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Rainwater Harvesting-Based Conservation Model in Urban Flood Control: A Study at SMPN 24 Semarang

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ABSTRACT

When the rainy season arrives, one thing we often hear about is flooding in the lower regions. This can happen if land on higher plains loses part of its function due to several reasons, such as development that does not pay attention to green open space, and if rainwater is not captured and reused, causing water to flow directly to lower plains. Rainwater harvesting is a conservation and technological method used to collect and store rainwater from the roofs of buildings, ground surfaces, roads, or hills. One of the methods of harvesting rainwater that collects and stores it at ground level is infiltration wells and *biopore* infiltration holes. This research supports SDGs 6, Clean Water and Sanitation. The purpose of this research is to create a rainwater harvesting model expected to provide great benefits in flood prevention, with the location at SMPN 24 Semarang. The research method used is qualitative descriptive. The results of research in the field show that the method of harvesting rainwater through a roof system, namely capturing rainwater in gutters which is then stored in a water storage reservoir, is very suitable to be applied at SMPN 24 Semarang, considering that around the building there are gardens and *taman* that require watering, so the water collected can be used to water plants. Next is the *biopore* infiltration hole, which has the benefit of absorbing water and can also compost organic waste into compost, so that the plants in the garden and *taman* are more fertile.

Keywords: *Rainwater Harvesting, Sustainability University*

INTRODUCTION

Flooding continues to be a persistent challenge for communities across Indonesia, especially during the rainy season when high rainfall exceeds the capacity of drainage systems and impacts residential areas (Ginting, 2021; Hadini et al., 2023; Ngan & Trung, 2023; Rakuasa et al., 2022; Waseem et al., 2023). Urban and semi-urban areas are particularly vulnerable to flooding, which can disrupt daily life, damage property, and force families to leave their homes. The impact of flooding goes beyond immediate inconvenience, affecting children's education, local economic activities, and community well-being. Recent flooding incidents highlight the need for better infrastructure and disaster preparedness in flood-prone areas (Al-Amin et al., 2019; Atanga & Tankpa, 2021; Olanrewaju et al., 2019; Sanjrani Manzoor et al., 2022; Yu et al., 2022).

One of the flood news reports published on detik.com contains the following narrative: The village in *Kudu Village*, Genuk District, Semarang City has been flooded for almost a week. A total of 288 heads of families (KK) were affected, and several residents were displaced. It appears that water flooded RW 7 *Kudu Village* until it entered residents' houses. The students also continued to attend school even though the flood hit their residences. The Chairman of RW 7 *Kudu Village*, Ainur Rofiq (55), said that the puddle even entered all the houses of RW 7 residents. There were around 288 houses affected by the flood, with a height of 20-50 centimeters (cm) (Detik.com, n.d.).

Not only in the city of Semarang, a number of big cities were also not spared from flood disasters; for example, the city of Bogor in the *Cisarua* area, where flooding occurred because the peak area as a highland that used to be an area that could catch water has now changed its function from a water catchment area to an area filled with buildings and villas for economic reasons. Therefore, it takes efforts from all parties to be responsible in building, not to spend the existing land covered by buildings, and to leave some land to conserve rainwater. Infiltration wells and *biopores* can be used as an effort to harvest rainwater on the ground surface as a groundwater reserve.

Several studies that have a similar scope include Putu and Ridho (2016), who researched the topic titled *Conservation Model Based on Rainwater Harvesting in Urban Flood Control, An Introduction*. The result of their research is rainwater harvesting in urban flood control.

Next, Saragih et al. (2023) conducted a study entitled *Rainwater Harvesting Modeling to Support the Green Campus Concept and Flood Risk Reduction*. The results of the research show that the Rainwater Harvesting System designed for the Polmed campus lecture building produces a tank capacity of 45 m^3 with a water-saving efficiency of 25% and a peak rainfall reduction efficiency of 67.5%. The SPAH analysis table from this study can generally be used to design SPAH.

The next research was conducted by Nurdin et al. (2019), researching the *Model of Storage and Processing of Rainwater into Drinking Water*. The result was that the potential volume of rain at the research site was 284.75 mm/month, with rainwater quality after treatment—going through a filtration process and adding 1 gr/10 liters of sodium bicarbonate—producing rainwater quality that qualified as drinking water. Before processing, the tank should contain 2,000 liters of rainwater so that there is stabilization of the parameters that affect especially the color and turbidity parameters.

Next, Nadif et al. (2021) examined the *Influence of Rainwater Harvesting Models on the Growth and Yield of Four Rice Cultivars (Oryza sativa L.) in the Agroforestry System with White Woodland (Melaleuca cajuputi L.) in the Rainy Season*. The results of the study showed that the treatment of trenches + organic litter + *biopores* was able to increase productivity by 11.02% compared to without trenches + without organic litter. *Patenggang Situ Patenggang* rice produces productivity of 2.92 tons/ha, 2.86 tons/ha, and 2.42 tons/ha, making it more adaptive to be planted in Gunungkidul Regency than other cultivars.

The purpose of this research is to create a rainwater harvesting model that is expected to provide great benefits in flood prevention, with a location at SMPN 24 Semarang. The urgency of this research is to support the target of UNNES as a sustainability university to achieve a better ranking from 5th to 4th in the UI Green Metric. As for the suitability of the Strategic Plan, it is IKS 8.2 UI Greenmetric Ranking and supports the achievement of SDG 6, Clean Water and Sanitation.

METHOD

This research uses a descriptive approach focused on research results related to rainwater harvesting in urban flood control. The research begins with problem identification, followed by field surveys and interviews with partners, and then a model design is created based on the partners' needs. The formulation of the problem is that floods in urban areas require handling from upstream to downstream. Upstream, there is a condition of land in the highlands that has *reduced* its function due to development; this needs to be restored to its ideal condition so it can properly store groundwater. The approach to solving the problem is to design a rainwater harvesting model at SMPN 24 Semarang in the form of rainwater harvesting using the gutter method, with water stored in a reservoir as an effort to harvest rainwater at ground level.

RESULTS AND DISCUSSION

Flooding is an event in which water overflows to the mainland, which is usually dry, due to high rainfall, snowmelt, or other problems that result in water not being absorbed quickly by the soil or drained by existing waterways. Flooding can occur suddenly or gradually.

Flooding is caused by a variety of factors, including:

1. High Rainfall: Prolonged heavy rain or heavy rain in a short period of time can cause flooding.
2. Snowmelt: In spring, rapid snowmelt due to rising temperatures can cause flooding.
3. Water Return: Excess river water that cannot be overcome by existing aqueducts.
4. Topography and Drainage: Poor topographic conditions and drainage systems can result in water not being able to flow properly.

Prevention and preparedness measures are important in reducing the impact of flooding:

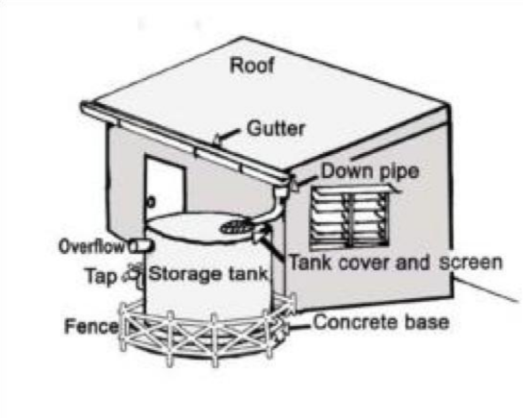
1. Early Warning: Receiving flood warnings quickly is key to safe evacuation.
2. Flood Infrastructure: Build embankments, waterways, and other infrastructure that can control flooding.
3. Public Counseling: Educate the public about safety measures during floods and their role in preparedness.
4. Weather Monitoring: Good weather monitoring can help predict flooding (BPBD Jawa Timur, 2023).

The results of a field study at SMPN 24 Semarang found that this school has applied the infiltration well rain harvesting method, but only one point, for that another rain harvesting model is needed to complement it. From the results of field observation where this school building has a number of buildings around it have gardens and gardens, so it is very good if this school applies the following two methods:

1. Infiltration wellRoof *system*

   Using the roof of the house as a form of harvesting rainwater individually allows the water to be collected is not too significant, but if applied en masse, the water that will be collected is very abundant. In general, the basic components of *this roof system have six basic components, namely:*

   a) Surface of rainwater catchment area
   b) Chamfers and *downspout pipes*
   c) Leaf filters and rainwater discharge channels (*first flush diverters*) and roof washers (for raw water procurement)
   d) Tub/container unit (Yulistyorini, 2011).



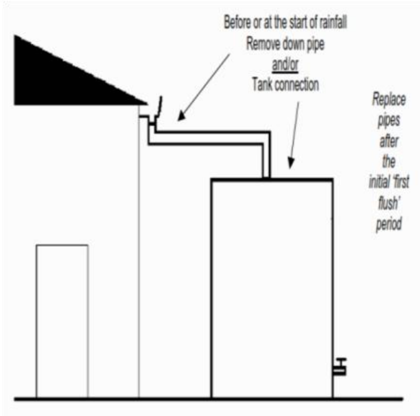


Figure 2.*RooF System* Picture3. *Simple down pipe first flush device*

Figure 1. school building model

Source: Mosley (2005).

This model is very appropriate to apply considering that this school building is on average one floor and around it there are gardens and gardens so that the water contained in the reservoir can be used to water plants on days when it does not rain.

2. Biopore infiltration holes are one of the efforts in the use of natural resources in the form of balancing the environment that lacks infiltration areas. Biopore holes can be useful as a water infiltration medium as well as a natural compost medium that can turn organic waste into compost fertilizer that can fertilize the soil and gardens owned by SMPN 4 Semarang.

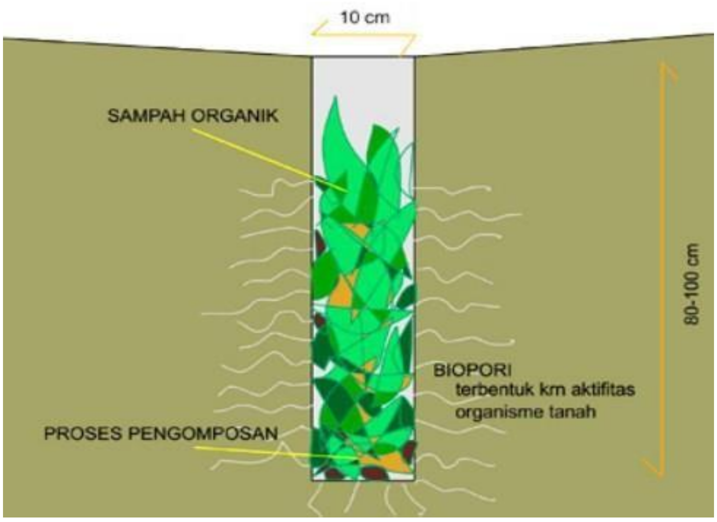


Figure 2. Sketch of the cross-section of the biopore infiltration hole

Source :www.biopori.com

Ir. Kamir R. Brata, Msc as the inventor of biopore technology has interpreted biopore infiltration holes as a water infiltration method aimed at overcoming floods by increasing water permeability in the soil. Biopore infiltration holes are made vertically into the cylindrical soil with a diameter of 10 – 30 cm and a depth of about 100 cm. The holes are filled with organic waste to trigger the formation of biopores created by the activity of soil fauna or plant roots (Biopori IPB Team, n.d.).

CONCLUSION

From the interview process and field study with related parties at SMPN 24 Semarang, we can conclude that to contribute to the prevention of urban flooding, the school has implemented efforts to capture rainwater through infiltration wells. However, this still needs to be optimized with other methods that are also very effective, namely the roof system and *biopores*. The roof system method has the advantage of storing rainwater that can be used in the future, while *biopores* have the benefit that, in addition to permeating water, they can also serve as a medium for making compost fertilizer that nourishes *taman* or *kebun*.

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