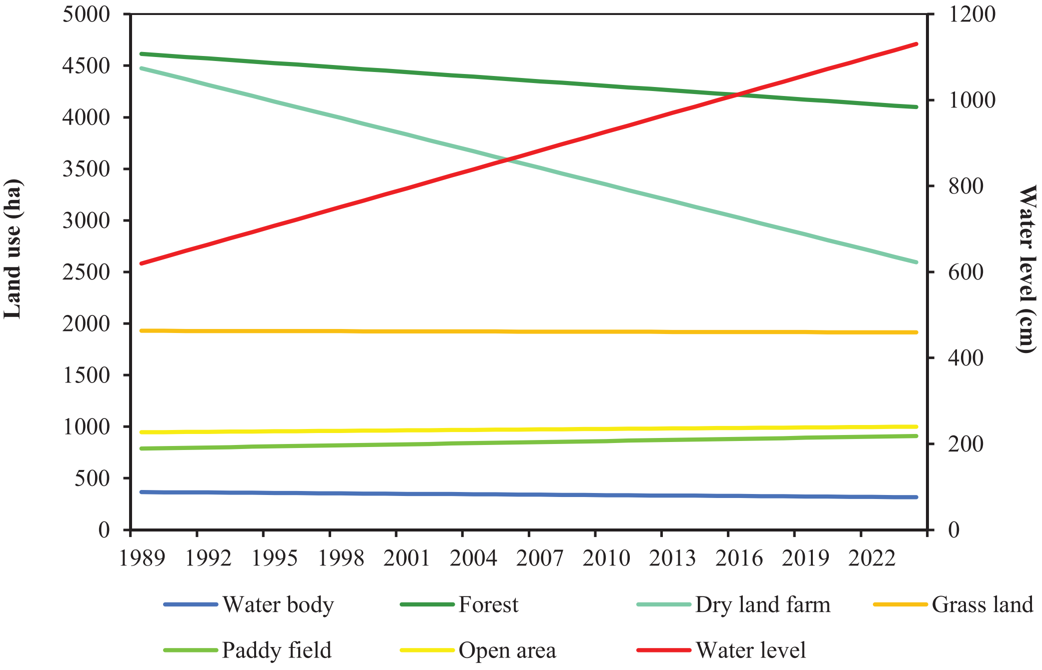

Figure 9 Description of land use pattern versus water level

The hypothetical payment was assumed as direct payment (cash transfer) through a hypothetical institution (regencies or autonomous body).

To administer the survey, the 76 respondents were randomly divided into groups. Each group was asked to provide their WTP for a specific monetary value ranging from IDR 5,000 to IDR 20,000. Respondents in this study were those who live in Ciliwung riverbank in Jakarta area. The questionnaires were tested with 30 experts and a smaller group of respondents prior to the actual survey. Using the Contingent Valuation Method (CVM), it was determined that the mean WTP in Ciliwung Watershed was around IDR 13,974 (USD 1.1) per household per month (Saridewi 2015).

Dynamic model of the initial conditions in this study suggested that if the land use patterns changes continue to reduce the water catchment areas, the runoff will be higher than the water level considered as high alert level (more than 950 cm). Changes leading to an increase in built-up areas and a decrease in water catchment areas in the upstream areas would cause an increase in the runoff which contribute to flood occurrence in downstream areas (Jakarta), as described in Figure 9.

The WTP values can be used as the basis of determining the value of compensation for environmental services (PES) by multiplying the number of households in the Ciliwung Watershed (Suyanto et al. 2005). PES was analyzed using the WTP approach which amounted to IDR 13,974.21 (USD 1.1) per household per month (Saridewi 2015). The numbers of households were 1,319,569 people. Thus, the amount of PES was IDR 18.5 billion (USD 1.4 million). Based on the determined amount of PES and the direction of land use patterns change, four scenarios were prepared to reduce water level. The four scenarios were:

1. PES Policy
   PES policy was established based on WTP approach amounted to IDR 13,974.21 per household per month. This value was further multiplied by the number of population in the downstream areas. The numbers of households in the downstream areas was 77% of the numbers of households in Ciliwung Watershed. The average numbers of household members were 4 people. Thus, there were 4,064,273 people the downstream areas.
2. PES policy in the form of market access
   This policy is the commitment of the Government of Jakarta Province to guarantee market access for agricultural products from the upstream areas by providing 10% of the price of agricultural products produced by

farming activities in the upstream areas to be used as fund for improving market access for farmers.

3. Reforestation policy
   Reforestation policy is tree planting activities in open areas to increase forest areas.
4. Land conversion prevention policy is an activity to prevent the conversion of forest land, paddy fields and dryland farming areas.

Simulation using PES policy scenario in the form of direct incentives to communities in the upstream areas showed that the water level was not reduced to the safe water level. The amount of this direct incentive was lower than the value of the agricultural production, which failed to halt land conversion. Therefore, PES policy scenario was ineffective to reduce flood in Jakarta if applied as a single policy.

Also, simulation using PES policy scenario in the form of market access failed to lower the water level to the safe condition. Under this policy, the price of the agricultural products at farmers level would depend on the market price. The 10% compensation from the Government of Jakarta Province is to cover cost required to bring the agricultural products from the farmers to the market. Condition required for this policy to succeed is a guarantee from the Government of Jakarta Province to purchase all agricultural products produced by farmers in the upstream areas. However, if this policy is implemented as a single policy, it is still not able to reduce flood in Jakarta, because this policy is only applied to paddy fields and dryland farming areas. In other words, maintaining the extent of paddy fields and dryland farming areas alone cannot reduce the river discharge/runoff to the safe level.

Simulation using 50% reforestation or 50% land conversion prevention was also unable to lower the water level to the safe condition. Economically speaking, reforestation policy implemented in open areas did not provide any incentives to the community. Land conversion prevention policy implemented in paddy fields, dryland farming areas and forests is a mandatory policy without economic incentives, which makes the policy difficult to be applied in communities who live on a land. Water level should gradually reach the safe condition when the four scenarios mentioned above are simultaneously applied, as is described in Figure 10, and the optimum condition should be achieved by 2023 (Table 4).

The optimum land use patterns in Ciliwung Watershed areas that should happen in 2023 are as follows: water body covers an area of 317.88 ha (0.82%), forest areas of 4,142.5 ha (10.74%), built-up areas of 27,116.55 ha (70.34%), dryland farming areas of 3,144.65 ha (8.16%), grassland areas of 1,914.65 ha (4.97%), paddy fields areas of 920.6 ha (2.39%) and open areas of 996.38 ha (2.58%). Under this optimum condition, water level would reach 850 cm, which is classified as level 3 alert (flood-free). Population in the upstream Ciliwung Watershed was 150,134 in 1989 and is projected to reach 240,863 by 2023.

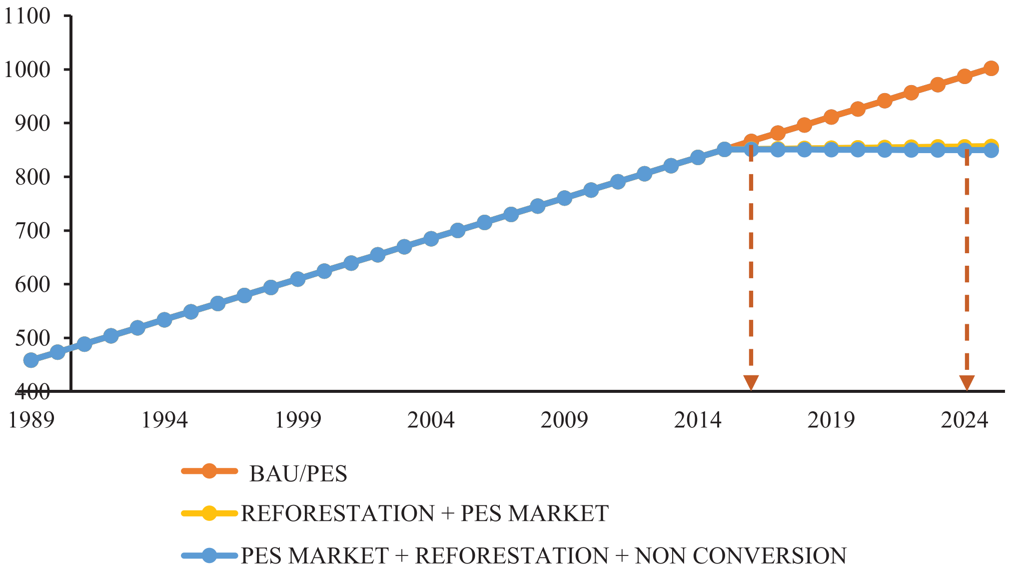

Figure 10 Simulation of water level resulted from the four scenarios

Table 4 Land use pattern in years 2014 and 2023

Land cover	Year 2014 (ha)	Year 2014 (%)	Year 2023 (ha)	Year 2023 (%)	Difference (ha)
Water body	299.85	0.78	317.88	0.82	18.03
Forest	4,241.21	11.00	4,142.50	10.74	-98.71
Built up area	27,957.0	72.52	27,116.55	70.34	-840.45
Dryland farming	2,272.64	5.89	3,144.65	8.16	872.01
Grassland	1,808.27	4.69	1,914.65	4.97	106.38
Paddy field	977.37	2.54	920.60	2.39	-56.77
Open area	996.86	2.59	996.38	2.58	-0.48
Total	38,553.20	100	38,553.20	100	-

Several legislations related to PES are stipulated in Law No. 26 Year 2007 on Spatial Planning (UUPR), Law No. 32 of 2009 on the Protection and Management of the Environment (UU PPLH), Law No. 37 Year 2014 on Land and Water Conservation (UU KTA), and Law No. 41 of 1999 on Forestry. Various laws above are related to the duties and functions of several ministries and agencies, so that the implementation of PES is highly dependent on the coordination of the government agencies, private institutions and other stakeholders (Fulazzaky & Gani 2009).

PES mechanism is believed to be a tool to effectively resolve conflicts between the upstream and downstream areas (Escobar *et al.* 2013) and should be arranged with contractual mechanisms that are flexible and can be updated (Lapeyre *et al.* 2015). Formulation of spatial planning should pay attention to these contracts in order to simultaneously meet the economic and conservation needs.

PES policy scenario in the form of market access was granted by the Government of Jakarta Province to the Government of Bogor Regency. West Java provincial government plays a role in the coordination process, because Bogor Regency is administratively located in West Java Province.

Under PES mechanism, it is important to determine the agreed land value to make conservation activities be more attractive. Three payment principles to be considered are the precautionary/prevention, users and polluters (Fulazzaky & Gany 2009), in which the precautionary principle is essentially a risk reduction where users must focus on overexploited resources and the payment made by polluters should emphasize on those who deal with the environment.

Reforestation policy scenario can be easily implemented because the status of forests in the upstream areas is state forest. However, the Payment for Environmental Services must be provided to the communities or people who lose their access due to the conversion of the forest areas (García-Amado *et al.* 2011).

Reforestation policy can be implemented with an advance payment system for tree planting and labor because the suggestions for investment has discouraged low income households from participating (Mahanty *et al.* 2013). Community groups are proven to be the managers of forest, soil and water conservation in the upstream areas (Fulazzaky 2014).

CONCLUSIONS

The optimum land use patterns in Ciliwung Watershed should be consisted of 0.82% water bodies, 10.74% forest areas, 70.34 % built-up areas, 8.16% dry land farming areas, 4.97% grassland areas, 2.39% paddy fields areas and 2.58% open areas. When the PES policies are simultaneously implemented, the runoff in Ciliwung River should be reduced from 972.04 to 850 cm by 2023, which is considered flood-free.

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