Potential Implementation of Rain Harvesting in Adiwiyata School, Case Study: Al-Irsyad Islamic School, Demak Regency

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Abstract: Water is the main component in the life of all living things, and the availability of fresh water that can be directly consumed and be used by humans is very limited. The exploitation of groundwater to meet the water needs of people above ground will only worsen the conditions of the water cycle, leading, among other things, to flooding in the rainy season and drought in the dry season. One way to address this condition is to conserve water, particularly by making optimal use of surface water and minimizing groundwater exploration. The implementation of water conservation will be ineffective if it is carried out only by the government. Community participation is also required, including the Adiwiyata School Program. There is a saying in Javanese at Al-Irsyad Adiwiyata Islamic School in Demak Regency or Madrasah Aliyah (MA) Al-Irsyad: " *mangsa rendeng ora bisa ndhodok*, *mangsa ketiga ora bisa cewok* " which means "During the rainy season it is impossible for people to use the river as toilet (because of flooding), whereas in the dry season, people cannot use the river to wash (because there is no water)." Excessive water during the rainy season can be reused and stored as an additional water source during the dry season. The aim of this study to analyze potential amount of water supply from rainwater harvesting at Al-Irsyad Islamic School, Gajah district, Demak regency. The results of the analysis showed that there is a potential for the use of rainwater. The study site requires an additional collection pond with a capacity of 20 m^3 and the implementation of good housekeeping. Especially at MA Al-Irsyad, water conservation can be done by changing people's habits to reuse rainwater for non-consumption purposes.

Keywords: *adiwiyata school, conservation, rain harvesting*

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1. Introduction

Demak Regency is located in the northern coastal area of Java Island which is very vulnerable to floods and drought (Ritohardoyo, Sudrajat, & Kurniawan, 2014). Almost all areas in Demak Regency are flooded during the rainy season and facing limitations in accessing clean water, including Gajah District (Asrofi, Hardoyo, & Sri Hadmoko, 2017). Water as a renewable resource has an important role in life. The availability of water on earth cannot be predicted in certainty because the form of water changes at each stage in the hydrological cycle. Of the total water on earth, only 0.26% available in the form of fresh water and can be used to meet daily human needs (Rohendi & Nur, 2019). The limited amount of fresh water that is not commensurate with water needs is not only the government's responsibility to fulfil, but community participation is absolutely necessary in the context of implementing environmental management and water conservation efforts (Faturrohmah & Marjuki, 2017). Water resource conservation is an effort to optimize the use value of water by efficiently using water. The implementation of water conservation can be done by improving water quality according to its intended purpose so that water availability is maintained and increases in terms of quantity (David, Pharmawati, & Usman, 2019). Community involvement in environmental management and water conservation activities is also carried out in school environments, especially Adiwiyata schools. Adiwiyata is a program that aims to increase the environmental awareness of school members and its implementation in school activities. The principles of implementing this program are learning, involvement and sustainability (Novitasari, Fadilah, & Rahaju, 2020). Based on the Peraturan Menteri Lingkungan Hidup Republik Indonesia No. 5/2013 (Regulation of Minister of Environment of Indonesia Republic No. 5 of 2013) concerning Guidelines for the Implementation of the Adiwiyata Program, it is explained that implementation of the Adiwiyata program in each educational institution must include the details of the vision, mission, goals and targets containing environmental preservation and management policies stated in the Learning Implementation Plan for all subjects in the educational institution (Novitasari Fadilah, & Rahaju, 2020). Adiwiyata schools as the basis for realizing concern and awareness of environmental culture are implemented based on participatory and continuous principles. The assessment criteria for Adiwiyata schools are the fulfillment of 4 (four) important components consisting of: 1) environmentally oriented policies and regulations; 2) implementation of the environmentally oriented curriculum; 3) implementation of participatory environmental activities; and 4) a management system for an environmentally oriented complementary facilities and main facilities (Priatna, 2020). Considering the most potential application of water resources conservation in a small scope is within educational institutions, therefore, water conservation is necessary to be implemented in the school. It can be done by rainwater harvesting and wastewater processing activities for reuse to maintain the availability of groundwater (David et al., 2019). The aim of this study to analyze potential amount of water supply from rainwater harvesting at Al-Irsyad Islamic School, Gajah district, Demak regency. It is expected from the study that implementation of rainwater harvesting, which is of course accompanied by the addition of other supporting facilities, could partially fulfill the water needed by people in the dry season.

2. Literature Review

In order to collect relevant supporting theories from the beginning to the end of the research, a literature review was carried out to examine the standards and regulations used. It is commonly understood that water resources are renewable non-biological resources. Based on the Law No. 23 of 1997 concerning Environmental Management, it is written that conservation of natural resources is the management activity of non-renewable natural resources to ensure their utilization in a wise manner and renewable natural resources to ensure their sustainability and availability by maintaining and optimizing their quality. Therefore, water resources are renewable natural resources, and its conservation is defined as an effort to maintain its availability and sustainability, physical properties, and its use of water that it will always be available in good quantity and quality to meet the needs of living things for now and in the future (Sallata, 2015).

Water conservation is also defined as efforts made to reduce and efficiently use water accompanied by increasing the usability of water (Arsyad, 1989). The application and implementation of water conservation can be realized together with water management which involves behavioral changes. Various methods can be used to implement water conservation are (Kumari & Singh, 2016):

2.1. Rainwater harvesting

The important point in rainwater harvesting is collecting rainwater that falls on the roof and then storing it (either in underground storage ponds or open ponds) to be used when needed. By harvesting rainwater, it not only increases the functional value of rainwater, but also gives the water time to pool in the pond and seep into the ground, as groundwater replenishment. Rainwater harvesting and groundwater recharge are very important issues, to anticipate land subsidence which is a result of groundwater decline. The advantages of implementing rainwater harvesting are (1) Independent provision of water supply; (2) Reducing pumping operational costs to access groundwater; (3) Providing high quality water with minimal lime content; (4) Improve groundwater quality; (5) Reducing surface soil erosion and flooding in road areas; (6) Economically effective and easy to build and operate; (7) In coastal areas, rainwater has better quality than existing groundwater (Kumari & Singh, 2016).

2.2. Implementation of a good irrigation system

In the agricultural sector, water conservation is important because for plant growth, water of good quality and in adequate quantity is needed. Rainwater harvesting also can be done by recharging groundwater. This type of rainwater harvesting is widely applied to overcome the problem of drastically decreasing groundwater. Implementation of rainwater harvesting can be done with good irrigation pattern and irrigation system. Areas with low rainfall force the residents to develop simple technology that suits their capabilities and regional conditions to minimize water deficit conditions (Lestari, Dalem, & Sundra, 2020).

2.3. Usage of desalinated water for irrigation

Salt water/sea water is available in large quantities; however, it cannot be used directly for agriculture or to meet daily human needs. Developing plant varieties that are resistant to salt can be done to increase the use of salt water. Apart from that, it is

still necessary to process salt water to reduce the salt content in it so that it is suitable for use for farming (Rohendi & Nur, 2019).

The success of water conservation implementation can be measured by (1) Reviewing and evaluating production processes and technologies used from a water use perspective; (2) Ensuring plant management and implementation of good housekeeping; (3) Minimizing leaks in pipe networks; (4) Optimizing maintenance to obtain operational duration (Lestari, Susanto, & Kastamto, 2021).

In general, there are many technologies can be used to optimize the recovery of water quality and quantity, but the easiest way is optimizing the use of fresh water available on earth and reducing wastewater generation, which will be the focus of this research (Geerts & Raes, 2009). Some efforts can be made to conserve the water, such as: (1) using water properly as needed which can be done by the following simple things: a) closing the tap after it is used; b) do not leave the water running on the tap is unused (either when brushing teeth, ablution, washing face, etc.; c) ensuring that there are no pipe networks leaking,; (2) when using a washing machine, we can choose an easily-rinsed detergent while ensuring the washing machine tap is running properly without wasting the water; (3) use a shower, both a bath shower and a toilet shower, to minimize water use using a dipper; (4) reusing used water optimally, e.g. for watering plants; (5) changing attitudes and habits to implement water conservation (Kumari & Singh, 2016).

In its implementation, there is a potential to fail in implementing water conservation by harvesting rainwater and utilizing greywater. Some of them are caused by the high organic content of greywater which will generate foul-smelling gas if the greywater is collected without processing for more than 24 hours. The detergent contained in greywater is dangerous for the microorganisms in the septic tank, which might cause clogging when greywater is used to flush the toilet. Moreover, toilets with flushing tanks are preferred when the greywater will be used to flush toilets, because it can be used to solve the strong smell caused by the greywater (Handayani, 2014).

3. Materials and Method

In Demak Regency, there are 103 Adiwiyata schools. Among those schools, an Islamic senior high school namely MA Al-Irsyad located in Gajah sub-district, Demak regency, has selected as the object of this research because its location was not directly affected by tidal wave. Apart from that reason, MA Al Irsyad also has the potential to apply this research concept to Islamic boarding schools which are also managed under the Al-Irsyad foundation. This research was started in September 2022 and finished in December 2022. The method for carrying out this research is described into several stages starting from data collection to analysis and making conclusions, by the following details.

3.1. Data Collection

The primary data required in this activity is the size of the land and buildings of MA Al-Irsyad, which are measured directly. Apart from the built-up land of MA Al-Irsyad Demak, a survey was also carried out on the activities of students and administrators of MA Al-Irsyad Demak to obtain patterns of habits carried out in the school environment.

3.2. Data Processing and Technical Planning

Calculation of Clean Water Needs

In determining the amount of clean water needed based on the population size obtained from secondary data, the following equation is used (Noerbambang & Morimura, 2005):

$$Q_d = population \times water\ needs$$

The amount of clean water needed for building occupants used refers to SNI 03-7065-2005 concerning Procedures for Planning Plumbing Systems. The following table shows the amount of water needed based on the space designation.

Table 1. Water needs for each functional building

Function	Water Needs	Unit
Apartment	100	L/ ppl/ day
Office/ school	50	L/ ppl/ day
Multiuse Building	25	L/ ppl/ day
Restaurant	15	L/ ppl/ day
Church/ Mosque	10	L/ ppl/ day

Source: Topare, Attar, Manfe (2019)

Calculation of Waste Generation

Wastewater is grouped based on its type, namely greywater and blackwater. The total generation of liquid waste included in greywater is 75% which comes from floor drain wastewater (Safriyanti, Pratama, & Nurprabowo, 2018). Calculation of the total liquid waste generated can be done using the following formula (Hardjosuprapto, 2000).

$$Q_{waste\ water} = 80\% \times water\ needs$$

Calculation of Wastewater Recycling Amount

Used water, also known as greywater, is recycled water comes from processing used water using a Sewage Treatment Plant (STP). This STP is a domestic wastewater treatment system to improve its quality to class 2 water which can then be used for daily non-consumption activities (Topare, Attar, Manfe, 2019). Greywater reuse is one of the efforts to conserve and optimize water use (Handayani, 2014). The amount of daily waste recycling water is determined as the total need for watering plants and the frequency of watering each day (Rahayu, Pratama, & Nurprabowo, 2020).

Rainwater Harvesting Calculations

One way to use rainwater is by rainwater harvesting. To use this method, a rainwater collection pool is required to collect rainwater that falls on the roof and, therefore it can be stored and can be used when needed. Apart from being reused during the dry season, this rainwater collection tank/pond is also intended to reduce the burden on urban drainage due to rainwater runoff (Ha, Susilo, & Wahono, 2018).

4. Result and Discussion

The MA Al-Irsyad Demak is part of the Wedung River system. The area of MA Al-Irsyad is 2,325 m^2 with all land built up. The land area covered by a clay tile roof is 2,200 m^2 in the form of a 3 (three-floors) building with a total area of 7,000 m^2. The source of clean water used for routine daily activities comes from a groundwater drilled well with a pumping capacity of 3 L/s which is stored in the upper tank and then distributed to the toilet tap. The number of students and managers who carry out routine activities at MA Al-Irsyad Gajah, Demak is 642 people, consisting of 603 students and the rest are managers. The activity that is routinely carried out at MA Al-Irsyad Gajah, Demak is the midday prayer together. During midday prayer, the school members are usually using water for ablution through 25 ablution tap points. However, the clean water sources are unable to meet water needs during midday prayers, which was proven that the water not flowing after 15 minutes the ablution tap points were opened.

4.1. Need and Availability of Water in Schools

Based on the analysis, by 642 people carrying out activities at MA Al-Irsyad, the water requirement is 0.5 L/s. Meanwhile, the capacity of the submersible pump used at MA Al-Irsyad is 1 L/s according to the condition and capability of the groundwater source being extracted. By these conditions, it should not indicate a deficit in the provision of clean water at MA Al-Irsyad. However, the availability of water flow during peak hours (during ablution for congregational midday prayers) turns out to be an insufficient flow of 1 L/s.

Based on the results of the analysis, a random sampling was taken to perform how students are usually doing ablution and collecting the water in a bucket while recording the time. The results indicated that the water flow required for a student to take ablution was 0.1 L/s. When 25 faucets were opened, the total water flow required is 2.5 L/s. This shows that a deficit in the supply of clean water during midday congregational prayers is certain to occur according to the analysis.

4.2. Potential amount of rainwater that can be harvested

Based on the analysis carried out, the amount of annual rainfall (2 years return period) that occurs at MA Al-Irsyad Demak is 60 mm/day. With daily rainfall intensity of 60 mm/day, if it is multiplied by the roof area of the school building covering an area of 2,200 m^2 and a network pipe loss and leakage factor of 80%, the potential amount of rainwater that can be reused as rainwater harvesting is 10.5 m^3. With the target of meeting water needs of 0.5 L/s, an additional storage pond of 20 m^3 is needed to fulfill water reserves in the dry season when there is a decrease in the type of discharge in groundwater drilled wells.

4.3. Change in habits

Based on surveys and observations, the activities that use the most water are ablution and defecation. Almost all respondents flushed the toilet before use with at least two dippers of water and turned on the faucet while carrying out activities in the bathroom, regardless of whether the water container in the bathroom was overflowing or not. Bathroom cleaning activities are carried out by the management routinely twice a day, before and after learning activities. During ablution, it was also seen that many

students turned on the faucet before they were ready for ablution, i.e., the female students were folding their sleeves, and the male students were folding their trousers, indicated that the water flowed and wasted in the first five seconds.

Changes in habits need to be implemented at MA Al-Irsyad by two alternatives. First, replacing manual faucets using sensor faucets in ablution areas and using jet showers in bathrooms to reduce unnecessary water use. Implementing alternative 1 requires relatively large investment costs, because the management is required to carry out modernization and replacement simultaneously. The failure rate for alternative 1 is relatively small, except for damage to newly installed equipment, because the ratio between administrators and students is very significant so that 1-1 observation and warnings are not needed for alternative 1. Second, counseling, socialization, inspections, and warnings for rule violators. This second alternative does not require investment costs to add many instruments or equipment. However, the implementation of counseling, socialization, inspections, and warnings is not easy considering the very unequal proportion of administrators and students, so the potential for failure of this second alternative is relatively greater than the first.

5. Conclusions

MA Al-Irsyad Adiwiyata School located in Gajah sub-district, Demak regency, has a land area of 2,325 m^2, and almost all of which is in built condition. During the rainy season, water height can reach up to 60 cm. Based on the results, the potential for rainwater harvesting at MA Al-Irsyad by installing gutters to catch rainwater runoff that falls on the roof of the school building during the annual heavy rainy season (2 years return period) is 20 m^3. This is comparable to the unmet water demand from groundwater sources which is the main source of meeting water needs in MA Al-Irsyad, i.e. 0.5 L/s. So that with the addition of reservoirs and gutters as well as an integrated piping network, water supply can be fully met. Optimizing the implementation of water resources conservation must be accompanied by the involvement of human resources involved in the activities. One of them is by providing education and socializing the importance of water conservation, implementing a water-saving lifestyle, and replacing clean water access facilities to more modern ones by using sensors to reduce water use that is not appropriate. All these things must be implemented in synergy and fully controlled by the management of MA Al-Irsyad.

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