Decrease in water level by rooter technology one-way system on flood-prone land in Sunggal District, North Sumatra, Indonesia

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Abstract. Rooter system technology is a technology used to accommodate and absorb water into the soil through pipes that are designed like tree roots where the pipe is planted into the ground as deep as two meters with a slope of 45 degrees. Rainwater is collected and absorbed into the soil. Rooter technology only holds rainwater, it does not waste water. The rooter system technology is a well or a hole on the ground surface which is made to accommodate rainwater so that it can seep into the soil. This study aims to control flooding in flood-prone areas using one-way rooter technology with an environmentally friendly concept. This research was conducted from 1 January 2018 to 28 February 2018 by observing directly in the field. Observations carried out included analysis of the study site, the water level at the study site, area of land affected by flooding, length of time, the soil absorbed, water level which did not use a rooter system technology. The results of this study indicated that by using rooter technology one-way water system is faster to enter the ground and can overcome flooding on the land.

1. Introduction

Water infiltration areas are places where rainwater can enter the soil and then fill or increase groundwater reserves. Not all locations have the same ability to absorb water so that the selection of infiltration wells must be done systematically and directed based on scientific studies in accordance with the level of water absorption [1].

Rooter system technology is a technology used to accommodate and absorb water into the soil through pipes that are designed like tree roots where the pipe is implanted into the ground as deep as 2 meters with a slope of 45°. Water rain is collected and absorbed into the ground. Technology Rooter System only holds rainwater, it does not waste water. The rooter system technology is a well or a hole on the ground surface which is made to accommodate rainwater so that it can seep into the soil. Based on the description above, the research was conducted on flood-affected land, as well as the main purpose of technology. This rooter system is to speed up the entry of water into the soil as infiltration. Thus, water will flow faster into the ground and flow less because a runoff gets...
more water flowing inward land. It means that much groundwater will be stored under the surface earth. The water can be recovered through community wells.

Infiltration wells are generally considered effective to reduce runoff surface if it is made of soils with high permeability. The appearance of infiltration wells is generally made without aesthetic review. When the soil texture is quite dense and massive, which means that the pore volume is relatively small and the permeability is low, the utilization of infiltration wells is significant to reduce the volume of runoff surface. It happens if the review is carried out in the large volume of rainwater that can be temporarily accommodated. Stagnant water occurs if the peak of the discharge exceeds the channel capacity. With a reduction in peak discharge, the inundation effect can certainly be reduced. Disturbance due to the presence of infiltration ponds can be overcome by 'hiding' the well behind the thick vegetation or being decorated with certain elements so it will be integrated with garden ornaments [2].

This study aimed to reduce flooding in flood-prone areas using one-way rooter system technology with an environmentally friendly concept.

2. Methods
2.1. Time and location
This research was carried out in 3 locations that were vulnerable to flooding and owned by the residents in Sri Gunting Village, Sei Semayang and Sei Mencirim Sub District, Deli Serdang Regency. This research was carried out from January 1st, 2018 to February 28th, 2018.

2.2. Tools and materials
The tools used in this study included 4-inch polyvinyl chloride (PVC) pipes with a length of 2 meters as many as eight pipes, drill tools soil, hoe, bucket, hammer, hacksaw, wrench, water pumping machine, gunny containing sands, meters, and camera. The material used for this study was land that was vulnerable to flooding. The criteria of the land are land that can absorb water to the ground.

3. Procedure
3.1. Prepare tools and materials
The tools used in this study included a 4-inch PVC pipe with a length of 2 meters where the edge of the pipe was perforated with eight pipes, drill, hoe, bucket, hammer, hacksaw, wrench, water pumping machine, burlap containing sand. The materials used for this study included waterlogged land, which its size is 8 meters x 5 meters.

3.2. Installation rooter system
The soil was drilled using a ground drilling machine with a depth of 2 meters and a width of 5 inches as many as 8 holes and 45° soil drill slope. After the soil drill process, a 4-inch PVC pipe with a length of 2 meters was inserted into the ground drilled with a ground drill slope treatment of 45°. The pipe used entered the soil with a length of 2 meters and was designed with the provision of 1 point 1 direction in the ground and adjusted to the surface of the soil layer.

The method used was a visual method by looking at and observing how the effect of using rooter system technology and not using the rooter system. The first observation was made in the first location in the Sri Gunting sub-district. The observation included: analysis of clay textured soil, water level at the same location with the same height, the length of time that the soil absorbs water without using rooter system technology, calculating the water volume entering the soil either using rooter system technology or not using rooter system technology with the same water volume 18 m³. The next observation was in the second location in the Sei Semayang Village area which included clay textured soil analysis. Water level at the location of the study with the same height, long time the soil
absorbs water that does not use technology rooter system, or the length of time the soil to absorb water with use rooter system technology, and calculate the volume of water that enters the soil using either rooter system technology or even so land that does not use technology rooter system with the same volume of water that was 18 m³. Then, the observations in the third location was in the Sei Mencirim Village area. The observation included analysis of sandy-textured soil, water level at the same location with the same height, how long the soil absorbs water without using rooter system technology, how long the soil absorbs water using rooter technology system, and calculating the water volume of water entering the soil either using rooter system technology or not using rooter system technology with the same water volume of 18 m³.

4. Results and discussion

4.1. Location description

One-way rooter system installation was carried out in 3 locations, Sri Gunting, Sei Semayang, and Sei Mencirim Sub-districts, Deliserdang Regency, North Sumatra. Based on observations and data retrieval, a location is a place or land that often experiences flooding and makes the surrounding community, especially farmers, suffering from losses. The problem of flooding in these locations has occurred for a long time due to limited land for irrigation or drainage. Recommended places for one-way rooter system technology are water drainage, around the tree, the contour of the park, the edge of the park with impermeable fields, side of the fence, and other places that are considered appropriate.

4.2. Installation of technology rooter system

Rooter system technology was used to absorb water into the soil through the pipe that was designed like a tree root where the pipe was drilled into the ground as deep as two meters with a slope of 45° and designed with system one point one-way. Installation of rooter system in the field was made by determining one point of installation location and eight pipes used; each point was installed with one pipe in the same direction. The distance between one point and another point was 2 meters. The point determination was based on the condition of the land which is frequently affected by flooding.

4.3. Hole making

After the determination of the point at the location, a hole was made. Making a hole on the ground aims to facilitate the installation of one-way rooter system technology. Making a hole on the ground for a one-way rooter technology system can use manual methods and a ground drill machine. However, to make it easier, faster, and have good result, we have to use a machine. The process of making a ground hole used a ground drilling machine by drilling the soil at a slope of 45°, and its depth was 2 meters. The process of punching the soil often results in soil holes that are not in accordance with the size of the pipe so that the pipe of rooter system technology cannot enter the hole provided and is damaged. The soil pitting process must be accurate and have the skills so that the piping of rooter system becomes easier.

4.4. Pipe installation

After making the hole, the pipe installation process continued. Pipe installation aimed to drain water from the ground surface into the soil and to accelerate the process of water absorption. In this process, skill and accuracy are needed so that the installed pipe does not damage in which it can interfere the observation process. A 2-meter long pipe was inserted into a hole made with a depth of 2 meters. Then, the top of the pipe was closed by using a cover made of plastic. This was done to prevent the entry of garbage or other dirt that could clog the pipe. The pipe cap was opened to measure the discharge of water flowing into the ground.
The way the rooter system technology works is to collect rainwater. Rainwater was collected and absorbed into the soil. Rooter system technology only holds rainwater, it does not waste water. Rooter system technology is a well or hole on the ground surface that is made to hold rainwater so that it can seep into the soil. One-way rooter system technology should be made in a groove because the water location is usually gathered. Water will flow from a high place to a lower place. Concerning this principle, the direction of flow can be discovered and the location of one-way rooter system technology can be determine so that water can enter it.

4.5. Observations

Observations carried out included analysis of the location of the study site, water level at the study site, area of land affected by flooding, length of time the soil absorbed the water surface which did not use one-way rooter system technology, long time the soil absorbed water using one-way rooter system technology, counting the volume of water that enters the soil using either rooter system technology or land that does not use rooter system technology.

Table 1. Observation 1 volume of water that enters the soil with and without rooter system technology in Sri Gunting.

| Time (minutes) | Without the rooter system | With the rooter system |
|----------------|---------------------------|------------------------|
|                | I                         | II                     | III                    |
|                | Volume (m³)               | Volume (m³)            | Volume (m³)            |
| 0              | 0                         | 0                      | 0                      |
| 30             | 3                         | 3                      | 3                      |
| 60             | 6                         | 6                      | 6                      |
| 90             | 9                         | 9                      | 8                      |
| 120            | 12                        | 11                     | 10                     |
| 150            | 15                        | 14                     | 12                     |
| 360            | 18                        | 16                     | 14                     |

From Table 1, it can be seen that without the installation of a rooter, the water absorption system in the soil takes place longer. The more volume of water, the longer it takes the soil to absorb water. When the water volume of 18 m³, it takes 360 minutes for soil to absorb water on the soil surface. It is in line with what stated by [3] that water absorption is said to be good if the water can go smoothly into layers of soil and the incoming water into groundwater reserves. Water infiltration acts as a filter for groundwater. When water enters the recharge area, there will be a water filtration process from the particles dissolved in it. It is possible because the journey of water in the soil is very slow. Therefore, it requires a relatively long time.

The table also shows that the water absorption with the installation of the rooter system on the ground takes place faster than without the installation of the rooter system. It can be seen from an increase in time. In test I, when the water volume was 18m³, it took 180 minutes for the soil to absorb water from the soil surface into the soil. In test II, when the water volume was 16m³, it took 180 minutes for the water to absorb into the soil. The resulting time is the same as repetition I, which is 180 minutes, whereas in the second test, the volume is less. In the test II, the pipe used was filled with plastic waste and a little mud which inhibited the rate of water infiltration. In replication III with a volume of 14m³, it took 180 minutes to get the water to absorb into the soil. Similar to repetition II, a part of the pipe was filled with mud or plastic debris which caused the pipe did not function properly.

The result of second observation is the same as first observation. It is caused by the soil conditions which are clay, and the soil has soil pore density so that water on the surface
of the soil is difficult to enter and absorbed by the soil. It is in accordance with [4] who stated that different soils cause water to seep at different rates. Each soil has a different absorption power, measured in millimetres per hour (mm / hour). Sandy soil types generally tend to have high infiltration rates, but the different clay tends to have a low infiltration rate. For the same type of soil with different densities, it has a different rate of infiltration. The denser the soil the smaller the rate of infiltration.

Table 2. The second observation volumes of water into the ground with the technology rooter system in the Sei Semayang village.

| Time (minutes) | Without | With the rooter system |
|----------------|---------|------------------------|
|                | Time (minutes) | I Volume (m³) | II Volume (m³) | III Volume (m³) |
| 0              | 0       | 0                      | 0              | 0               |
| -              | 30      | 3                      | 3              | 3               |
| -              | 60      | 6                      | 6              | 6               |
| -              | 90      | 9                      | 9              | 8               |
| -              | 120     | 12                     | 11             | 10              |
| -              | 150     | 15                     | 14             | 12              |
| 360            | 180     | 18                     | 16             | 14              |

The second observation did not have significant changes, which are similar to first observation. where at the time it was carried out repeat I when the volume of water as much as 18 m³ takes 180 minutes for the soil to absorb water on the surface. In replication II, when the volume of water was 16 m³, it took 180 minutes. In replication III, when the volume was 14 m³, it took 180 minutes. The condition of the pipe in test II and replication III was filled with waste and mud so that the pipe did not function properly to drain water from the surface land into the ground. Land conditions are very influential for drain water from the ground surface into the ground. It is in line with [5] who stated that the condition of the soil is very influential on the size of the soil absorbing power against rainwater. Thus, the construction of the well must consider the physical properties of the soil. Direct physical properties take effect against the amount of infiltration (water absorption) which includes the texture and soil pores.

In the third observation, there was a significant change from previous observations because the third observation was carried out in a land that is easier for water to absorb into the soil; the land is sedimentary soil. When the volume of water was as much as 18 m³, it took 320 minutes to absorb water into the soil. This is because the soil in the location is easier for water to absorb into the soil. It is similar to what has been stated by [6] that the higher the water content in the soil, the lower the rate of soil infiltration. This decrease in infiltration rate is caused by the soil layer which has a lot of water so that the groundwater content becomes higher than before. Consequently, the ability of the soil to infiltrate decreases, and the infiltration rate decreases in a long time. Then, the soil conditions will be saturated by water, so the soil is unable to pass on the water which results in a constant rate of infiltration. It is because the soil is increasingly saturated, so the water decreases its motion space [7].

From all the three observations, the change of time reduction of observations of the 1st and 2nd, which is done on the replay I is at water volume of 18 m³ takes 160 minutes for water to absorb into the soil. In repetition II when the water volume of 16 m³ takes 160 minutes, just like observations previously the problem of the pipe that had been filled with mud made the pipe not function properly as it was first used, which caused a different volume but the time produced was the same. And in replication III with volume 14 m³ the time needed is 160 minutes, just like the previous observation on replication III the pipe
does not function properly as it was first installed because the conditions in the pipe have been filled with garbage, mud and other impurities. In the third observation, the process of water absorption using rooter system technology has increased time because in this third observation it has soil that is easy for water to absorb into the soil or called sedimentary soil. The physical properties of the soil are very influential in draining water into the soil [8].

| Without the rooter system | With the rooter system |
|----------------------------|------------------------|
| Time (minutes) | Time (minutes) | Volume (m³) | Volume (m³) | Volume (m³) |
| 0 | 0 | 0 | 0 | 0 |
| - 30 | - 30 | 3 | 3 | 3 |
| - 60 | - 60 | 6 | 6 | 6 |
| - 90 | - 90 | 9 | 9 | 8 |
| - 120 | - 120 | 12 | 11 | 10 |
| - 140 | - 140 | 15 | 14 | 12 |
| 360 | 160 | 18 | 16 | 14 |

5. Conclusion and suggestion
5.1. Conclusion
By using rooter system technology in flooded land, it is better to accelerate the absorption of water from the soil surface into the ground, which is mitigated by not using rooter system technology. The result of rooter system installation in sedimentary soil or sandy text was the water was absorbed faster into the soil than clay textured soil.

5.2. Suggestion
In subsequent studies using rooter system technology, the pipe should be used more because of the number of pipes inserted into the infiltration hole. The faster the rate of absorption, the faster the water flows into the soil.

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