Analysis of flood by using river flow map from Landsat 8 imaging to mitigate flood and the use of bamboo planting to prevent the flood study case: Kemuning river, Madura

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Abstract. Sampang included in the area that traversed by the Kemuning river which has 30 km length. The Kemuning River flow usually cause frequent flood, especially in the Sampang District. Slope data will be made using Landsat 8 and the solution will be given to prevent the flood. From the research conducted, it was found that the most influential river flow in causing flood is the river that through pass Robatal District and Kedungdung Subdistrict with the output volume is reaching 1060 liters, while the bamboo planting is done in the river area through Kedungdung Subdistrict, Sampang District and Omben Sub-District.

Keywords: Bamboo, flood, river border, outflow discharge, and watershed

1. Introduction
District of Sampang is located between 605°-7013” SL (South Latitude) and 113004°-113024 EL (East Longitude). It has an area of 1.233 Km2. The geology of this region consists of limestone (Madura formation), alluvium deposits, sand, and clay. Sampang has two main structures in the form of anticline in the north and south with orientation direction from west to east (Bemmelen 1949). This area is an area prone to flooding. It has been known that there have been 6 times the floods hit the capital of Sampang Regency, Madura throughout the year 2016 beginning in February, March, April, and July. Floods hit various districts with the highest flood height up to 2 meters. Floods have soaked a number of roads and entered the settlement of citizens. According to Head of Emergency and Logistic Division of Regional Disaster Management Agency (Badan Penanggulangan Bencana Daerah) of East Java there are thousands of houses and streets flooded due to high tide and high rainfall at the weekend (tempo.co). Sampang through Kemuning river along ± 30 km with upstream elevation ± 200 m and downstream area is a subdistrict area of the city covering Sampang, Torjun, Camplong, Omben, Kedungdung, Robatal, and Palenggan with elevation ± 4 m from sea level then boils down to Madura Strait. Runoff discharges due to rain are the main contributing factors in causing flooding. By knowing the runoff discharge can find out how the runoff debris generated by rain and how many discharge can be accommodated by the river (Usri Amrullah et al 2015).

One of the causes that often become the root of flood problems in the destruction of upstream and river border areas. To overcome this problem, bamboo plants are considered to be one good solution.
By planting certain types of bamboo on the upstream and river border, the potential for flood disaster can be suppressed.

2. Theory

2.1 Bamboo
Bamboo is able to grow in the lowlands up to the plateau with altitude range around 100-2200 m above sea level. The topographic of the bamboo planting can be divided into 3, i.e wavy, bumpy, and mountainous. For the bumpy type has a 35-8% of slope, the wavy type has 9%-15% of slope and the mountainous type has a slope more than 30%. Acid concentration (Ph) of land needed for bamboo planting is around 5-6.5 and Ph 3.5.

The temperature required for bamboo to live is 8.80°C-36°C with a climate range from wet to dry climate. The minimum of rainfall required by bamboo is 1020 mm/year and the minimum of moisture is 76%. The average temperature required during the rainy season is 21°C with moisture reaching 75.1% while in the dry season is 25.83°C and humidity is 61%. However, bamboo itself has species that can survive on certain land condition as follows:

| No | Land Condition | Type of Bamboo                  |
|----|----------------|---------------------------------|
| 1  | Dry land       | petung (*D. asper*)             |
|    |                | surat (*G. pseudoarundinaceae*) |
|    |                | apus (*G. apus*)                |
|    |                | legi (*G. atter*)               |
|    |                | ampel gading (*B. vulgaris v. striata*) |
|    |                | ampel hijau (*B. vulgaris v. vitata*) |
|    |                | ori (*B. blumeana*)            |
| 2  | Wet land       | ampel gading (*B. vulgaris v. striata*) |
|    |                | ampel hijau (*B. vulgaris v. vitata*) |
|    |                | duri (*B. blumeana*)           |

2.2 Time Concentration (tc)
Time Concentration is time required for water to flow from upstream to downstream. Kirpich formula can be used to calculate tc as follows:

\[ tc = \frac{0.0195}{60} \left( \frac{L}{\sqrt{S}} \right)^{0.77} \]  

Description:
- \( tc \) = time concentration
- \( L \) = river length (m)
- \( S \) = slope (%)

2.3 Outflow debit (Q)
Calculation of debit value due to runoff of water. Rational method is used to calculate the outflow debit:

\[ Q = A \times I \]  

Description:
- \( Q \) = outflow debit
- \( A \) = area
- \( I \) = rainfall intensity value
3. Methodology
This research is done by collecting data from Landsat 8 and watershed. The process of making NDVI, Anomaly, and temperature map from Landsat 8 to get overlay data and produce bamboo planting zone map.

![Workflow used in this research](image)

**Figure 1.** Workflow used in this research

4. Result and Discussion

4.1 Kemuning Waterhed Determination
In this research, the Kemuning watershed was simplified into six path (Figure 2) with upstream areas located in the north and downstream in the South. Those path are the main rivers consist of many river branches that exist in the Kemuning watershed. The time concentration and water flow of each path are being calculated which is enter and out from it.
4.2 River Flow Map
From the river flow map below can be seen that map with green colour shows areas without flood potential and the red one are areas with flood potential. The villages which are prone to flooding are: Polagan, Banyuanyar, Gunung Maddah, Rong Tengah, Gunung Sekar, Dalpenang, Paseyan, Panggung, Baruh, Tanggumong, Karoning, Banyumas, Panggelen, and Komis.

**Figure 2. Kemuning Watershed**

**Figure 3. River flow map of District of Sampang**
4.3 Bamboo Planting Zone Map
The solution that is given is to plant bamboo in those areas which are prone to flooding. Below shown a bamboo planting zone map. The red colour show a very low potential to plant bamboo in those areas, the orange colour show a low potential to plant bamboo, and the green colour show a moderate value, and the last one is the dark green colour which show a high potential to plant bamboo.

![Bamboo Planting Zone Map](image)

Figure 4 Bamboo Planting Zone Map

4.4 Overflow debit
Overflow debit is the value of the volume of increased water in a river for a certain period of time obtained from the difference between the volume of flow in water and flow out of each stream path. This is the overflow debit value of each path:

**Table 2. Overflow debit value in each path every rainfall**

| River path | Overflow volume every 2 hours (liter) |
|------------|--------------------------------------|
| 1          | 496.01                               |
| 2          | 557.41                               |
| 3          | 205.30                               |
| 4          | 188.97                               |
| 5          | 2725.21                              |
| 6          | 1082.41                              |

5. Conclusions
Based on the simulated overflow debit result if it is raining for two hours in all watershed areas of Kemuning River with 14.8 mm / 2 hour rainfall, the most potentially flooded path is the fifth track and the sixth path through Kedungdung, Sampang, and Omben with the overflow volume of 2725.21 and 1082.41 liters. While the path that plays the most active role in causing the flood potential is the second path through Robatal and Kedungdung with an output volume of 1060 liters. From riverflow map also shows some areas which are prone to flooding. With this result, it can become a
consideration in planting of bamboo in the areas which are prone to flooding because of bamboo’s characteristic which can absorb water from the rain or the river.

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