

Identification Of Ecosystem Services In Gajahwong Watershed

M. Chrisna Satriagasa¹, Faizal Rachman¹, Widiyana Riasasi¹

¹Scholarship holder of Beasiswa Unggulan BPKLN KEMDIKBUD RI on Magister Program on Planning and Management of Watershed and Coastal Area, Faculty of Geography UGM

Email: satriagasa@yahoo.co.id

Abstract

Gajahwong is one of river crosses Yogyakarta city which densely populated. It leads to environment degradation caused by human activities. As result, natural ecosystem of the river changes into artificial ecosystem that cannot give any natural ecosystem services completely. Watershed management should be integrated, which means all the components should be managed appropriately to achieve ecosystem sustainability. Thus, ecosystem services can keep giving its benefit to human and other users. Undirectly, well management of the ecosystem can reduce disaster risk that might occur in a watershed. Aim of this research is to identify the existence and types of ecosystem services in Gajahwong watershed. This research uses descriptive method to explain the existence and types of ecosystem services in Gajahwong watershed based on 12 observation spots. The 12 observation spots are divided in upper, middle, and down area of the watershed. Ecosystem services of river is categorized in four types, those are provisioning, regulating, cultural, and supporting services. The result shows ecosystem of Gajahwong watershed, from up to down part, is still enabling to give ecosystem services for human in various types even though it is limited. Middle part of Gajahwong watershed is the least part in providing ecosystem services because it is located in city area therefore the existence of natural ecosystem is threatened to be extinct and replaced by artificial ecosystem. As recharge area, the upper part still provides complete ecosystem services. As well as the down part which its function as discharge area, there are still many natural ecosystem working as its capacity.

Keyword : Ecosystem Services, Watershed, Environment degradation, Human activities

1. Background

Ecosystem is community of plants, animals, organisms and non-organisms, and processes which connecting each others in unity to create equilibrium, stability, and productivity (Policy number 27 year 2007 conjoined number 1 year 2014). Environmental equilibrium can be achieved when each components give benefit consistently in the ecosystem. The stable ecosystem will provide ecosystem services in maximum, included for human. Basically, nature provides huge potential of resources.

Human population keeps decreasing and has correlation with demand of land for living and other needs which provided by nature. Over exploitation without proper

rehabilitation will harm ecosystem stability. Watershed area is an ecosystem which treasures huge potential of resources because its scope area is from upstream to downstream. While development keeps running, at times environment of watershed area degrades because of human intervention, i.e. land use change and pollution by domestic waste (Figure 1). The environmental degradation, either directly or indirectly, will affect, disturb, or even eliminate the natural ecosystem in watershed area.



Figure 1. Human Activity and The Impact in Gajahwong Watershed; (A) Accumulation of Garbage on the River; (B) Change of Natural Ecosystem in River Caused by Engineering Modification; (C) Dense Settlements on Riverbank (Satriagasa, 2013)

Millennium Ecosystem Assessment (2005) states human life is depend on services provided by ecosystem, either directly or indirectly. The services can be formed as natural ecosystem or artificial ecosystem. Biodiversity gives important role in ecosystem services because the more diverse biologic in the ecosystem, the more benefits will be provided. That diverse of the biologic can be interpreted as type or numbers. Ecosystem services for human particularly, is grouped into 4 groups, those are provisioning services, supporting services, regulating services, and cultural services. Provisioning services consist of human main needs, i.e. food and water. Some supporting services is related to disaster management in the ecosystem, as example water management, climate, disease inhibition and disaster risk reduction. Cultural services is local wisdom in the ecosystem, like

aesthetic, knowledge and education. While supporting services consist of soil formation and water cycle.

Watershed integrated management means all watershed's components should be managed properly to achieve sustainable ecosystem, thus ecosystem services keep providing benefit for human life and the other users. Indirectly, appropriate management to ecosystem can reduce disaster risk which might occur in the watershed area.

Gajahwong is one of river crosses Yogyakarta city. Its headwater is on Merapi Volcano then flows to south towards Opak river in Bantul. Area of Gajahwong watershed covers city of Yogyakarta, which is high of population density. Development of settlements and public facilities changes natural ecosystem and harm availability of the ecosystem services in Gajahwong watershed. Degradation in Gajahwong watershed which is getting worse, can be minimized by identify the existing ecosystem services left and the form in Gajahwong river. Based on the background, the aims of this research is to identify and describe the existing ecosystem services left in Gajahwong watershed.

2. Method

Watershed area is ecologic system which consists of interaction between biotic and abiotic components to make conformity (Asdak, 2007). Asdak also stated that ecologic system or ecosystem is a system consists of integrated components and creates unity. Ecosystem might have broad or small scope, depends on the boundary. Watershed can be considered as an ecosystem, however the scope can be narrowed into smaller ecosystems, which are upstream, middle, and downstream.

Gajahwong watershed is divided into three parts, those are upstream, middle stream, and downstream (Figure 2). Each part has different physical characteristic and social characteristic of interaction between human and environment. Areas in a ecosystem will have similar characteristic and the ecosystem services provided will be equal as well.

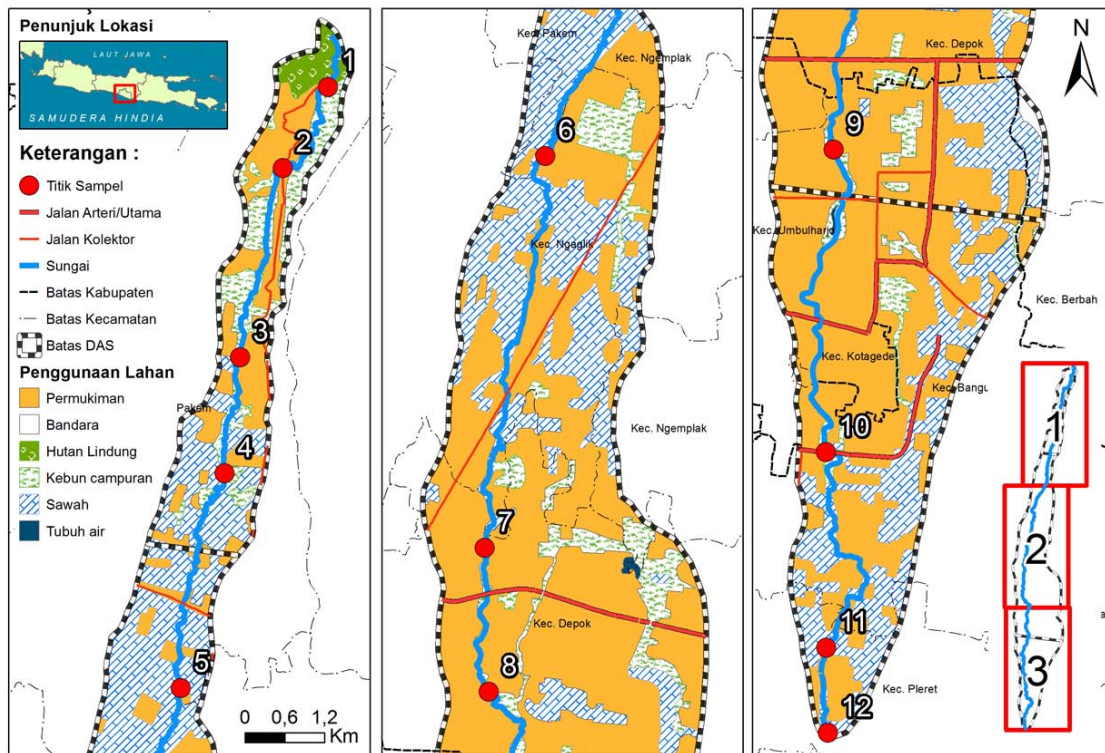


Figure 2. Sampling Location in the Research Area

This research used some data taken from Gajahwong watershed regarding to types of existing ecosystem services. Primary data was taken by sampling on 12 spots spread equally in the watershed, from upstream to downstream. Those sample spots was determined by physical characteristic, including morphology of the slopes, the genesis, and the land cover which can be identified by interaction between human and the environment. Secondary data was collected by literature review, field observation, and interview to local people.

Those data was proceed descriptively and presented in matrix of types of existing ecosystem services which was divided according to each category. Millenium Ecosystem Assessment (2005) is sorting ecosystem services into 4 main category, those are provisioning services, regulating services, cultural services, and supporting services.

3. Result and Discussion

a. Upstream Ecosystem of Gajahwong Watershed

Upstream area of Gajahwong is originated on slope of Merapi Volcano, precisely on Merapi National Park. Identification of ecosystem service in upstream area is divided into 4 samples. Existing ecosystem services in the area is relatively homogeneous, but on the first spot which is conservation area, can be found monkey as genetic source. Fiber

cropsthat exist on the area is perennial plants, like rosin wood and pine. Those genetic and plant sources can only be found on the highest spot. On the 2nd, 3rd, and 4th spots, kind of non-agriculture crops is coconut and bamboo. Snake fruits as genetic crop can be identified on the 3rd, and 4th spots. Snake fruit is grouped in genetic sources because it can only grow on higher place, like on top slope or middle slope of Merapi Volcano. There is ponds for fishery. Fishery is included in food source category. Springs, ponds, and intermiten river provide fresh water in upstream area (Figure 3).



Figure 3. (A) Conservation Area of Merapi Volcano; (B) Fishery (Ponds) as Ecosystem Services; (C)&(D) Genetic Source in Upstream of Gajahwong

Bamboo plant can be found surrounding watershed area, since the 2nd spot, and considered as ecosystem services for erosion regulation. Bamboo plant is effective component to prevent riverbank erosion. Dense vegetation on the 4th spot provides ecosystem services for air quality and climate regulation. The vegetations absorb carbondioxide and at times produce oxigen, which it gives ecological function for Gajahwong watershed. Indicator of the regulating services of water quality and quantity in those four spots can be identified by the existing of vegetation. Vegetation has function to decrease runoff, increase infiltration and to filter the water. Well drainage can prevent disease, while snake and frog have function as predatory animal to eat pest. Regulating services can be identified by pollinated flower and disaster risk reduction. The existence of flower plants, i.e. petai and mlinjo, can be considered as ecosystem service in the area is

well provided. Pollinated flower only happens when insects exist to support pollination, and it proves that the ecosystem is still varied and balance. Disaster risk reduction services in upstream area of Gajahwong watershed is formed by natural riverbank, which its function to reduce riverbank erosion risk. Riparian and bamboo trees on the sides of rivers (Figure 4) completes the watershed ecosystem variation to give maximum benefits for environment.

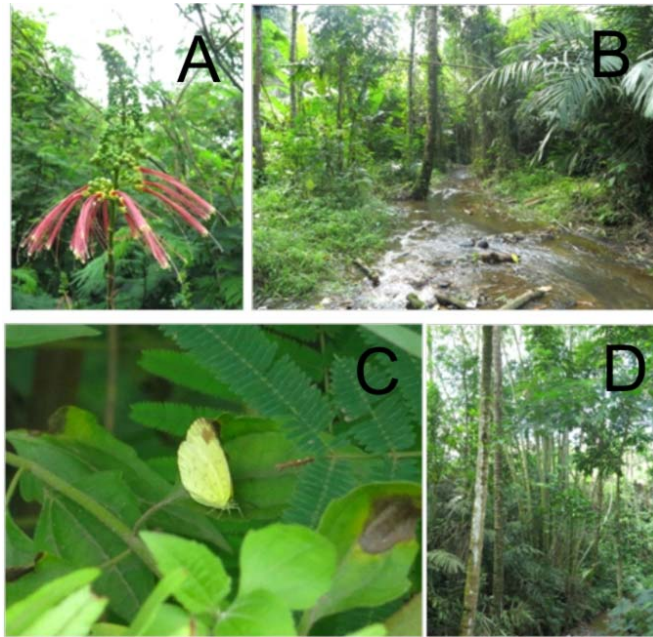


Figure 4. (A) Regulating Service of Flower Pollination; (B) Ecosystem Variation for Air and Water Regulation; (C) Plants Pollination by Butterfly; (D) Bamboo as Erosion Regulation Service

Cultural services in upstream area of Gajahwong watershed provides inspiration value in form of beautiful natural view. Inspiration indicator in the ecosystem is natural panorama of upstream area with various ecology. Aesthetically, combination of biotic and abiotic components interacted to create beauty. Culture and tradition related to nature is still exist, called Merti Bumi (earth thanksgiving). The tradition is activity to meet local community to work together caring the environment as respect to earth which has provided all human needs. Cultural diversity such as collecting stem and grass, or fish farming, is still exist in the upstream area. Spiritual services in the area is pilgrimage of religious figure Syekh Djumadil Qubro. The area has tourism spot because it is conservation area (Figure 5).



Figure 5. (A) Cultural Services Provides Tourism Area in Upstream of Gajahwong Watershed; (B) Cultural Diversity, Aesthetic and Inspiration Value

Supporting services provides soil solum, identified by soil formation and soil fertility. Those indicators are proven by density of the vegetation. Nutrient cycle produces nutrient for living creature is still ongoing. Water cycle is also still exist, determined by the existence of springs, ponds, and intermiten river. Some processes in water cycle are interception and infiltration. Generally, mostly ecosystem services in upstream area of Gajahwong watershed are still exist.

b. Middlestream Ecosystem of Gajahwong Watershed

Ecosystem on middle stream area shows significant different of morphology and land use aspects, among the all sections of Gajahwong watershed. The area is formed of plain morphology and structure of well sorted layer by transport and sedimentation activity of young material from Merapi volcano through Gajahwong river.

Interaction between human and environment is formed as land use (Santosa, 2012). Kind of land use can be found on middlestream area of Gajahwong watershed is rice field (1,364.1 Ha), settlement and developed land (2,853.5 Ha), and fixed field (385,3 Ha). The great wide of developed land changed for agriculture and farming, shows many changes have been done originally from natural ecosystem to artificial ecosystem. Besides affected to ecosystem, human activity also gives contibute to environmental degradation, which aggravating the watershed ecosystem. Impact of the case, ecosystem services provided by middlestream area of Gajahwong watershed is getting more scarce. Pictures of ecosystem changes and degradation on middlestream of Gajahwong watershed can be seen on Figure 6.



Figure 6. Ecosystem Changes and Degradation as Impact of Human Activity; (A) Dense Population Settlement; (B) Garbage on the River; (C) Settlement on Riverbank; (D) Artificial Embankment

Field observation on 5 spots of middlestream area of Gajahwong watershed shows the existence of various type of ecosystem services, eventhough the numbers is less and limited variation. Some ecosystem services are provided by natural ecosystem and the rest is artificial ecosystem. Provisioning services can be found on the area is provision of food, provision of fiber, provision of freshwater. Provisioning of food is still provided on three spots, while the rest of two spots, the condition is threaten to be lost. Types of food provisioning services is existence of agricultue and farming plants, including rice, watermelon, papaya, mlinjo, rambutan, jackfruit, durian, banana, petai; and existence of duck and fishery farming (Figure 7).



Figure 7. Provisioning Services on Middlestream of Gajahwong Watershed; (A) vegetable provisioning; (B) Animal Food Provisioning Services; (C) Sengon Wood and Bamboo Provisioning Services; (D) Freshwater Provisioning Services

Fiber provisioning services of non-food product is coconut, sengon wood, mahoni wood, teak wood is still exist on the middlestream area, but limited. Fresh water provisioning services is provided on whole research area, however two spots are in bad condition. Striagasa, et al (2014) stated water quality on middlestream area is on pollution boundary line, and is not suitable for consuming. Type of freshwater provisioning services is river, water storage, and freshwater well.

Existing regulating services on the middlestream area is air and climate regulating, erosion regulating, disease regulating, pollination regulating, and disaster risk reduction regulating. Those regulating services is provided on 4 of 5 observation spots while the 2 of the 4 spots area are threaten condition. Type of air and climate regulating services is existence of vegetation to absorb carbon dioxide in the air. The existence of water regulating services is provided by land, vegetation, litter to support infiltration of runoff. Erosion regulating services is provided by bamboo, natural embankment, riverbank, riparian, and jeti.

2 of 3 spot area have well-drainage to support disease regulating services. Natural pollination by insects and butterfly can be seen on 2 spots of middlestream area. It indicates pollination services is still exist on the area. Some risk disaster, like flood and riverbank erosion, can be reduced by existence of riverbank, jeti, and riparian.



Figure 8. Supporting, Cultural, and Regulating Services on Gajahwong Watershed; (A) Vegetation as Climate and Water Cycle Regulating Services; (B) Riparian as Risk Disaster Reduction Regulating Services; (C) Fishing as Social Services

Cultural services on Gajahwong watershed is barely exist. There is only one service can be found, which is social relation service on one of spots. Type of the service is public fishing area, where people meet and make relation. While nutrient cycle and water cycle services as supporting services. Nutrient services can be identified in the existence of sedimentation by riverflow, riparian, and leaves litter. Water cycle is identified by riverflow and natural riverbank to support infiltration.

c. Downstream Ecosystem of Gajahwong Watershed

Downstream ecosystem of Gajahwong watershed is relatively different to upstream and middlestream area. Middlestream is dominated by artificial ecosystem. While on the downstream, the services is more complete than on the middle, which provides food provisioning in forms agriculture, farming, and fishery. The commodity is petai, banana, mango, papaya, cow, horse, fish, and duck (Figure 10).



Figure 10. (A) Fish Pond; (B) Cow; (Petai); (D) Horse; are food provisioning services on the downstream of Gajahwong Watershed.

Beside food provisioning services, it still provides fiber of bamboo and sengon wood. Relatively, condition on downstream area is quite similar to upstream area, which is many natural ecosystem exist, such as dense vegetation and bush. Dense vegetation provides air quality regulating service. Polluted air is filtered by vegetation. Vegetation also has function as climate regulating service. Water quality regulating service can be found from riparian and litter, which reducing water pollution.

On the downstream area, there are some public fishing place. The activity influences public relationship in the community. Downstream of Gajahwong is meeting point of Gajahwong river and Opak river. Local people believes on the meeting point is magical holy place. They believes by taking bath on the area would make their soul clean. Those phenomena on the downstream area is prospect to be tourism area in well management.

Downstream area's diameter is wider than middlestream's diameter. On the river slope, there is jeti covers stone to prevent erosion, aside of terrace to avoid landslide (Figure 11).



Figure 11. Jeti for Erosion Reduction on Riverbank

Regulating service is still exist on downstream are, identified by flower pollination. For disaster risk reduction, riparian, riverbank, and river embankment area still exist as well. Riparian has function to reduce high riverflow.

Soil formation services on downstream area is formed by sedimentation of material from upstream area. Soil formation can be identified by the existence of solum and soil profile, and also dense vegetation. The first spot on the downstream area does not provide soil formation because of high riverflow. Besides, nutrient cycle on the spot is barely exist because of less vegetation and litter.

Meeting point of Gajahwong and Opak river, garbage, discharge area area type of supporting services that exist on the downstream area, as seen on Figure 12.



Figure 12. Meeting Point Between Gajahwong and Opak River

Land use on downstream area consists of developed land, ricefield, mixed field, and water storage. Settlement and developed land are dominated land use on the area. Total area of settlement and developed land is 11,808,480 meter square, while the second widest area is rice field of 5,029,672 meter square. Based on the data, ricefield is smaller than developed land. If the total area of ricefield is getting smaller, its production is getting lesser as well.

Area of mixed field is 901,344 meter square, consists of various type of plants while the land belongs to community living along Gajahwong river. The least land use on the area is water storage of 18,848 meter square, consists of river and fish ponds belongs to local community.

Tabel 1. Type of Ecosystem Services og Gajahwong Watershed Based on Category and Segmentation

No		Jasa Ekosistem																					
		Provisioning services					Regulating services							Cultural services					Supporting s.				
		Bahan pangan	Serat	Sumber daya genetik	Obat alami	Air tawar	Pengatur udara & iklim	Pengatur air	Penghambat gasi	Penghambat neovakit	Penghambat hama	Penyerbukan	Pengurangan resiko bencana	ragam budaya	spiritual	pendidikan	Inspirasi	Estetika	Relasi sosial	Wisata	Pembentukan tanah	Daur nutrien	Daur air
Hulu	1	√	√	√	√	√	√	√	√	√	-	-	√	√	√	√	√	√	√	√	√	√	√
	2	√	√	-	-	√	√	√	√	√	√	√	-	-	-	-	-	-	-	√	√	√	√
	3	√	√	√	√	√	√	√	√	√	-	√	√	-	-	-	-	-	-	√	√	√	√

No	Jasa Ekosistem																					
	Provisioning services					Regulating services							Cultural services					Supporting s.				
	Bahan pangan	Serat	Sumber daya genetik	Obat alami	Air tawar	Pengatur udara & iklim	Pengatur air	Penghambat aerosol	Penghambat partikulat	Penghambat hama	Penyerbukan	Pengurangan risiko bencana	ragam budaya	spiritual	pendidikan	Inspirasi	Estetika	Relasi sosial	Wisata	Pembentukan tanah	Daur nutrien	Daur air
4	v	v	v	v	v	v	v	v	v	v	v	v	-	-	-	-	-	v	-	v	v	v
Tengah	5	v	v	-	v	v	v	v	v	-	v	v	-	-	-	-	-	v	-	v	v	v
	6	v	v	-	-	v	v	v	v	v	v	x	-	-	-	-	-	-	-	v	v	v
	7	x	x	-	-	x	x	x	v	-	-	-	-	-	-	-	-	-	-	-	x	-
	8	x	x	-	-	x	-	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-
	9	v	v	-	-	v	x	x	v	-	-	-	v	-	-	-	-	-	-	-	v	v
Hilir	10	v	v	-	-	v	x	v	v	-	-	-	-	-	-	-	-	-	-	-	x	x
	11	v	v	-	-	v	v	v	v	-	-	v	v	-	-	-	-	-	-	v	v	v
	12	v	v	-	-	v	v	v	v	-	-	v	v	-	-	-	-	-	-	v	v	v

(v) exist; (x) threaten; (-) none

4. Conclusion

Conclusions of this research are :

1. Gajahwong watershed still provides ecosystem services for human, even its type and quantity are limited.
2. Ecosystem services is divided into 4 main category, provisioning services, regulating services, cultural services, and supporting services, in form of natural and artificial ecosystem on Gajahwong watershed.
3. Ecosystem services on upstream is still complete and good condition, on downstream provides limited ecosystem services , while on middlestream the ecosystem services are barely exist.

References

- Asdak, Chay. 2007. *Hidrologi dan Pengelolaan Daerah Aliran Sungai*. Edisi keempat. Yogyakarta : Gadjah Mada University Press
- Millenium Ecosystem Assessment. 2005. *Ecosystem And Human Well-Being : Current State and Trends*. Volume 1. Wasington : Islandpress
- Santosa LW, Adji TN, Nurjani E, Suyanto A, Pitoyo AJ, Muta'ali L, Herumurti S, Nugraha AK, Zein AGI, Fahrudin MA, Mujiyanto BA, Hadi MA. 2012. *Laporan Akhir Kajian Lingkungan Hidup Strategis Kabupaten Banggai Kepulauan*. Tidak dipublikasikan
- Satriagasa MC, Wicaksono D, Widyastuti M. 2014. *Water Quality Study in Gajahwong River Using Contamination Index*. Dipublikasikan pada Indonesian Japan Joint Scientific Symposium (IJSS) 2014
- UU 27 tahun 2007 tentang pengelolaan pesisir dan pulau-pulau kecil
- UU PPLH nomor 32 tahun 2009 tentang perlindungan dan pengelolaan lingkungan hidup