Change of Soil Erosion Characteristic under Different Vegetation

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Abstract. The runoff amount, soil erosion amount and infiltration rate were analyzed on different rainfall and different underlying horizon in base of yellow river institute of hydraulic research at 2018. The date shows: the runoff amount of bare slope is 7 times that of grass slope, the runoff amount of heavy rainfall is 2 times that of middle rainfall and is 20 times that of small rainfall; the soil erosion amount of bare slope and arable slope is 100 times that of grass slope; the steady soil erosion amount of small rainfall is 1/4 times that of middle rainfall and is 1/30 times that of heavy rainfall on grass slope; the infiltration rate of bare slope and arable slope is 1/3 times of grass slope; the grass slope infiltration rate is about 0.6mm/min in small rainfall, the middle and heavy rainfall get the steady infiltration rate at experiment continue 30min and 12min.

1. Introduction
The human being activity is one of the reasons effect soil erosion in valley[1-4]. The soil erosion research mainly focused on the changing rules of water and sediment in valley and river at the positive effects of human being activity reduce soil erosion[5]. The research result by hydrology method and soil and water conservation method shows: the soil and water conservation projects have a great contribution about the reduction of sediment in Yellow River, besides the cause of rain was reducing. Many researchers studied the soil erosion and sediment yield in different land use ways, especially in countryside natural condition[6-10], other researchers studied the soil erosion from the erosion power characteristic in different rainfall, and they get many significative results. Those researches were focused on the long tine and natural reinstate, it is necessary to research more the slope flow power characteristic effect the soil erosion on control condition rainfall and different land use way. This paper researched the soil erosion process and the effect on flow transportation in different land use way, and analyzed the slope soil erosion law and the critical shear force when producing the rill erosion, it is hoped that the results could supply the technology support to fixed amount assess the soil and water benefit.

2. Experiment Design and Method
2.1. Experiment Model Design.
Experiment was done in the Yellow River Model Base of Yellow River Institute of Hydraulic Research. The model slope degree could be adjusted from 5°-45°, could be used to the artificial rainfall experiment or be used for scouring experiment. The slope model was done 5m length, 3m width, and 60cm depth. the model will be divided three same parts which 5m length, 1m width by PVC, to do 3 times repeated experiment. The rainfall device was made by Institute Of Soil and Water Conversation,
Chinese Academy of Sciences & Ministry of Water Resource, the erosion model have a outlet to collect runoff and sediment (Figure 1).

2.2. Experiment Design.
The experiment soil was carried from Mangshan Mountain, particle composition is different (Table 1), and soil dry bulk density was about 1.3g /cm³. The slope degree was 20 °, rainfall strength were 45 mm/h, 90 mm/h, 130 mm/h, land used ways were: Bare slope, farmland and 60% coverage grassland, every experiment have two repeat tests.

| grain diameter (mm) | >1.0 | 1~0.25 | 0.25~0.05 | 0.05~0.01 | 0.01~0.005 | 0.005~0.001 | < 0.001 |
|---------------------|------|--------|----------|----------|------------|------------|--------|
| percent (%)         | 0    | 1.05   | 35.45    | 43.4     | 3.2        | 6.4        | 10.5   |

2.3. Experiment Method.
To fill in 10cm thick natural sand on the lower part of the model firstly, and then continue to fill in 20cm thick loess which carried from Mangshan mountain, use wooden planks to pat the soil, so that its density reached 1.3g/cm³, and then put twice 15cm thick loess soil samples, controlled bulk density are 1.3g/cm³. Laying a 20cm long carpet on junction between the steady flow pool and slope for ensuring the wash flow arrive slope steadily. The slope soil should be watering saturation at the beginning of the eve of experiment. The filling method of farm land was similar with bare land, and then the 20cm top soil of plot will be plowed to simulate the farmland. The filling method of grass land was similar with bare land, and then sow grass seed, the grassland experiment was done when the grass growd 3 months and the coverage was about 60%.

When the rain intensity meet the design, beginning to time, recording the time of runoff into the barrel, and then change one barrel every 2 min. Surveying the runoff weight and volume in every barrel to count the erosion and sediment using conversation method. At the same time, determinates the hydrodynamic parameters every 2 min.

3. Results

3.1. The Changes of Runoff in Different Rainfall and Land Use Ways on Slope.
Fig.2 is the changes of runoff in different land use ways in 90mm/h rainfall on 20°slope, It can be seen from this figure that the bare land and farm land runoff increased rapidly and then they arrived the
relative balance about 25 min, the grass land runoff increased slowly and then it arrived the relative balance about 30 min. the balance runoff of bare land about same as farm land, they were about 7 times as the runoff amount of grass land.

Fig. 2 Changes of runoff with time in different land use ways

Fig. 3 Changes of runoff with time in different rain on grass slope

Fig. 3 was the changes of runoff in different rainfall on 20°grass slope, It can be seen from this figure that the 45mm/h rainfall’s runoff had a small change in experiment, 87mm/h rainfall’s runoff increased slowly in the initial period of experiment, and then it get relative balance at 30 min, 127mm/h rainfall’s runoff increased sharply in the initial period of experiment, and then it get relative balance at 12 min. when they get the relative balance, the 127mm/h rainfall’s runoff was about 2 times that of 87mm/h rainfall and was about 20 times that of 45mm/h rainfall.

3.2. The Changes of Soil Erosion in Different Rainfall and Land Use Ways on Slope.

Fig. 4 Changes of erosion with time in different land use

Fig. 5 Changes of erosion with time in different rain on grass slope

Fig. 4 is the changes of soil erosion in different land use ways at 90mm/h rainfall on 20°slope, It can be seen from this figure that the bare land and farm land erosion increased rapidly and then they arrived the relative balance about 25 min, the grass land erosion increased slowly and then it arrived the relative balance. the balance erosion of bare land about was the same as farm land, they were about 100 times as the erosion amount of grass land.

Fig. 5 was the changes of soil erosion in different rainfall on 20°grass slope, It can be seen from this figure that the 45mm/h rainfall’s erosion had a small change in experiment, 87mm/h rainfall’s erosion increased slowly in the initial period of experiment, and then it get relative balance at 20 min, 127mm/h rainfall’s erosion increased sharply in the initial period of experiment, and then it get relative balance at 15 min , and then maybe the cause of rill occurred, the sediment had a proliferate
point at 40min. when they get the relative balance, the 45mm/h rainfall’s erosion was about 1/4 times that of 87mm/h rainfall and was about 1/30 times that of 127mm/h rainfall.

3.3. The Changes of Infiltration in Different Rainfall and Land Use Ways on Slope.

![Infiltration charts](image)

Fig.6 Changes of infiltration with time in different land use ways

Fig.6 is the changes of infiltration in different land use ways at 90mm/h rainfall on 20°slope, It can be seen from this figure that the bare land and farm land infiltration decreased rapidly and then they arrived the relative balance about 14 min, the grass land infiltration decreased slowly and then it arrived the relative balance at 20min. the balance infiltration of bare land about same as farm land, they were about 35% as the infiltration amount of grass land.

Fig.7 was the changes of infiltration in different rainfall on 20°grass slope, It can be seen from this figure that the 45mm/h rainfall’s infiltration had a small change in experiment, 87mm/h and 127mm/h rainfall’s infiltration decreased sharply in the initial period of experiment, and then it get relative balance at 30 min. when they get the relative balance, the 45mm/h rainfall’s infiltration was about 0.6mm/min, 87mm/h and 127mm/h rainfall were about 0.75mm/min.

4. Summary

1) the runoff amount of bare slope is 7 times that of grass slope, the runoff amount of heavy rainfall is 2 times that of middle rainfall and is 20 times that of small rainfall; the soil erosion amount of bare slope and farm slope is 100 times that of grass slope.

2) the steady soil erosion amount of small rainfall is 1/4 times that of middle rainfall and is 1/30 times that of heavy rainfall on grass slope.

3) the infiltration rate of bare slope and farm slope is 1/3 times of grass slope; the grass slope infiltration rate is about 0.6mm/min in small rainfall, the middle and heavy rainfall get the steady infiltration rate at experiment continue 30min and 12min.

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