Feasibility analysis of fresh water condition in Mangunan Village - Dlingo Subdistrict after Bantul earthquake of May 27th 2006

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Abstract. The earthquake of May 27th 2006 has caused drought to several water sources in Mangunan Village. Hence, it needed a preliminary study on the hydrology condition in the aftermath of earthquake in Mangunan Village – Bantul. Methods to identify the hydrology availability and water need condition using data calculation discharge and geometric population growth. According to the measurement result in Mangunan Village, the actual water availability is 128,484 m3/day, which can cover the water requirement to fulfill the need of the people amounting to 657,75 m3/day. Although, in fact, the village potentially has enough water availability with the amount of 14,037,845 m3/day. So, a further research could be done to achieve a stable condition of the dynamic discharge. Groundwater conservation is very needed in this research area. In general, the dry region in the village needs to be planted with vegetation that are resistant to dryness in the region with shortage of water and also with plants that do not absorb much groundwater or soil moisturizer.

1. Introduction
Water is one of the most valuable natural resources which supports human life and their socio-economic development and needs to be managed and developed on a sustainable way [1]. Water resource problem is an important matter to be concerned by the Local Government, in relation with the effort of improving public prosperity. As the availability of fresh water sources are very less throughout the world, there is more pressure upon maintaining the remaining sources and in conservation structures. Environment continuity is influenced by pattern, policy and the environment management order. It is certain that the policy applied and arranged must give the benefit for all stakeholders[2]. Water resource becomes a highly crucial problem in Indonesia, mainly in Java island, Bali, and The Island of Nusa Tenggara. Therefore, it is necessary to conduct the research on the use of freshwater and the impact on freshwater quality in the research area to minimize or even to deprive water scarcity. An aspect that must be considered in the supply of freshwater is to pay attention to prevent the water-born disease[3].

The earthquake of May 27th 2006 has caused drought to several water sources in Mangunan Village. Hence, it needed a preliminary study on the hydrology condition in the aftermath of earthquake in Mangunan village – Bantul. With that being done, the condition of fresh water
provision and its problems faced by the people obtaining the clean water in the Mangunan can be identified[4]. The role of water source has been rising in value and strategic importance because it covers basic requirements of many people life in their various activities. This contributes to the increasing water need and the regional development and demographic growth. There would be rapid increase in population where the demand for water would increase exponentially[4].

The village of Mangunan belongs to the Dlingo Sub District, Regency of Bantul, Yogyakarta Special Province. Mangunan village is located in 110°24’20” BT – 110°26’30” BT and 8°55’05” LS – 8°58’00” LS, 400 m above sea level in height. The village of Mangunan, Dlingo Sub District, Bantul Regency has the width of approximately ± 952,3715 Hectares, consisting of 6 sub village (sub village) with administrative boundaries: Girirejo village (Western side), Wukirsari village (Northern side), Muntuk village (Eastern side), and Sriharjo village (Southern side). Mangunan village has 6 sub village with the total number of people 4,385 people.

Figure 1 shows study area of research.

2. Methodology

Methods to Indentify the Hydrology Availability and Water Need Condition

Secondary data is used of this research and its obtained through institutional survey, such as alphabetic data collection and the collection of map of the previous research results, and also explanation of the region condition in related institutions in the study region. Some related institutions are: Office of Village, Office of Statistic Centre (BPS), Office of Water Resource, etc. Result of all data calculating for analysis of comparison between water availability and people need of water to know the possibility of water shortage, so as to implement the exact solution alternative of the problem. Figure 2 shows flowchart of research process.
Discharge is the measurement of how much volume of water which flow in a coverage of width per length of time (example m$^{3}$/second) [6].

$$Q = TIL = K \cdot b \cdot I \cdot L$$  \hspace{1cm} (1)

Where:
- $T$: transmisivity, consists of $K \cdot b$
- $K$: hydrolic conductivity (m/day)
- $b$: aquifer depth (m)
- $I$: hydrolic gradient
- $L$: the length of coverage in which groundwater stream flows (m)

In this research, most of the springs/ponds available do not have exit passage, so the determination of discharge is done through estimation. It is done by calculating decrease volume of water (the water which is used) and the time when the water flows back. The formula used is shown below:

$$Q = \frac{V}{T}$$  \hspace{1cm} (2)

Where:
- $Q$: Discharge (m$^{3}$/detik)
- $V$: Water Volume (m$^{3}$)
- $T$: Time (second)

The water need of every people is not similar in every region because it is highly influenced by the number of people, education level, field of occupation, and water availability in which they live. To calculate the water need in the study area, it must be previously done interview with the inhabitant in order to know the water need of inhabitant per litre/ people/day. The calculation of water need is formulated as below:

$$Q_{\text{need}} = \left( \frac{q}{100} \times P \right)$$  \hspace{1cm} (3)

Where:
- $Q_{\text{need}}$: The people need of water (m$^{3}$/day)
- $q$: Assumption of people water need (130 liter/person/day)
- $P$: The number of people (person)

Calculating rate of geometric people growth is the discreate people growth, that is calculating the people growth only at the end of year in a period. Another term of people growth is the people projection[7].

$$P_t = P_0(1 + r)^t$$  \hspace{1cm} (4)

Where:
- $P_t$: the number of people at the end year
3. Results

3.1. Hydrology Availability and Water Need Condition of Mangunan Village

The village of Mangunan, the Regency of Bantul, is one of the regions which frequently face dryness in the dry season. The condition is worsened by the loss of water sources, such as wells and springs after the occurrence of earthquake on May 27th 2007. The earthquake causes fissures on the soil and destroys the aquifer system in this region. The ground water which was expected to be stored in the aquifer system has gone.

In this research, the classification of dryness which happens in Mangunan village is divided into two categories, they are (1) Rather severe dryness. It happens if 20-50% of water requirement every day is fulfilled. Usually, there are 2-4 RW (Rukun Warga/People Solidarity) suffer the shortage of water, therefore its location is relatively closed to the sources of water, compared to the villages with severe category (2) Severe dryness. It happens if there is no water which is sufficient for everyday water requirement. The people in these villages have to obtain water or to buy water from the other villages. The scarcity of water in the villages do not allow water utilization for irrigating farms.

Considered from social-economy aspect, the people in the dry regions can be categorized as poor, so they are unable to buy water in expensive price for every day’s use. The research result suggests the price of water from PDAM (local water company) is different between the regions, ranging Rp. 65,000,00 to Rp.90,000,00 per tank of water. The research results indicate that the average amount of water usage in Mangunan village for every people in a day is 60 litres. This condition indicates water usage in Mangunan village is still be considered under developed. In reality, most of the village areas is vulnerable to dryness.

The results of research show that the regions which now suffer from dryness, did not face dryness in 5 or 10 years ago. But with the increasing number of inhabitants, there comes another consequences, one of which is the bigger the demand on water requirement. Consequently, water availability decreases. Another factor which contributes to the decreasing amount of water availability is livestock sector. Some of people raise cattle and need water to bathe their cattle. Every household raise approximately 1 – 2 cattle, mainly cow, and uses 60 litres of water per day. In the dry season, people often give more priority of water to their cattle, so they only bathe one time in a day and wash their clothing 1 -2 times per week. People living in the high topography regions, for instance, do not have the access to the helps or the aids.

The number of people in Mangunan village is 4385 orang. Based on research results and interview, it is predicted that every people need 100 litres of water for domestic use and 150 litres for all use. Table 1 shows water requirement of Mangunan.

| Inhabitant (Person) | Domestic Water Requirement | Overall Water Need |
|---------------------|----------------------------|-------------------|
|                     | (Liter/day) | m³/da | (liter/day) | m³/da |
| 4385                | 438500      | 438,5 | 657750      | 657,7 |

Source: Primary Data Processing, 2010

The availability of actual water in the research area is based on the availability of ground water, especially springs in the research area. From the calculation on the springs and wells in Mangunan.
village, it is found the total availability of water in the dry season which 128,484 m$^3$/day. Meanwhile, the people domestic water requirement is 438.5 m$^3$/day, therefore if compared to the availability, there is lack of 310,016 m$^3$/day. This shortage of water is fulfilled by people by purchasing water every month. The availability of actual water in the dry season can be seen in table 2.

| Water Source | Availability (m$^3$/day) |
|--------------|--------------------------|
| Wells        | 24,148                   |
| Springs      | 104,336                  |
| **Total**    | **128,484**              |

Source: Primary Data Processing, 2010

3.2. **Guidance of Management and Conservation of Groundwater**

The dynamic water reserve can be multiplied once more with specific yield of each aquifer [8]. The observation coverage in the calculation of ground water dynamic potency [9]. In actual condition, water availability is inadequate to fulfill people need. Potentially, ground water availability in the basins expected to store water in the rainy season is described in table 3 as follow:

| Basin | Dynamic Discharge (m$^3$/day) |
|-------|-------------------------------|
| I     | 4206,348                      |
| II    | 4098,312                      |
| III   | 5733,185                      |
| **Total** | **14037,845**           |

Source: Primary Data Processing, 2010

For predicting water adequacy in the later 5 years (year 2012), a prediction of the number of people is done, based on demographic data of the year 2006, while aquifer parameter is considered relatively stagnant to reach the same dynamic discharge.

| Inhabitant (people) | Water Requirement (m$^3$/day) | Inhabitant (people) | Water Requirement (m$^3$/day) |
|---------------------|-------------------------------|---------------------|-------------------------------|
| 4385                | 657.75                        | 5143                | 771.450                       |

Source: Primary Data Processing, 2010

Based on the tables of prediction of water need adequacy until 2012, it is shown that the water need of people of Mangunan village is still lacking if only rely on wells and springs. Rain water utilization needs to be concerned, considering the great amount of rainfall in this region (approximately 1.647 mm). As calculation example, it is proposed the calculation of rain water which precipitate in the area of research as followed:

1. In one place, it is made a rain water storage. Later the water will be distributed to all people who need it. Calculation example: Total width of the three village 952,3715 Ha = 9,523.715 m$^2$. Precipitated rain water 1.647 mm/year = 1,647 m/year. If the maximum amount of evaporation is 30
% of the amount of rain, so the rain water which can be stored numbers about: 70% x 1,647 x 9,523,715 = 10,979,891 m$^3$/year.

In order to achieve a safer result, that is based on the assumption that only half of the rainfall amount can be stored, then the rain water amount available during 6 months is: 0.5 x 10,979,891 = 5,489,946 m$^3$/year. The number of inhabitant in the Mangunan village is 4,385 people. If the assumption of people water requirement is 150 liters/people/day, then the people water need in a day is 657,750 liters/day = 657,750 m$^3$/day. To be more save, if people need water for a year full, the requirement is only 657,750 x 365 = 240,078,75 m$^3$/year. This value is much smaller than the actual amount of rain water can be stored, so rain water is sufficient to fulfill the people water.

2. To make a rain water storing place in every village. This alternative is rather similar with the first one, except it will be needed a much smaller cover because it is organized by every village. However, there is still a problem of its distribution and storage, so the alternative number 3 is proposed.

3. To make rain water storage place in every house. There are two alternatives, both of which easily executable according to the people wish on condition that the construction/building is made correctly and well-maintained. This alternative is expected to be able to fulfill the water need of people forever (at least for 50 years) on the assumption that the local climate condition is quite similar within the period of 50 years. The people also have the obligation of maintaining, cleaning (at the end of the dry season), and replacing (about 3-5 years) the roof/cover used as the permanent part of the structure if it is damaged.

4. Discussion
According to the the measurement result in Mangunan Village, the actual water availability is 128,484 m$^3$/day, which can cover the people water requirement amounting to 657,75 m$^3$/day. Although, in fact, the village potentially has enough water availability with the amount of 14,037,845 m$^3$/day. So, a further research can be done to achieve a stable condition of the dynamic discharge.

Groundwater conservation is very needed in this research area. In general dry regions need to be planted with plantation which are resistant to dryness in the region where water is scarce. The plantation which do not absorb much groundwater is also needed to be planted, eventhough this needs further research.

Later, physically the basins at the region with high topography needs to be made as to be able to store water or to reduce the amount of evaporation, through conservation and rejuvenation at the catchment area. Also in the region with low topography needs to be made groundwater well, water storing basins to add groundwater storage, and the suitable vegetation [10]. The two guidance still need further detailed research with well allocated time. Beside, the making of rain water storage can still be continued with calculation alternatives as described above. Physically, the lithology of aquifer is not favourable for water uplifting effort, so it this advised to preserve the springs through vegetation management, the making of groundwater percolation place, and the making of rain water storage [11]. Socially, the programs of conserving saving of water, and storing as much rain water in the rainy season needs to be done [12]. Based on the calculation of dynamic water, in can be done a furher research in order to prevent the uplifting of water from the surrounding aquifer [14]. This calculation, however, is not advised to be implemented if, through further research, the making of basin and rain water storage is more beneficial [13,14].

The recommendation for emphasizing rain water storage utilization in high topography region is suggested, considering the more cheaper price of making and maintaining the storage, on condition that the construction or building needs to be made from proper material and size and its maintenance should be obviously applied. In further research, this recommendation can be compared with the uplifting of water from drill wells. From the two choices it should be choosed which one is the cheapest in maintenance, and which one is more sustainable in water availability. Through an effective research during one month, the alternative in the table above is considered feasible or applicable from price aspect or sustainability of water supply. With the conservation of vegetation and
the making of ponds, more water can be stored. Instead of it, the region with sufficient water supply is expected to help the other region which suffer water shortage, but it is advisable for the region with low topography in order to cut distribution cost.

5. Conclusion
Groundwater conservation is very needed in this research area. Based on the calculation, the village which has more priority to receive aid is Mangunan sub village. The alternative method considered most appropriate to supervise water distribution is water storing which is done in every household. This method only needs a little repairment and operation, so that it can be easily done by every household. Besides, the will cut the distribution cost, allow a sustainable development, and will fulfill all water requirements during the dry season.

The social and economy condition of people with the occupation of farming and construction worker, forces the people to find the most suitable alternative in financing in order to help them to fulfill their daily needs. The alternative which is considered suitable is self-supporting program or long-term credit. The long-term credit is applied through the giving of help, so the people will be able to cover their water requirement using drill wells, rain harvesting and the making of water storage tank. As for the amount of credit should be adjusted with the financial ability of the local people.

The consequence of the regional development is the growth of requirement in various sectors, like domestic, industry, commerce and service, agriculture, and other sector, which directly or indirectly need the provision for water source demands. If this is not immediately anticipated, the degradation in the quantity or quality of water resource will be a matter of concern.

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