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Checklist of Riparian Vegetation Potentially as Phytoremediators in the Upper Gajah Wong River, Yogyakarta

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Abstract. This study aims to determine the types of plants in the upper reaches of the Gajah Wong river which have the potential as phytoremediation agents and provide information about the function of riparian ecosystems. Plant sampling was carried out in December 2016 in three villages namely Sardonoharjo, Hargobinangun and Widomartani. The method used in this research is the transect and plot method. Transect measuring 200 meters according to the shape of the river and paired with a plot of 10 meters long, so that in each location there are 5 plots on the left and right of the river. Inventaritation of vegetation at the river level conducted in three villages upstream of Gajah Wong river found 84 types of plants consisting of 28 types of floor plants (herbs), 23 types of bush plants, 13 types of shrubs, and 21 species of trees. Whereas for phytoremidiator agents 30 plants were found that were able to reduce pollutants based on previous research. The village that has the highest diversity is Wedomartani and Sadonoharjo villages with 41 plant species. Whereas for Hargobinangun village where the place is higher, only 37 species of plants are found.

Keywords: Gajah wong river, Phytoremediation, Plot method, Riparian ecosystem, Transect method

INTRODUCTION

Gajah Wong River is one of the major rivers that divide the city of Yogyakarta in addition to the Code and Winongo rivers. The upstream part is on the slopes of Mount Merapi in Sleman Regency, while the downstream is in Bantul Regency. Gajah Wong River is an aquatic ecosystem that has a vital function to maintain environmental balance in the Yogyakarta. Based on the Governor's Decree of the Head of Yogyakarta Special Region (DIY), Gajah Wong River is included in class B, which means that river water can be used as a source of drinking water by being processed first. The condition of the Gajah Wong river is strongly influenced by community activities on the banks or in the watershed (DAS). So that river conditions can describe the social conditions of the local community. But ironically, the river pollution has been classified as severe. One of the causes of the high level of river pollution can be due to less integrated river function, and waste disposal. Plus the cement closure of river banks also causes vegetation of river banks (riparian) difficult to grow to carry out their functions in phytoremediation agents.

According to Yasaroh (2016), one of the highest contaminants in the river is non-integrated waste disposal. The results of the Gajah Wong River analysis show that PT. Budi Makmur Jaya produces a very high chromium (Cr) content of 80.4530 ppm, while the quality standard limit is only 0.5 ppm. Of course it will endanger the environment. Other studies have shown that the chrome content of Gajah Wong river water has a major influence on the accumulation of chromium in plants. This shows that plants are able to reduce chromium levels by absorbing and accumulating waste. Chromium heavy metals can have adverse effects, including triggering cancer and tumors, killing water and soil microorganisms, and reducing soil fertility.

One component of the ecosystem that plays an important role in maintaining water quality is the riparian ecosystem. Some riparian plants that have the ability to remediate contamination include *Limnocharis flava*, *Ipomoea aquatica*, *Fimbristylis globulosa*, *Vetiveria zizanoides*, *Equisetum ramosissium*, *Typha angustifolia*, *Sesbania grandiflora* and *Scirpus grossus.* *Ipomoea aquatica* and *Typha angustifolia* plants can also remediate Cd, Co, Cu, Ni, Pb and Zn (Kumar, 2012). *Limnocharis flava* is also capable of remediating Fe, Cu, and Pb (Korsah, 2011). The laboratory research conducted by Prahardhika (2013) showed that the plants of *F. globulosa* and *V. zizanoides* were able to reduce nitrate concentrations up to 99%, whereas according to Sundari (2013) a combination of hydromacrofita *S. grossus* and *L. flava* was able to reduce nitrate concentration by 99 , 44 - 99.61%. The results of laboratory studies show that *E. rammositionum* grows with *T. angustifolia* can reduce nitrate concentration by + 99.41 - 99.51% (Vidyanti, 2013). Based on the results of research on plants proven to significantly reduce environmental pollution.

The vegetation of Riparian is a zone that connects two ecosystems between river and land ecosystems. The ecological function of riparian vegetation is to support the stability of the ecosystem because it plays a role in the cycle of carbon, oxygen, nitrogen and the water cycle. Riparian vegetation damage occurs due to various functions of one land function. Therefore, protection against riparian vegetation is needed. Riparian vegetation is a supplier of energy into river systems and as a parameter of biotic diversity. This is

because the riparian vegetation area is a source of water, food, and habitat for various kinds of flora and fauna. The vegetation of riparian has a very important role in determining the structure and function of the Gajah Wong river ecosystem. Water quality and river ecosystems depend on the ecological sustainability of riparian vegetation. Therefore, protection against riparian zones is needed. Based on this background, it is necessary to conduct riparian vegetation research in the Gajah Wong river.

MATERIALS AND METHODS

Study Area

Plant sampling was carried out in December 2016 in three villages namely Sardonoharjo, Hargobinangun and Wedomartani. The sample taken is plant vegetation at each observation station. Observation of riparian vegetation is classified into 4 groups, namely Bush, Shrubs, tree and Herb.

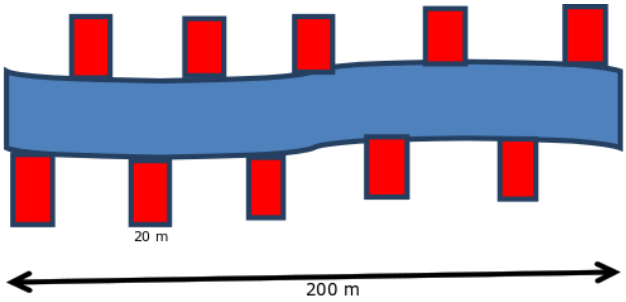

Figure 1. Sampling scheme for riparian vegetation.

Procedures

This research uses purposive sampling method. The station determination was carried out purposively in each type of riparian for vegetation analysis. At each station a transect is installed which is equipped with a plot. A 200 m transect follows the shape of the river and is installed in a 10 meter long plot. So that at each location there are 5 plots on the left and right of the river with a size of 20x10m.

Data Analisys

Observations were analyzed descriptively comparatively by comparing the number of species found at each station. Composition of vegetation types was also correlated descriptively with the condition of the station. Whereas for the types of plants that have potential as phytoremediator are determined through literature studies using research journals.

RESULTS AND DISCUSSION

Composition of Riparian Vegetation Types

Vegetation inventory at the river level carried out on three villages in the upper reaches of Gajah Wong river found 84 types of plants consisting of 28 types of floor plants (herbs), 23 types of bush plants, 13 species of shrubs, and 21 species of trees. Floor vegetation plants dominate because the character of this plant grows very easily. Whereas the composition of tree stands is strongly influenced by the presence of the agent of seed dispersal and the wide habitat of the land.

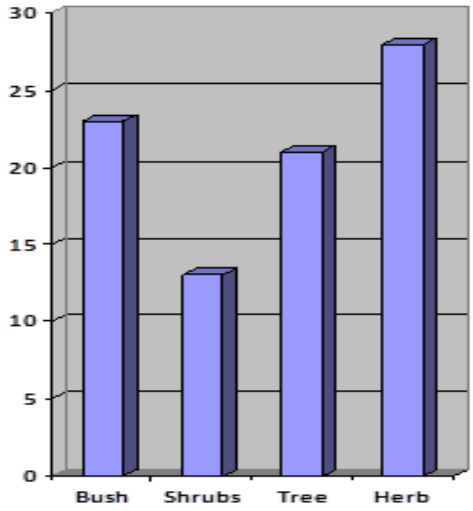

Figure 2. Composition of number of types of stand.

Table 1. List of tree species results inventories.

No	Family	Local Name	Species
1	Fabaceae	Petai cina	*Laucena leucocephala*
2	Muntingiaceae	Talok	*Muntingia calabura*
3	Euphorbiaceae	Telo Karet	*Manihot glaziovii*
4	Myrtaceae	Jambu air	*Syzygium aqueum*
5	Fabaceae	Trembesi	*Samanea saman*
6	Sapotaceae	Sawo kecik	*Manilkara kauki*
7	Moraceae	Nangka	*Artocarpus heterophyllus*
8	Clusiaceae	Nyamplung	*Calophyllum inophyllum*
9	Fabaceae	Sengon	*Albizia chinensis*
10	Moraceae	Beringin	*Ficus benjamina*
11	Fabaceae	Gayam	*Inocarpus fagifer*
12	Moraceae	Sukun	*Artocarpus altilis*
13	Moraceae	Elo	*Ficus racemosa*
14	Malvaceae		*Pterospermum javanicum*
15	Combretaceae	Ketapang	*Terminalia catappa*
16	Malvaceae	Waru	*Hibiscus tiliaceus*
17	Meliaceae	Mahoni	*Swietenia mahagoni*
18	Anacardiaceae	Mangga	*Mangifera indica*
19	Gnetaceae	Melinjo	*Gnetum gnemon*
20	Meliaceae	Mindhi	*Melia azedarach*
21	Meliaceae	Mahoni	*Swietenia mahagoni*

Table 2. List of shrubs species inventory results.

No	Family	Local Name	Species
1	Moraceae	Awar-awar	*Ficus septica*
2	Poaceae	bambu	*Bambusa tuldoides*
3	Euphorbiaceae	petung Mara	*Maracanga tanarius*
4	Arecaceae	Pinang	*Areca catechu*
5	Arecaceae	Kelapa	*Cocos nucifera*
6	Arecaceae	Langkap	*Arenga westerhoutii*
7	Euphorbiaceae	Puring	*Codiaeum variegatum*
8	Musaceae	Pisang	*Musa paradisiaca*
9	Euphorbiaceae	Telo Karet	*Manihot esculenta*
10	Fabaceae	Kaliandra Putih	*Calliandra haematocephala*
11	Euphorbiaceae	Jarak	*Jatropa curcas*
12	Pandanaceae	Pandan duri	*Pandanus tectorius*
13	Caricaceae	Pepaya	*Carica papaya*

Table 3. List of bush species inventory results.

No	Family	Local Name	Species
1	Asteraceae	Babandotan	*Ageratum conyzoides*
2	Euphorbiaceae	Kucing-kucingan	*Acalypha indica*
3	Phyllantaceae	Meniran	*Phyllantus niruri*
4	Pandanaceae	Pandan	*Pandanus amaryllifolius*
5	Malvaceae	Sidaguri	*Sida rhombifolia*
6	Canaceae		*Cana glauca*
7	Euphorbiaceae	Teh-tehan	*Acalypha siamensis*
8	Campanulaceae	Ki tolod	*Hippobroma longiflora*
9	Arecaceae	Salak	*Salacca zalacca*
10	Amaranthaceae	Bayam	*Amaranthus tricolor*
11	Araceae	Talas	*Celocasia esculenta*
12	Asterceae	Kriyuh	*Chromolaena odorata*
13	Poaceae	Kalanjana	*Pennisetum purpureum*
14	Bromeliaceae	Nanas	*Ananas comosus*
15	Piperaceae		*Piper aduncum*
16	Malvaceae		*Sida acuta*
17	Araceae	Keladi	*Caladium bicolor*
18	Araceae	Senthe	*Alocasia macrorrhizos*
19	Apocynaceae	Tapak dara	*Catharantus roseus*
20	Araceae	Kimpul	*Xanthosoma sagittifolium*
21	Poaceae	Rumput payung	*Cyperus alternifolius*
22	Araceae		*Philodendron sagittifolium*
23	Araceae		*Colocasia argentea*

Table 4. List of herbs species inventory results.

No	Family	Local Name	Species
1	Araceae	Kayu apu	*Pistia stratiotes*
2	Marsileacea	Semanggi	*Marsilea crenata*
3	Piperaceae	Suruhan	*Peperomia pelludica*
4	Solanaceae	Ceplukan	*Physalis angulate*
5	Euphorbiaceae	Patikan kebo	*Euphorbia hirta*
6	Fabaceae	Putri malu	*Mimosa pudica*
7	Pteridaceae		*Adiantum latifolia*
8	Pteridaceae		*Adiantum trapeziforme*
9	Solanaceae	Kangkung	*Ipomea aquatic*
10	Poaceae	Rumput teki	*Cyperus rotundus*
11	Poaceae		*Digitaria ciliaris*
12	Poaceae		*Eleusina indica*
13	Asteraceae		*Wedelia trilobata*
14	Asteraceae		*Vernonia cinera*
15	Acanthaceae		*Asystasia gangetica*
16	Asterceae		*Blumea lacera*
17	Poaceae		*Eriochloa procera*
18	Poaceae		*Cyperus alternifolius*
19	Poaceae		*Arthaxon hispidus*
20	Fabaceae		*Desmodium gigantea*
21	Selaginellaceae	Cakar ayam	*Selaginella doederleinii*
22	Asteraceae		*Mikania micranta*
23	Araceae	Daun bahagia	*Diffenbachia seguine*
24	Aspleniaceae		*Asplenium longissium*
25	Vitaceae		*Cissus discolor*
26	Asteraceae		*Sphagneticola trilobata*
27	Amaranthaceae	Bunga Kancing	*Gomphrena globosa*
28	Fabaceae		*Clitoria ternatea*

Composition of Riparian Vegetation in Each Station

Based on the research that has been carried out by villages that have the highest species diversity are Wedomartani and Sadonoharjo villages with 41 plant species. Whereas for the village of Hargobinangun, which is more upstream, only 37 species of plants. This is because the village is commensurate river as concrete construction to facilitate the activities of local residents in the use of river water. River water in Hargobinangun village is one of the sources of clean water used by residents for consumption needs. Concrete construction on the river is considered to facilitate the activities of the people even though it has an impact on the decline of riparian plants. Lack of public understanding of the importance of maintaining river ecosystems is considered to be one of the causes of the lack of

wisdom managing rivers. In this study shows that making concrete construction greatly affects the composition of riparian vegetation types. It can even be said that the manufacture of concrete construction on river banks can reduce the abundance of riparian vegetation. The composition of riparian vegetation is strongly influenced by the character of river banks. This is evidenced by the high data on the composition of riparian species in the villages of Wedomartani and Sadonoharjo because they have riverbanks that are still natural or derived from the soil. As for the composition of the number of tree stands affected by the presence of community activities. Riverbanks that are close to residential areas have resulted in more tree stands. The existence of a tree stand can grow because it is intentionally planted by the community for the benefit of consumption or seeds of plants that are naturally spread by animals or river flow.

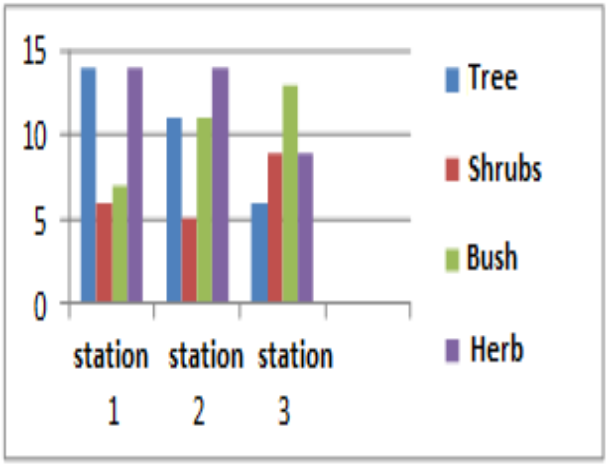

Figure 3. Composition of the Number of types of enforcement in each station.

Riparian Species That Have Potential As Phytoremediators

Riparian vegetation that has potential as a phytoremediator is selected based on a literature study that examines the effectiveness of vegetation types in remediating waste. The effectiveness of remediation results is seen after going through the process of calculating the reduction of waste levels carried out in the laboratory. Of the 84 species obtained from the inventaritation, obtained 30 potential species as pollutant phytoremediator agents based on previous research. The following are 30 plant species from the inventaritation of riparian plants in the Gajah Wong river along with the phytoremediation capacity of pollutants for each type:

Table 5. Riparian species of Gajah Wong river that have potential as phytoremidiators.

No	Species	Potency
1	*Ipomea aquatica*	Remediate Cd, Co, Cu, Ni, Pb, Zn and reduce phosphate levels in laundry waste
2	*Marsilea crenata*	Decreasing levels of sulfonate (S) and phosphate (P) groups from soap waste and being able to absorb cadmium meta (Cd)
3	*Pistia stratiotes*	Apu wood can reduce Organic Pollutants and P-PO4 by 55.52% and 60.62% is able to purify water and neutralize pH
4	*Eleusina indica*	Reducing pollutant petroleum hydrocarbons waste oil and being able to accumulate cyanide and Pb
5	*Wedelia trilobata*	Accumulating Hg reaches 2.5 ppm and improves soil properties
6	*Cyperus rotundus*	Accumulating Sn, Zn, As, Cu and Pb
7	*Musa paradisiaca*	Accumulating Cu ions
8	*Bambusa tuldoides*	Reducing and accumulating phosphate compounds (P) in detergent waste
9	*Pandanus tectorius*	Metal accumulation of iron (Fe)
10	*Ficus racemosa*	Store water and prevent erosion
11	*Samanea saman*	Revegetation plants and absorb high CO2
12	*Digitaria ciliaris*	Reducing mercury levels (Hg)
13	*Ficus benjamina*	Absorb heavy metals Cd (Cadmium)
14	*Laucena leucocephala*	Reclamation plants because they can reduce the levels of heavy metals in the soil
15	*Ageratum conyzoides*	Reducing metal Cd 52.2%
16	*Acalypha indica*	Reducing the levels of metal chrome (Cr) and lead (Pb)
17	*Celocasia esculenta*	Absorption of organic pollutants (C, N and P) reaches 20ppm
18	*Chromolaena odorata*	Reducing metal Cd 22.1%
19	*Cyperus alternifolius*	Reducing the level of lead (Pb) in Lindhi water
20	*Pennisetum purpureum*	Effectively accumulates Pb levels
21	*Alocasia macrorrhizos*	Reducing ammonium levels in Lindhi water
22	*Sida acuta*	Accumulating Chromium (Cr) in skin waste amounting to 7489.8 ppm
23	*Caladium bicolor*	Absorbs the mercury content (Hg) in the former gold mine
24	*Amaranthus tricolor*	Absorbs the As and Zn content and holds it in the leaves
25	*Swietenia mahagoni*	Reclamation plants because they can reduce the levels of heavy metals in the soil
26	*Mikania micranta*	Accumulating large amounts of cyanide and lead
27	*Mimosa pudica*	Pioneer plants for land succession and able to accumulate heavy metals
28	*Euphorbia hirta*	Reducing metal Cd 51.2%
29	*Jatropa curcas*	Levels of toxic compounds (ammonia, heavy metals, compounds and chlorinated organics) in Lindhi water
30	*Calliandra haematocephala*	Reclamation plants because they can reduce the levels of heavy metals in the soil

Phytoremediation

Each riparian vegetation species has the ability to remediate different pollutants. But the existence of riparian vegetation has a real function in breaking down river pollution. This is consistent with Martini (2005) which states that riparian plants are able to respond significantly to river pollutants at the level of individuals, populations or communities. In conducting phytoremediation in order to obtain effective results, things that need to be considered are choosing plants that have resistance criteria for heavy metals, high growth rates, resistance to fluctuating water conditions, and characteristics of spreading roots. There are several factors that can affect the absorption of heavy metals by plants, namely plant species, the nature of the media used, root distribution, and vegetative uptake (Sholeh, 2016).

Phytoremediation has several advantages, that is the operational is lowest cost when compared with other remediation techniques because it does not require energy to be generated (using solar energy) and does not require waste treatment equipment. This method is aesthetically very good and interference to the environment impact is minimal because it can maintain topsoil that can be used for agricultural reclamation. However apart from that, phytoremediation has weaknesses, while the weaknesses of phytoremediation are the need for a long time to remove pollutants in a sometimes area for years. Another disadvantage is that the root depth is limited and unable to reach pollutants that enter too deeply into the soil. The concentration of contaminants that are too high and the conditions of climate change will certainly greatly affect plant growth (Tangahu et al., 2011).

CONCLUSIONS

Based on the research "Inventaritation of Riparian Vegetation Potentially as Phytoremidiators in the Upper Gajah Wong River" it can be concluded that:

1. The species of riparian vegetation types is strongly influenced by the condition of the river banks and the presence of seed dispersal agents (humans and animals). Harjobinangun village has the lowest level of riparian vegetation due to the riparian banks of riparian growing habitats that have undergone cement closured. Whereas for Sadonoharjo and Wedomartani villages which still have natural riverbank habitats, the riparian species is higher.
2. The species of tree stands is influenced by the character of the banks and the extent of river banks.
3. Floor vegetation has the highest level of species because it has an adaptive growth character and does not require extensive growth.

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