

04. The evaluation of water hyacinth (*Eichhornia crassiper*)

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Submission date: 19-Nov-2019 07:28AM (UTC+0700)

Submission ID: 1216676921

File name: 04._The_evaluation_of_water_hyacinth_Eichhornia_crassiper.pdf (708.38K)

Word count: 2629

Character count: 14070

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To cite this article: N Hidayati *et al* 2018 *IOP Conf. Ser.: Earth Environ. Sci.* **142** 012016

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The evaluation of water hyacinth (*Eichhornia crassiper*) control program in Rawapening Lake, Central Java Indonesia

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Abstract. The existence of water hyacinths and other aquatic plants have been a major concern in Rawapening Lake for many years. Nutrient input from water catchment area and fish feed residues suspected to leads eutrophication, a condition that induces uncontrolled growth of aquatic plants. In dry season, aquatic plants cover almost 70% of lake area. This problem should be handled properly due to wide range of lake function such as water resources, fish farming, power plants, flood control, irrigation and many other important things. In 2011, Rawapening Lake was appointed as pilot project of Save Indonesian Lake Movement: the Indonesian movement for lakes ecosystem conservation and rehabilitation. This project consists of 6 super priority programs and 11 priority programs. This paper will evaluate the first super priority program which aims to control water hyacinth bloom. Result show that the three indicators in water hyacinth control program was not achieved. The coverage area of Water hyacinth was not reduced, tend to increase during period 2012 to 2016. We suggesting better coordination should be performed in order to avoid policies misinterpretation and to clarify the authority from each institution. We also give a support to the establishment of lake zonation plan and keep using all the three methods of cleaning water hyacinth with a maximum population remained at 20%.

1. Introduction

One of sustainable development goals (SDGs) is to ensure the availability and sustainable management of water and sanitation for all [1]. This goal was in line with one of Indonesian national development agenda during 2014-2019 increasing water security [2]. One of its indicators is improving water quality in 15 priority lakes and 5 priority river areas.

Since 2010, the Indonesian government has set fifteen lakes to prioritize its management. This is based on the urgency of its ecosystem damage due to over capacity [3]–[5]. There are at least four symptoms for a lake that has exceeded its capacity: the diminishing production of fisheries, the rapid growth of aquatic plants, pollution of water sources and the loss of endemic organism, and the silting up and depletion of lake [6].

Uncontrolled growth of aquatic plants is the most recognizable characteristic and most common feature of lakes in the world. This phenomenon occurs due to eutrophication, a condition of increased



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nutrient content of waters [7,8]. Nutrient input may come from waste and agricultural activity in water catchment area [9] and fish feed residues from floating net cages. For an example, Lake Rawapening has experienced the phenomenon of the floating island since the 1920s [10]. Since that time, endless problem of aquatic plants, especially water hyacinth, is began. In 2005, it was observed that hyacinth cover the water are until 65% [11] even more, until 70%, in dry season [5]. This condition threatened lake function as water resources, fish farming, power plants, flood control, irrigation, tourism, etc.

To overcome the problems experienced by those 15 priority lakes, in October 14th, 2011 nine ministries have an agreement to conduct a save lake movement [10] stand Indonesian movement for lakes ecosystem conservation and rehabilitation. Rawapening Lake was appointed as the pilot project for period 2012-2016. The program of Rawapening consists of 6 super-priority programs and 11 priority programs with the first super-priority is to control water hyacinth bloom.

Now, 5 years have passed since the save lake movement program launched. For that this study aims to determine the extent to which water hyacinth control program indicators have been achieved and what efforts have been done by the government to pursue these targets.

2. Methods

There are 3 activities in water hyacinth control program: mechanical, biological and chemical strategies. Those activities have 3 indicators: the percentage of water hyacinth coverage for mechanical, the number of grass carp fish for biological and the amount of eco-friendly herbicide for chemical efforts. The percentage of water hyacinth coverage is measured by geographical information system (GIS) technique, while the number of grass carp fish and eco-friendly herbicide is assessed from the information of the implementing agency.

High resolution satellite imagery (HRSI) was used to measure the coverage of water hyacinth in the beginning of program (2012) and by the end (2016). The satellite imageries were generated from GeoEye-1 and WorldView-2, selected of the adjacent date which has a clear image quality i.e. July 5, 2012 and July 16, 2016. Groundcheck of 15 points was done using global positioning system (GPS) to ensure the suitability of the image with field conditions.

Image data was processed using ArcMap 10.1. Manual digitization was used to create lake's surface boundary. Supervised classification was used to distinguish water vegetation with others. Then, classified aquatic plants were digitized and grouped to obtain the size of the water hyacinth coverage area.

The achievement of the controlling activities of water hyacinth is confirmed to program implementing agency to determine the constraints they have faced.

3. Result and discussion

Rawapening Lake is a semi-natural lake located at 7°4' - 7°30' S and 110°24'46" - 110°49'06" E at altitudes between 455 - 465 meters above sea level. Administratively, it is located in Semarang Regency, Jawa Tengah Province with water catchment area covering Semarang regency (89.63%), Salatiga city (9.31%) and Magelang Regency (1.2%) [11]. Rawapening has 9 inlets which are Galeh, Torong, Panjang, Legi, Parat, Sraten, Rengas, Kedung Ringin dan Ringis and 1 outlet: Tuntang River.

Water hyacinth control program involving three government agencies from different level governance that are Ministry of Public Works and Public Housing Directorate General of Water Resources Balai Besar Wilayah Sungai Pemali Juana (BBWSPJ), Jawa Tengah Provincial Agency of Water Resources (Dinas Pekerjaan Umum Sumberdaya Air dan Tata Ruang/Dinas PUSDATARU) and Jawa Tengah Provincial Agency of Marine and Fisheries (Dinas Kelautan dan Perikanan/DKP). BBWSPJ was appointed as leading sector and program coordinator. Based on Ministry of Public Works and Public Housing Regulation No.4/2015, Rawapening Lake is managed by central government (BBWSPJ), while the rivers which cross regency boundaries around Rawapening are managed by regional government (Dinas PUSDATARU).

The first activity in water hyacinth control program is reducing water hyacinth coverage using mechanical equipment conducted by BBWSPJ. From 2011 until 2016, BBWSPJ only using excavator

to cleaned water hyacinth combined with human resources by empowering surrounding community. Funded as much as 500 million Indonesian Rupiah/ year, this method was only able to clean water hyacinth as much as 20 ha per year. Meanwhile, Dinas PUSDATARU controlled water hyacinth population at Tuntang Canal by built klante, a series of pole to stem the spread of water hyacinth. Other efforts undertaken by government such as building check dam, river normalization and infiltration wells, didn't directly targeted water hyacinth blooming but effectively blocked sediment entering the lake.

Rawapening was dammed in 1936 by the Dutch East Indies Government with maximum water surface area 2,667 ha in rainy season (November-April) and 1,650 ha during drought season (May-October) [11,12]. The water surface area widens and narrows depending on the rainfall intensity in the water catchment area. Based on satellite imagery observation, it can be seen that the lake surface area has increased from 2012 to 2016, from 1.693 ha to 1.720 ha.

From the determination of water surface area using HRSI, it could be calculated the percentage of water hyacinth coverage. This study was not distinguishing water hyacinth with other aquatic plants because practically, the cleaning hadn't distinguished it anyway. Aquatic plants area in 2012 was 775,49 ha, while in 2016 its widens as much as 990,53 ha respectively. So, the coverage of aquatic plants was increased from 46 % to 58 % (Figure 1 Figure 2).

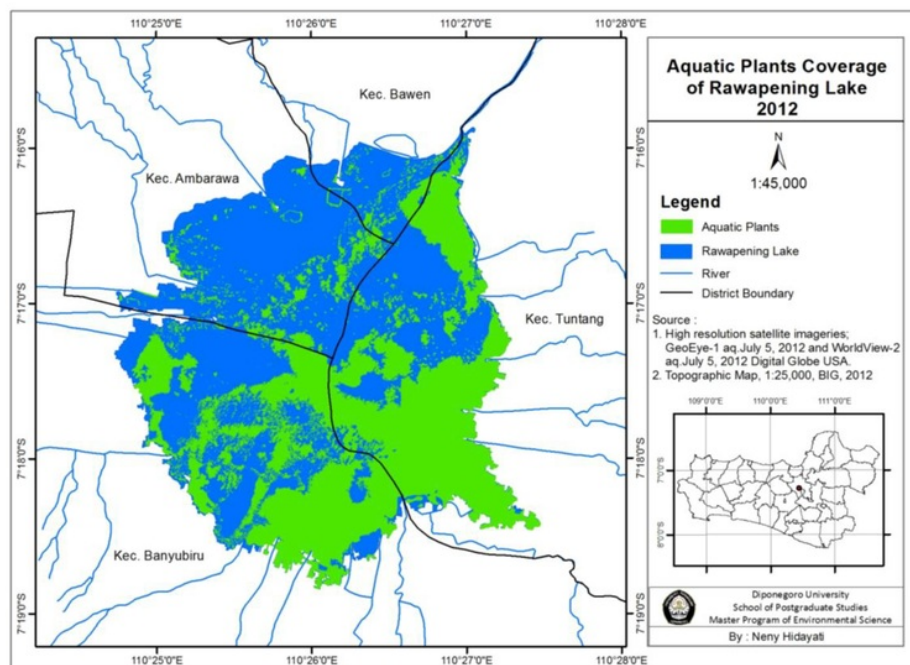


Figure 1. Aquatic plants coverage of Rawapening Lake 2012

In 2012, aquatic plants mostly distributed in Tuntang and half of Banyubiru district (Figure 1), while in 2016 the aquatic plants almost cover Banyubiru's part and invaded to Ambarawa district (Figure 2). The cleaning of these plants should conducted regularly since water hyacinth could be able to doubled within 12 days [13] or it may said that it took 52 days to form 1 m² colony. Water hyacinth is a floating plant that able to move following wind and water flow. During rainy season, it moves to peripheral, blocking waterways and make it difficult for farmers to cultivate their land. The existence

of water hyacinth is not always harmful, it can be used as a sediment trap, bioaccumulator, fish shelter and protect shorelines from erosion [14].

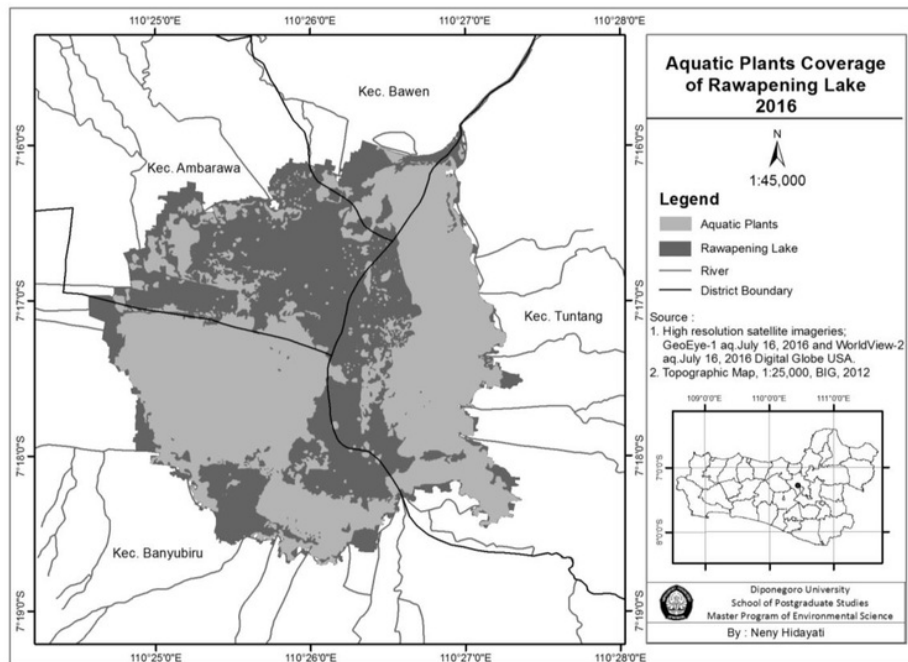


Figure 2. Aquatic plants coverage of Rawapening Lake 2016

Given the protracted water hyacinth problem, BBWSPJ feels the need to establish its own operating and control unit. In January 2017, it was set up Operasi & Pengendalian IV unit Rawapening (OP IV) which specifically manages the lake. As the first step, OP IV equipped with more adequate equipment such as excavator long arm (1 unit), excavator short arm (1 unit), multipurpose dredger (1 unit), amphibious weed harvester (3 units) and dump truck (3 units). The capacity of these equipment is 1 ha/day. If it is operated everyday, it will take 3 years to remove all of water hyacinth, assuming no vegetation doubling. Mechanization may be effectively used in small area, but in wider lake, it consume more time, money and energy [15]. Mechanical method also threatening the ecology, affecting other species life and even ruining it [16]. In case of Rawapening, mechanization potentially caused social conflict with the owner of floating net cages and craftsmen.

The second activity of water hyacinth control program is reducing water hyacinth using biocontrol. Jawa Tengah provincial agency of marine and fisheries (Dinas Kelautan dan Perikanan/DKP) using grass carp fish *Ctenopharyngodon idella* (ikan koan). Grass carp targeted the stocking of 5.000.000 grass carp whose 100 g of weight every year. DKP was only able to provide 100.000 in 2012 and 2013, 105.000 in 2014, 148.300 in 2015 and none in 2016 due to the implementation of Law No.23/2014 on Regional Government. According to DKP, there is still unclearly explanation about the fisheries regional government authority at Rawapening Lake. Beside there are other priorities that need attention as well.

It could be said that controlling water hyacinth growth using grass carp is inefficient in Rawapening Lake because the amount is too small and fisherman still freely caught it. Nevertheless, 5.000.000 grass carp a year seems too much since Kerinci Lake in Jambi Sumatra whose success

stories of biological method used only 2.000 grass carp per year. After 10 years using grass carp, the lake now clean from water hyacinth, but some of endemic fish species reported had been scarce to found [17]. Using grass carp to control water hyacinth growth is the most ecologically secure way, but it takes time and its need to maintain the number of predator and prey population. To overcome those problems, one of viable way is to combine several species such as grass carp and weevil (*Neochetina* spp) that have been proved to be more efficient and sustain [18].

The third method of water hyacinth control is using eco-friendly herbicide. This method is unconduted because the agency reluctant to do so. There is also unclear statement to whom the responsibility of this activity addressing to, because of lack coordination between the agencies. Cleaning up using herbicide had been done in 1964/1965. Despite its price and speed, cheaper and faster, herbicide no longer use because several damage effects, such as irritation and light poisoning. Even so, herbicides can still be an option to clean the water hyacinth in the middle of the lake that is difficult to reach by mechanical equipment.

Overall, after some of interviews with the stakeholders, the problems during program implementation are unsynergistic law and regulation, lack of coordination between stakeholder, low financial support, potential social conflict, and technical constraint in each method that described above.

4. Conclusion

The three indicators in water hyacinth control program which observed in this study were not achieved. The main indicator is Water hyacinth coverage area which not reduced and tend to increase during 2012 to 2016. We are suggesting a better coordination in order to avoid policies misinterpretation, as well as to clarify to the authority in each institution. We also suggesting the establishment of lake zonation plan and keep using all the three ways of cleaning water hyacinth with a maximum population remained at 20%.

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