EVALUATION OF UNIVERSITAS INDONESIA'S RECHARGE POND PERFORMANCE AND POTENTIAL UTILIZATION FOR RAW WATER SOURCE

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Abstract

The UI recharge pond has been constructed 5 years ago. However, monitoring and evaluation activities on its performances are very lack. Aims of this study are to understand the recharge rate, and to evaluate existing quantity and water quality of the pond during dry and rainy season. Measurement of water depth, rainfall intensity, and evaporation is conducted to determine water availability, recharge rate, and water balance of the recharge pond. Amount of surface water is collected from recharge pond and river at three sampling point to determine existing water quality of the pond. The results showed that recharge rate of the pond between dry season (3.2 mm/day) and wet season (6.1 mm/day) are considered as insignificant different. The water balance of the recharge pond shows an excessive rate. Various physics and chemical parameters (turbidity, color, TDS, pH, and Cl) are found to have concentration lower than the water quality standard. The results suggest that the pond surface water is remain suitable to be recharged into aquifer zone so that sustaining ground water conservation campaign, and it is potential to be utilized as an additional raw water source for domestic water demand of UI Campus Depok.

Abstrak

Evaluasi Kinerja Waduk Resapan UI dan Potensi Pemanfaatannya sebagai Sumber Air Baku. Waduk resapan Universitas Indonesia (UI) telah dibangun sejak 5 tahun yang lalu. Namun kegiatan monitoring dan evaluasinya sangat minim dilakukan. Tujuan dari studi ini adalah untuk mengetahui laju resapan, dan untuk mengevaluasi kondisi kuantitas dan kualitas air waduk resapan selama musim kemarau dan penghujan. Pengukuran kedalaman muka air, intensitas curah hujan dan penguapan dilakukan untuk menentukan ketersediaan air, laju resapan, dan imbangan air waduk. Sejumlah air permukaan diambil dari waduk resapan dan sungai di tiga titik sampling untuk mengetahui kondisi kualitas air eksisting. Hasil studi menunjukkan tidak ada perbedaan yang signifikan antara laju resapan musim kemarau (3,2 mm/hari) dan musim penghujan (6,1 mm/hari). Imbangan air waduk resapan menunjukkan nilai yang berlimpah. Berbagai parameter fisik dan kimia air (kekeruhan, warna, TDS, pH, dan Cl) mempunyai konsentrasi di bawah standar baku mutu. Temuan dari studi ini antara lain bahwa air permukaan waduk masih layak untuk diimbuhkan ke dalam lapis aquifer sehingga mendukung keberlanjutan gerakan konservasi air, dan ketersediaannya sangat berpotensi untuk dikembangkan sebagai sumber air baku tambahan bagi kebutuhan air domestik di lingkungan Kampus UI Depok.

Keywords: raw water source, recharges rate, UI recharge pond, water conservation, water quantity and quality

1. Introduction

Among of several drought and flood countermeasures effort in Jakarta and surrounding area, one of the potential alternatives recommended is by constructing small scale reservoirs, such as recharge pond. By the present of a recharge pond, the load of a flood can be reduced; where the pond will collect, stores and infiltrates excess water during the flood event. In order to mitigating flood discharge and conserving water at Depok city area as a buffer zone for ground water at Jakarta areas, a recharge pond has been built in Universitas Indonesia (UI) campus, Depok.

The UI recharge pond which constructed in 2006, initially, was aimed to collect water discharges from a drain channel, storm water, surface runoff, and allow it to infiltrated, percolated and thus recharging ground water. As a model reservoir at field scale, UI recharge pond having significant quantitative and qualitative values [1]. Consequently, monitoring and evaluation both on quantity and water quality is required to ensure

its function works properly, and the water that recharged into ground surface is kept in good quality. However, since the last 5 years of the recharge pond have been operated, such a continuous monitoring and evaluation activities is very lack, especially during the dry and rainy season. Quantitatively, Legowo and Sudinda [1] conducted a preliminary study after two years construction of the UI recharge pond. They investigated and calculated merely the recharge rate of the pond in rainy season of December 2007 and January 2008. Similar investigation was continued by Rasmiati on February 2009 [2]. Qualitatively, related research based on analysis result of recharge pond water quality shown that concentration of Iron (Fe) is relative higher than water quality standard [3], and so does for other parameters; COD, Nitrogen–Ammonium, and Phosphate [4]. Despite given an important basic data, those researches were carried out separately. Therefore, a preliminary research analyzing recharge rate of the pond as well as examining quantity and water quality during dry and rainy season is urgently required. In addition, a study on the recharge pond potency to be developed as raw water source for domestic use of UI campus in near future is valuable.

This paper describes the results of preliminary research on the UI recharge pond performances in both quantity and water quality during dry and rainy season in order to evaluating its function to conserves water and the potential utilization for raw water source.

2. Methods

The evaluation is carried out based on both observation and measurement at site, and water quality analysis at laboratory. Hydrometric measurement and water sampling are conducted on June 2011; represents the dry season, and on October-November 2011; represent the rainy season.

Hydrometric measurements. Observation at the field covers identifying current condition of water discharge, intake channel, solid waste, outlet channel, spill channel, pond banks, and land cover. The water depth is measured using conventional measuring ropes, and conducted for 11 times during the measurement period. The location of measurement is distributed into four control points inside the recharge pond to get the averaged water depth of the pond; three points at the outer pond (CP_1, CP_2, CP_3), and one point at the main pond (CP_4) as shown in Figure 1.

The rainfall intensity is measured daily using automated rain gauge and manual rain gauge as a control. Daily evaporation was measured at the field using pan evaporation, conducted at one single day by assuming that there is no significant change of evaporation data during one year.

Water balance. The water balance of recharge pond in this study is defined as subtraction between the volume of water availability against water demand and recharge rate. The recharge rate is determined using the Darcy's law formulated as the following [5]:

$$v = \frac{Q_{rp}}{A_{rp}} \quad (1)$$

where v is the recharge rate (or known as Darcy velocity or specific discharge), Q_{rp} is the discharge of recharge pond, A_{rp} is the surface area of recharge pond.

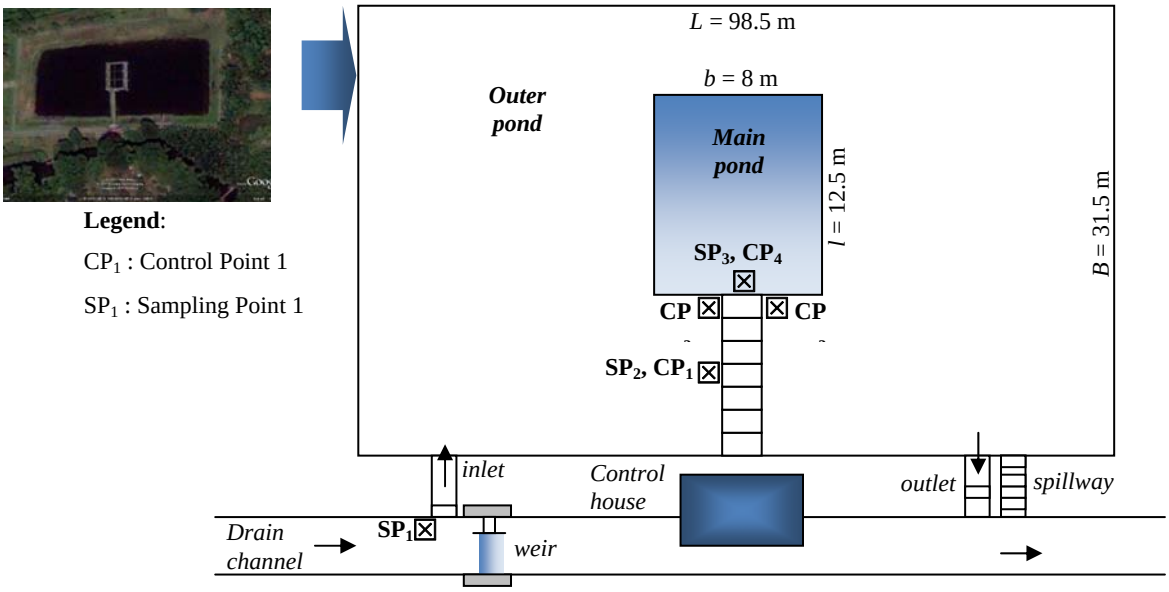

Figure 1. Location of the Control Point and Sampling Point

The discharge of recharge pond Q_{rp} is simply calculated based on the balance between inflow and outflow discharge, formulated as the following [1]:

$$Q_{rp} = \Sigma Q_i - \Sigma Q_o$$
$$\Sigma Q_i = Q_p + Q_{ro} + Q_s$$
$$\Sigma Q_o = Q_{sp} + Q_e \quad (2)$$

where Q_i is the total inflow discharge into recharge pond, Q_o is the total outflow discharge out the recharge pond, Q_p is the precipitation discharge, Q_{ro} is the surface runoff discharge, Q_s is the supply discharge from drainage channel, Q_{sp} is the outflow discharge from spill channel, Q_e is the evaporation discharge from recharge pond surface.

Water demand. Raw water demand in this study is determined from the total academia society and inhabitant of student dormitory multiplied by raw water consumption for campus/ institution usage. According to the Communication Section of UI year 2011 data, it is found that the number of academia society is about 56,537 capita, and students who stayed in dormitory is about 1,014 capita. While raw water consumption for institutional education was assumed about 30 liter percapita perday [6].

Water availability. The water availability of the recharge pond is defined as the total volume of surface water in the recharge pond area, which is depend on the rainfall intensity and water supply from drainage channel.

In the calculation of water balance analysis, the recharge pond storage volume -that will be designed as raw water utilizatioin- is estimated only from the outer pond storage volume. While the recharge rate of the pond is calculated based on recharge rate from both outer and main pond.

Water sampling. Three sampling points is determined to understand the water quality condition outside recharge pond; before the inlet channel (SP_1) and inside recharge pond; at the outer pond (SP_2) and at the main pond (SP_3) as shown in Figure 1.

At each sampling point, amount of 1 liter water is collected at 30 cm depth from the pond surface by using specific bottle sampler.

The Parameter of water quality to be analyzed is based on the common parameter that widely used to monitor recharge water quality and surface water as raw water by referring to the water quality standard. The selected parameters are pH, color, turbidity, total dissolved solids (TDS), Iron (Fe), Manganese (Mn), and Chloride (Cl).

3. Results and Discussion

Recharge pond characteristics. The surface area of pond is about 3,102.75 m^2, consisted of 2 compartment; the outer pond (A = 3,002.75 m^2) and the main pond (A = 100 m^2). The main pond is dig-up to the aquifer layer approximately 6.75 meter deep, attend to the core of recharge pond. Conversely, the outer pond –having averaged depth less than 3 meter- is attend to collecting-pool of excess water come from intake channel, rain water and surface runoff.

During the June-November 2011 observation, there are no significant changes of surface water level both at the outer- and main-pond. This indicated that the recharge pond may have reached a stable saturated condition at underground layer.

Water quantity of the recharge pond. During the measurements periods, there was no supply discharges observed into the pond, nor the outflow discharge from outlet or spill channel. The surface runoff discharge was assumed near to zero, since the surrounding land of pond-bank was covered by grass densely. Hence, surface water volume of the recharge pond was estimated from the average water depth at each pond multiplied by surface area of each pond. By using Eq.(1) and Eq.(2), recharge rate of the pond was calculated around 3.2 mm/day (June), 9.9 mm/day (October), and 2.4 mm/day (November). The recharge rate of present study is found relative smaller compared to Legowo and Sudinda's [1] measurements. This might be due to Legowo and Sudinda used greater evaporation value (4.5-5.0 mm/day), also they included large amount of supply discharge and outflow discharge.

In this study, the water availability of the pond is represented by the storage of surface water volume which was estimated from the average water depth at each pond multiplied by surface area of each pond. Regarding the water demand, assuming the water consumption for educational institution is around 30 liter percapita perday and total academia society and inhabitant of students dormitory of UI is about 57,551 capita, it was found that the total water demand is about 1,726,530 L (1,726.53 m^3). Figure 2 shows the water balance of the pond represented by water availability (water volume of the outer and main pond), water demand, and recharge rate, along with rainfall intensity during the observation month.

It can be seen from Figure 2, the water balance (volume of water availability – volume of water demand – volume of recharge) of the recharge pond during measurement period is "positive", which means excessive water (surplus). Therefore, suppose that the supply discharge into recharge pond could be maintain as much as possible meet the stable storage volume, the

recharge pond is very potential to be utilized as raw water source to fulfilling domestic water demand of 30 liter percapita perday at UI Campus Depok area.

Water quality of the recharge pond. The total dissolved solids (TDS) as an indicator of water physics parameter, along with pH and Chloride (Cl) as an indicator of chemical inorganic parameter all of the sampling point showing a lower concentration than the Water Quality Standard Class I, according to Government Regulation No.82/2001 about Water Quality Management and Water Pollution Control (see Table 1).

The result also in line with a research carried out by Sutopo [3], where the water quality analysis result for the three parameters mentioned above also lie under the water quality standard. According to Rao [8], total

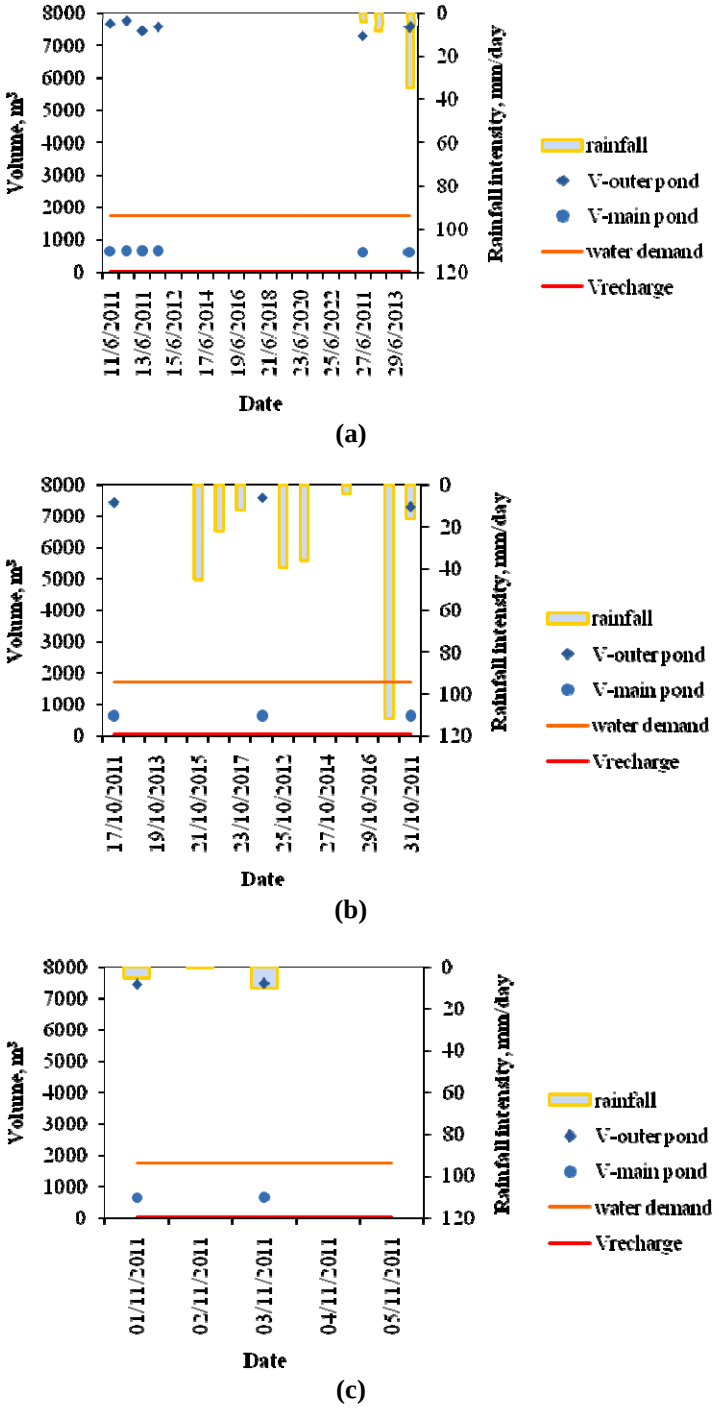

Figure 2. Water Balance of the Recharge Pond on; (a) June, (b) October, and (c) November 2011

Table 1. The Water Quality Analysis Result at Each Sampling Point

Parameter	Unit	SP_1		SP_2		SP_3		Quality Standard
		Jun	Nov	Jun	Nov	Jun	Nov	GR No.82/2001
pH	-	7.11	7.2	6.56	6.82	6.86	7.14	6-9
TDS	mg/L	129.6	106.4	87.6	107.8	109.9	106.2	1000
Color	Pt-Co	93	98	69	126	23	42	-
Turbidity	NTU	17	16	12	20	4	8	-
Manganese (Mn)	mg/L	0.5	0.2	0.2	0.5	0.3	0.3	0.1
Iron (Fe)	mg/L	0.88	0.28	0.33	0.71	0.14	0.1	0.3
Chloride (Cl)	mg/L	18.0	1.5	11.9	4.3	8.1	1.3	600

dissolved solids is defined as a dissolved material having diameter $<10^{-6} - <10^{-3}$ mm, as a chemical contains and other substance. As the concentration of TDS is low, it can be assumed that there is insignificant increment of pollutant which contains inorganic content resulted from human activities at surrounding UI campus Depok, nor suspended sediment due to soil surface erosion. On the other hand, according to Water Quality Standard Class I [7], the permitted concentration for color and turbidity as an indicator water physic parameter is not available. So that, physically, the surface water quality at three sampling points can be classified as good-quality.

In contrary, parameter Iron (Fe) shows relative higher concentration than the Water Quality Standard Class I (>0.3 mg/L), except at the main pond, SP_3 (0.1 mg/L). Similar value at the same location is also obtained from a research conducted by Sutopo [3], it was found around 0.192 mg/L. While, at the outer pond (SP_2) Fe concentration is more than 0.3 mg/L, which might be due to lack of aeration (aerobes) on the water body. Iron concentration at a nature water body usually ranging from 0.05-0.2 mg/L [9]. Higher level of Fe concentration >1.0 mg/L is assumed to be endanger aquatic organism lifecycle [10]. It is proven in the study field, especially at the outer pond there was such a fish species grows rapidly. The Manganese (Mn) concentration for all the three sampling point is found >0.1 mg/L, though in averaged concentration each sampling point shows a similar value, about 0.3 mg/L. Generally there is a relation between concentration of Manganese and water color [11].

In order to reduce the Fe and Mn concentration, several methods can be applied to the recharge pond by installing such a water treatment plant such as; aeration, rapid sand filtration [11], or the combination aeration and filtration method [12].

4. Conclusion

The recharge rate of the pond between dry season (represented by June is around 3.2 mm/day) and wet season (represented by the averaged recharge rate of October and November is about 6.1 mm/day) showing insignificant different. This might be due to the recharge pond has reached a stable saturated condition.

From the view point of water quantity, the water storage volume of the recharge pond is abundantly available. It is shown by the water balance between "water availability and water demand" on the observed months resulting a "positive" value.

In general, water quality of the recharge pond can be classified into good-quality. It is indicated by the result of laboratory analysis of various physics parameters (turbidity, color, and TDS) and chemical inorganic-metal (pH, and Cl) showing a value below the quality standard, though there are parameters have a value relative higher than the quality standard (Fe, and Mn).

The pond surface water is remain suitable to be recharged into aquifer zone so that sustaining ground water conservation campaign, and it is potential to be utilized as an additional raw water source for domestic water demand of UI Campus Depok.

In order to get comprehend results and better understanding on the quantity and water quality of the UI recharge pond, more detail study needs to be conducted in near future, such as continuous monitoring during dry and rainy season in equal number of samples, observation and measurements. Furthermore, regulating the operational of weir flushing gate and intake gate to maintain the inflow discharge into recharge pond is necessary.

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