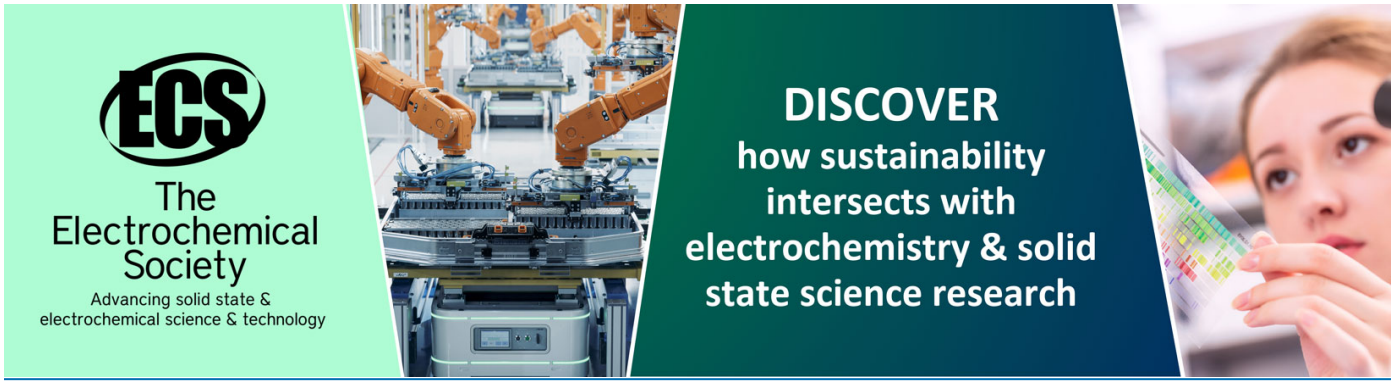
An Environmental Development Study: The Effect of Vegetation to Reduce Runoff



An Environmental Development Study: The Effect of Vegetation to Reduce Runoff

A. Rakhim* **& Nurnawaty**

Civil Engineering Department, Muhammadiyah University Of Makassar

*Email: abd.rakhimnanda@unismuh.ac.id

Abstract. Water absorption on land is influenced by several factors, namely, soil conditions and vegetation of land cover. The denser the condition of the soil surface, the infiltration rate will be smaller, and runoff will increase. The purpose of this study was to determine the role of plant roots and grass as an alternative to reduce inundation or runoff due to rain. Research on embankment soil samples in the laboratory was carried out using mini elephant grass and the roots of red shoots. Through testing of the Rainfall Simulator, the results of the tests found that the runoff without cover reached 25456.79 ml, while runoff with tree cover was 19665.10 ml. As if the tree root material can reduce 22.75% of the inundation/runoff that occurs in soil samples. Whereas in soil samples with grass cover can reduce as much as 19.35%. From this study, it was concluded that the roots of red shoots used in testing could be an alternative to land cover vegetation to minimize surface runoff.

1. Introduction

The presence of plants on the ground will affect the nature and density of the soil, where the denser the condition of the soil surface, the infiltration rate will be smaller. This happens because dense soil is difficult to penetrate by water, where the presence of plants on the surface of the soil will increase the rate of infiltration because plant roots can cause the soil structure to become loose, which can inhibit the flow of rainwater that falls to the ground. Thus the long stay time for rainwater will be longer. Furthermore, compaction caused by falling rainwater will decrease. Farming methods such as *terassiring* and correct counter plaughing can increase infiltration and reduce surface runoff. In other words, plant density has a positive effect on the level of infiltration and runoff. For the development of environmental types of vegetation that can block the running of runoff or runoff water and increase the amount of infiltrated water and enter the soil. Based on the preceding, this study was conducted to examine the relationship between vegetation density and runoff by modeling soil with grassland cover and tree root density to reduce surface runoff. Or in other words, based on the preceding, this study examines the importance of land cover vegetation to reduce surface runoff and accelerate infiltration rates regarding the relationship between root density and length of cover crops and runoff by modeling soil piles of rainy plants and trees and observed the amount of inundation that occurred. Finally, the problem of this research is the extent to which the influence of plant roots as land cover vegetation can reduce surface runoff and recharge.

In the previous study, the highest land runoff was found only in the intensity of I_5 rainfall without using vegetation. This occurs because the level of soil density before rain and after rain which results in compression by the largest runoff occurs and decreases in accordance with the increasing variation in tree density. This research continues the previous research with the limitation of the problem that

the embankment soil material used has been tested according to the characteristics of the ASTM and SNI standards with the material using rainfall simulators with intensity I_5, I_{10} and I_{25}.

2. Method of Research

In this study continued with embankment soil material used has been tested characteristics referring to ASTM and SNI standards, the tree material used is *pucuk merah* plant *(Oleina Syzygium)* and grass, Rainfall Simulator was tested, it to find out the effect of land cover can reduce inundation on the embankment soil model. The research was conducted by testing in the area using rainfall simulators with intensity I_5, I_{10} and I_{25} continuously until there is inundation or surface runoff at the Laboratory Hydrology and Hydraulics, Civil Engineering Department, Muhammadiyah University Of Makassar.

The material used in the research as modeling of embankment soil is adjusted to the reservoir of rainfall simulator reservoir as given in figure 1, 2, and 3 below.

Figure 1. Model of embankment in rainfall simulator tool. Length 100 cm, Width 120 cm, height 40 cm

The testing model was carried out with mini elephant grass *(Black Mondo Grass*) and red shoot *(Oleina Syzygium)* vegetation with an average root length of 20 cm, as land cover (figure 2)

(a) Land cover with grass (*Black Mondo Grass)*

(b) Land cover with grass *pucuk merah (Oleina Syzygium)*

Figure.2. Landfill Model with vegetation cover (a) Grass and (b) Pucuk Merah tree *(Oleina Syzygium)*

Rainfall intensity uses rainfall simulators with variations of I_5, I_{10} and I_{25}.that are used in a row: 246,841 mm, 290,335 mm and 344,900 mm continuously until there is inundation or surface runoff (Figure 3)

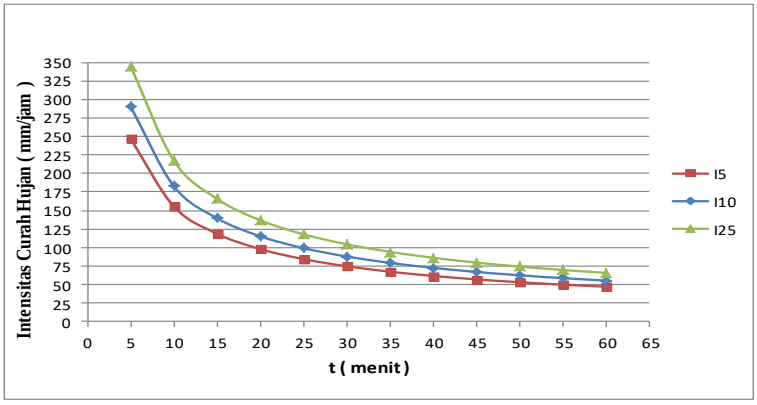


Figure 3. Rainfall Intensity with return period 5, 10 and 25 year

Runoff is measured by giving rain with variations of time 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55 and 60 minutes with soil density of 90%

3. Result and Discussion

The results of surface runoff measurements on the coverless landfill model and with vegetation in the 5, 10, and 15-year rainfall intensity are given in Figures 4, 5, and 6 below.

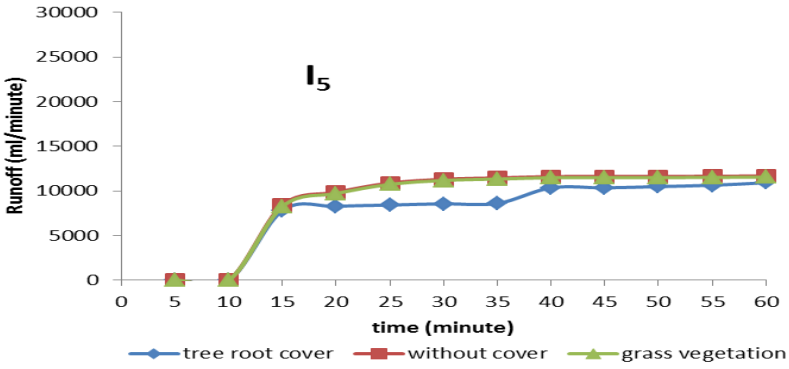


Figure 4. Runoff on $I_{5.}$

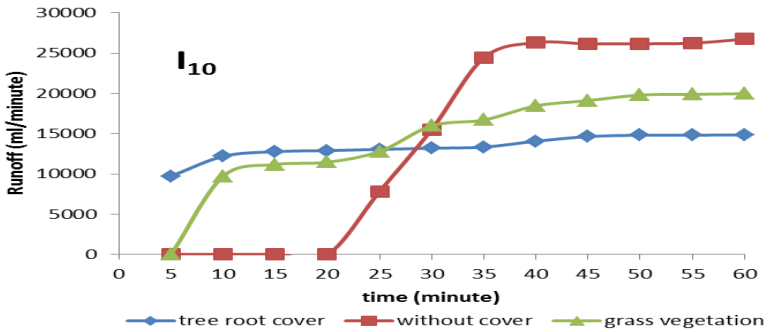


Figure 5. Runoff on rainfall I_{10}

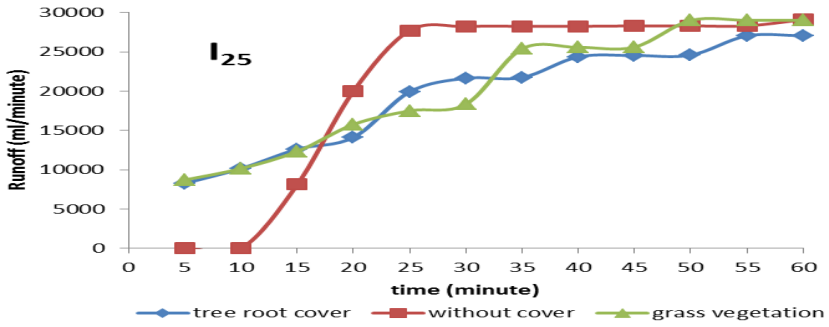


Figure 6. Runoff on rainfall I_{25}

Figure 4,5 dan 6 is the relationship between duration rainfall and runoff in the original landfill / no-cover model and with vegetation cover, figure showed difference in the amount of runoff in each type of vegetation. This result can be said that the longer the root of the cover plant a land, the greater the absorption and runoff or surface inundation that occurs the smaller. It is according to Arsyad (2010) that the amount of water flowing above the surface of the ground depends on the relationship between the amount, the intensity of the rain and the infiltration capacity of the soil and the storage capacity of the groundwater. The type of land cover reduces the amount of surface flow, the longer the root of the plant also increases the water absorption thereby reducing surface runoff. The types of plant vegetation and tree characteristics have a direct effect on soil permeability to reduce infiltration; vegetation of land cover serves to increase infiltration by destroying the microbiotic soil crust; the better the nature of the soil, the smaller the surface runoff may occur; and the level of infiltration below the tree roots is higher than among trees.

Accuracy testing / model validation can be done if there is measurable data used as input model data which then produces simulation data. The simulation results of the model can be said carefully if there is a high correlation value between the simulation and measured results data.

4. Conclusion

The conclusions of this study are: the presence of vegetation covering grass land and tree roots into the soil influences the value of surface runoff coefficient. The longer the root of the plant, will be the smaller the value of surface runoff. The type of vegetation that varies in a land influences the size of runoff. Pucuk Merah plants can be used as vegetation for alternative land cover to reduce runoff

5. References

[1] Abd Rakhim, Nurnawaty, 2017, Pengaruh Intensitas Curah Hujan Pada Model Kolam Resapan Bervegetasi Untuk Mereduksi Limpasan Permukaan, Prosiding Seminar Nasional Teknologi Terapan V, PTM Mataram, Vol 5(2017) P.475-485

[2] Ayni, Lady Noor (2010) *Pengaruh Karakter Individu Pohon Terhadap Laju Infiltrasi Dan Permeabilitas Tanah Di Sub Das Samin, Das Bengawan Solo Hulu, Kabupaten Karanganyar.*, Fak Pertanian Universitas Sebelas Maret, Surakarta, Perpustakaan.uns.ac.id

[3] *Deni Arista A, 2014,* Model Hubungan Hujan Dan *Runoff, Jurnal Teknik Sipil dan Lingkungan Vol. 2, No. 2, Juni 2014 P.215-224*

[4] Kazemi Zadeh M, M , A.R. Sepaskhah , 2016, Effect of tree roots on water infiltration rate into the soil, Iran Agricultural Research (2016) 35(1) 13-20

[5] *C.W.W. Ng, A.K. Leung, K.X. Woon*, 2014. Effects of soil density on grass-induced suction distributions in compacted soil subjected to rainfall. *Canadian Geotechnical Journal*, 2014, 51(3): 311-321, https://doi.org/10.1139/cgj-2013-0221

[6] Liu Jianbo, Gao Guangyao, Wang Shuai, Jiao Lei, Wu Xing, Fu Bojie, 2018, The effects of vegetation on runoff and soil loss: Multidimensional structure analysis and scale characteristics, Journal of Geographical Sciences, http://www.geogsci.com/EN/1009-

637X/home.shtml
[7] Putra Mahardika. 2009. Besar aliran permukaan (run-off) pada berbagai tipe kelerengan di bawah tegakan *Eucalyptus spp* [skripsi]. Medan. Fakultas Pertanian,Universitas Sumatera Utara.
[8] Risky Munandar , Dewi Sri Jayanti , Mustafril, 2016, Pemodelan Intersepsi untuk Pendugaan Aliran Permukaan Interception Modelling to Predict Surface Runoff, Jurnal Ilmiah Teknologi Pertanian Agrotechno Volume 1, Nomor 1, April 2016, hal. 62-69
[9] Wenbin Mu 1,2, Fuliang Yu 1,*, Chuanzhe Li 1,3, Yuebo Xie 2, Jiyang Tian 1, Jia Liu 1,4, and Nana Zhao 5, 2015, Effects of Rainfall Intensity and Slope Gradient on Runoff and Soil Moisture Content on Different Growing Stages of Spring Maize, Water 2015, 7, 2990-3008; doi:10.3390/w7062990, p.2990 – 3008
[10] http://www.nafiun.com/2012/12/struktur-dan-fungsi-akar-pada-tumbuhan-gambar.html
[11] (https://id.wikipedia.org/wiki/Pohon)