P-27 Erosion Processes of Deposited Sediment in a Sand Pocket

Untung Budi Santosa** , Takahisa Mizuyama* , Masaharu Fujita*
* Faculty of Agriculture, Kyoto University
** Graduate Student

1. Introduction

Deposition of debris-flow sediments in piedmont regions results in the formation of either lobe cones (Suwa, 1984) or fans. Suwa (1984) observed that these fan structures tend to show a preferred direction rather than spreading uniformly over the whole area. Schumm (1977), recognized alluvial fan-head trenches that had alternating debris-flow and stream-flow deposits. These fan-head deposits are reworked by the fan stream and deposited in mid and lower fan regions.

Sand pockets, similar in geomorphology to alluvial fans are utilized in volcanic areas by Sabo engineers. The role of these sand pockets is to trap potentially hazardous debris-flows and lahars. The main aim of this study is to observe the erosional processes within sand pockets, in order to understand and increase their effectiveness in hazard control. To achieve this, a simulated sand pocket was set up in the laboratory and the pattern of erosion, stream-flow and infiltration were observed.

2. Aims:

1. To study the pattern of erosion and the change in flow direction of channel flow in the depositional area.
2. To examine the competence of ordinary flows to transport deposited sediment.
3. To examine the fluvial process within an artificial channel in the deposition area.

3. Method:

A simulated sand pocket was constructed on an inclined board using sand sized material (d_m= 0.5 mm). The deposited sediment was fan shaped with a length and width of 80cm, maximum depth of 4 cm (upstream), and slope gradients of 3 degrees. A flume (10cm wide, 15cm high and 200cm long) was connected to the inclined board to feed sediment and water to the fan structure. The flume`s gradient was set lower than that of the inclined board in order to maintain a low sediment supply upstream of the fan and encourage erosion. Water was supplied (20 to 35 cm^3/sec.) to generate stream-flow on the fan and observations were made over a 90 minute period. The fan sediment was saturated prior to experimentation to reduce water loss through infiltration. In the series of experiments a temporary channel was made down the center of the fan to deter initial spread surface flow.

4. Observation of stream flow pattern

The stream flow in the series of experiments with temporary channel flowed initially in a straight channel and erosion occurred of the stream bed and bank, which disrupted the straight temporary channel. With a low water supply (Q = 20-25 cm^3), the infiltration become dominant on the change of stream profile, with decreasing water depth and velocity, deposition was likely to occur in the channel and on bars, appears from the head to downstream. Erosion on the bank formatted the stream flow meander along the stream. After 45 minutes a single straight or small bend channel formed on the fan head and spread-surface flow was seen on the mid to lower fan region beginning the formation of a braided stream, but full braiding did not occur. With an increase in the water supply (30-35 cm^3) the disruption of the temporary channel was rapid (after 5 minutes) in the mid to lower fan region, but a single stream still remained at the fan head. A meandering stream developed briefly then changes to bending stream on the fan head following spread-surface flows occurred in the mid fan to lower fan region, and led to stream braiding. Figur 1 shows an example the trance stream flow changes with different mark line indicats a respective time. Widening and migrating of channels occurred due to deposition and formation of bars and bank erosion. Migration of stream direction on the fan head causes large change the formation of braided stream in mid to lower fan. Formation of braided stream tend to go upstream until the head of fan. Figure 2 shows the rate of sediment distribution in which erosion and deposition occur on the sand pocket model, after one hour reworking of stream flow. Rate of deep to light colour is represent as rate of erosion and deposition respectively. Erosion shown deep occur on the fan head stream to form the deep channel and deposition spread on downstream. Trance of braided stream shown the reworked of stream flow to distribute wider of the deposit sediment

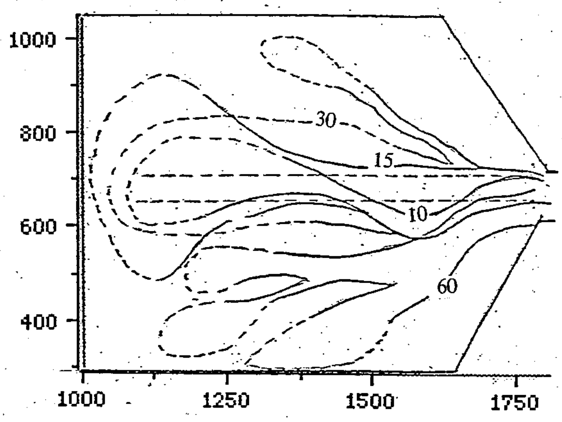

Figure 1 The stream trance on deposition fan

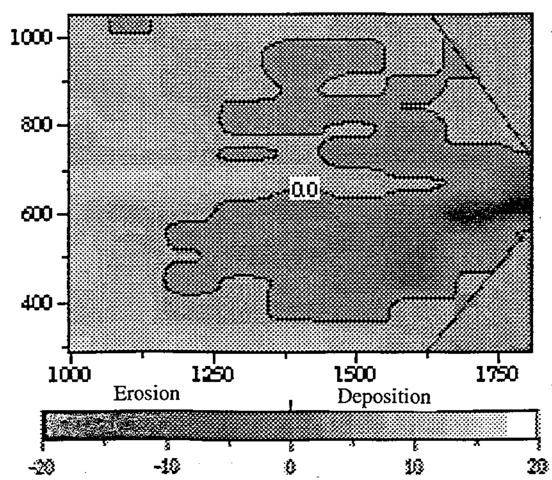

Figure 2 The rate of erosion and deposition

5. Width of stream flow

In the series of experiments stream width observed after the temporary channel broke and self perform channel have composed. The empirical theory for a relationship of water discharge (Q), and width of Channel (B) that was proposed in the Regime theory is used to examine the tendency of stream width.

The formula is:

$$B = \alpha Q^{\beta}$$

B is channel width; α is a coefficient width; Q is water discharge; β is an exponential. This experiment shows stream width adheres to this formula where the value of a ranges between 6 and 10 and the b is 0.5 (Figure 3). With a small water supply (Q = 20-25 cm^3), the stream width is smaller than expected, because some of the discharge infiltrated.

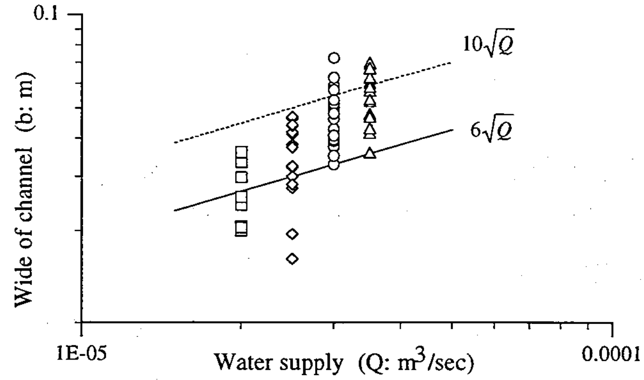

Figure 3. Width ofstream flow vs water discharge

6. Flow direction change

The stream-flow, although, showing a tendency to deflect and braid, had a dominant channel at the fan head which is the subject of this analysis. The temporal change in flow direction observing from medial line is a sinusoidal pattern curve and there is no similarity in patterns of stream-flow direction between each running test. The angle of dispersion was measured when the stream-flow changed its direction. The duration of stream-flow in each direction was timed. The standard deviation of flow direction change is shown in Figure 4. For low water discharges the standard deviation can be seen to be smaller than the standard deviation for higher discharges. During low discharges only small amounts of sediment are transported, causing the stream to remain relatively stable. During high water discharges the stream bed and bank were eroded, causing the stream flow tend to deflect or migrate.

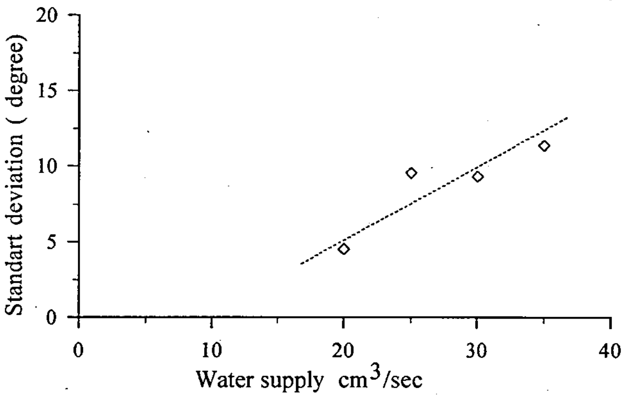

Figure 4. Standard deviation of flow direction change

7. Infiltration

During stream flow on the temporary channel, some of the water infiltrated to the subsurface region, causing sediment deposition in the stream, surface flow tending to disappear in the mid to lower fan region. Loss of water due to infiltration was calculated using a one dimensional simulation model with the assumption that infiltration rate is constant upstream to downstream.

8. Discussion and Conclusion

In small water supply, the infiltration liable to decreasing of the stream profile, causes the sediment load deposit on the stream and at a moment erosion bank occurred to perform bending or meandering flow. Increasing the water supply the infiltration was not much influence on the stream profile, furthermore, the stream flow on the head of fan formed a single straight channel before being spreading surface flow in mid to lower reach fan, lead to braided stream. Temporary channel deterred the spread surface flow to keep flows through the channel initially, then the pattern of stream is single stream in upper fan and tend to braided stream on the mid and lower fan.

The standard deviation for low water discharges can be seen to be smaller than the standard deviation for higher discharges, because during low discharges only small amounts of sediment are transported, causing the stream to remain relatively stable and the deflection of stream was not much change. Whenever the water discharge increasing larger over that did in this experiment the velocity may control the flow direction, causing the deflection of stream flow would smaller.

Trance of braided stream shown the reworked of stream flow to distribute wider of the deposit sediment was appear mostly on the temporary channel and on larger water supply at first experiment without channel.

Acknowledgment

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