Priority Scale of Drainage Rehabilitation of Cilacap City

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Abstract. Characteristics of physical condition of Cilacap City is relatively flat and low to sea
level (approximately 6 m above sea level). In the event of a relatively heavy rainfall resulting
in inundation at several locations. The problem of inundation is a serious problem if there is in
a dense residential area or occurs in publicly-used infrastructure, such as roads and settlements.
These problems require improved management of which include how to plan a sustainable
urban drainage system and environmentally friendly. The development of Cilacap City is
increasing rapidly, this causes drainage system based on the Drainage Masterplan Cilacap
made in 2006 has not been able to accommodate rain water, so, it is necessary to evaluate the
drainage masterplan for subsequent rehabilitation. Priority scale rehabilitation of the drainage
sections as a guideline is an urgent need of rehabilitation in the next time period.

1. Introduction
Flood is a natural disaster that often occurs in Indonesia, especially in the rainy season. This incident
hit almost all cities in Indonesia and repeated every year, but this problem has not been resolved, even
tends to increase, both frequency, extent, depth and duration [1,2].

Therefore every development of the city should be followed by the evaluation and improvement of
the drainage system as a whole, not only on the development site, but also the surrounding areas
affected [3]. For example, the development of a settlement area in upstream of a drainage system, then
drainage planning is not only done in the settlement area, but the downstream drainage system should
also be evaluated and redesigned if necessary.

The drainage development masterplan needs to be revised to suit the development of the city. Since
the last five years the growth of housing construction, office buildings, and shophouses is quite rapid,
so a lot of open land that turned into buildings [4,5,6]. Complete drainage system improvement is
necessary but drainage improvement at the same time is not possible. Therefore, priority scale is
needed to determine which drainage sections need to be prioritized for rehabilitation [7].

2. Experimental
Analythical Hierarchy Process (AHP) is a method used in the decision-making process of complex
issues such as planning problems, alternative determination, prioritization, policy selection, resource
allocation, needs determination, forecasting performance planning needs, optimization and conflict
resolution. Saaty establishes a quantitative scale of 1 (one) to 9 (nine) to assess the comparative
importance of an element to another. [8].
According to Wignyosukarto, the use of Analytical Hierarchy Process (AHP) method in urban drainage system has the following strengths [9]:

a. Structuring the problem systematically.

b. Designed to use ratios and intuition to choose the best alternative, in the event of flooding in urban / an area. The best alternative is the one that has the least disadvantage, and has the greatest advantage.

c. Match the factors that make decisions gradually from the general to the specific

The reason for choosing the AHP method, according to Marimin, is that AHP has many advantages in explaining the decision making process:

a. Determination of the most dominant criteria greatly affects the outcome.

b. The end result can be graphically depicted, so it is easy to be understood by all parties involved in decision making.

c. A complex decision process can be decomposed into smaller decisions. [10].

3. Results and Discussion

Cilacap City area is relatively flat field typology and there are many river. The relatively flat surface of land makes the drainage slope limited, so it is very possible that the flow becomes substandard. While the proximity of areas of the city with a coastline allows the back water (reverse flow) on the rivers and drainage canals during high tides. Generally Cilacap City drainage system is shown in Figure 1. Cilacap City Drainage System outline served with drainage that flow by gravity, divided into 17 Main Drainage (Major and Sub Maj Drain) as shown in Table 1. In preparing the proposed priority criteria used are Condition Values, Debit Plan and Rehabilitation Costs.

Table 1. Main Drainage
(Major and Sub-Major Drain)

| Number | The name of river segment |
|--------|--------------------------|
| 1      | Kali Sabuk               |
| 2      | Kali Yasa                |
| 3      | Kali Menganti            |
| 4      | Kali Irigasi             |
| 5      | Kali Ciglagah            |
| 6      | Kali Tanjung             |
| 7      | Kali Karangwaru          |
| 8      | Kali Cinyemeh            |
| 9      | Kali Sentul              |
| 10     | Kali Kodok               |
| 11     | Kali Gubed               |
| 12     | Kali Donan               |
| 13     | Kali Watu                |
| 14     | Kali Beji                |
| 15     | Kali Sendangsari         |
| 16     | Kali Cidapur             |
| 17     | Kali Sendang             |

Figure 1. Drainage System of Cilacap City.
3.1. Hierarchical structure

The diagram in Figure 2 presents the decision to select the priority of rehabilitation of the drainage network, while the criteria for making the decision are the value of condition, debit plan, rehabilitation cost.

![Hierarchy Structure Diagram](image)

The alternative in making the decision is the main drainage section Kali Sabuk, Kali Yasa, Kali Menganti, Kali Irigasi, Kali Ciglagah, Kali Tanjung, Kali Karangwaru, Kali Cinyemeh, Kali Sentul, Kali Kodok, Kali Gubed, Kali Donan, Kali Watu, Kali Beji, Kali Sendangsari, Kali Cidapur dan Kali Sendang.

3.2. Assessment of criteria by filling in comparative data between criteria

Table 2 shows the comparison between criteria

| Table 2. Comparison Between Criteria |
|--------------------------------------|
| Condition value | Debit plan | Rehabilitation costs |
| Condition value | 1          | 7              | 9          |
| Debit plan      | 1/7        | 1              | 5          |
| Rehabilitation costs | 1/9        | 1/5            | 1          |

In the comparison of criteria can be explained as follows: Condition value is very important than the debit plan; Absolute Condition Value is more important than the cost of rehabilitation; Debit Plan is more important than the cost of rehabilitation

3.3. The weight data of each criteria on each alternative (river segment).

The obtained data are in the form of value/ weight of the degree of importance between the criteria and sub criteria that affect the decision making of the priority of drainage maintenance and rehabilitation. The weight result according to the Condition Values in Table 3., The weighted results according to Plan Debit in Table 5., and Weight Results According to Rehabilitation Cost in Table 7.
### Table 3. The Assessment of Alternative Weight of Condition Value

| River          | Condition Value (%) | Weight assessment | River          | Condition Value (%) | Weight assessment |
|----------------|---------------------|-------------------|----------------|---------------------|-------------------|
| Kali Sabuk     | 62                  | 7                 | Kali Kodok     | 77                  | 8                 |
| Kali Yasa      | 75                  | 8                 | Kali Gubed     | 74                  | 8                 |
| Kali Menganti  | 53                  | 6                 | Kali Donan     | 68                  | 7                 |
| Kali Irigasi   | 67                  | 7                 | Kali Watu      | 67                  | 7                 |
| Kali Ciglagah  | 54                  | 6                 | Kali Beji      | 56                  | 6                 |
| Kali Tanjung   | 51                  | 6                 | Kali Sendangsari| 66                  | 7                 |
| Kali Karangwaru| 55                  | 6                 | Kali Cidapur   | 57                  | 6                 |
| Kali Cinyemeh  | 66                  | 7                 | Kali Sendang   | 62                  | 7                 |
| Kali Sentul    | 68                  | 7                 |                |                     |                   |

### Table 4. Weight scale of condition value

| Condition Value (%) | Weight Scale |
|---------------------|--------------|
| 0-10                | 1            |
| 11-20               | 2            |
| 21-30               | 3            |
| 31-40               | 4            |
| 41-50               | 5            |

### Table 5. The Assessment of Alternative Weight of Debit Plan

| River          | Debit Plan (m3/s) | Weight assessment |
|----------------|-------------------|-------------------|
| Kali Sabuk     | 44                | 9                 |
| Kali Yasa      | 44                | 9                 |
| Kali Menganti  | 43                | 9                 |
| Kali Irigasi   | 39                | 8                 |
| Kali Ciglagah  | 35                | 8                 |
| Kali Tanjung   | 34                | 7                 |
| Kali Karangwaru| 32                | 7                 |
| Kali Cinyemeh  | 35                | 7                 |
| Kali Sentul    | 38                | 8                 |

### Table 6. Weight scale of Debit Plan

| Debit Plan (m3/s) | Weight Scale |
|-------------------|--------------|
| 0-5               | 1            |
| 6-10              | 2            |
| 11-15             | 3            |
| 16-20             | 4            |
| 21-25             | 5            |
The Assessment of Alternative Weight of Estimate Cost

Table 7. The Assessment of Alternative Weight of Estimate Cost

| River          | Estimate Cost in Billion | Weight assessment | River          | Estimate Cost in Billion | Weight assessment |
|----------------|--------------------------|-------------------|----------------|--------------------------|-------------------|
| Kali Sabuk     | 88                       | 2                 | Kali Kodok     | 95                       | 1                 |
| Kali Yasa      | 98                       | 1                 | Kali Gubed     | 92                       | 1                 |
| Kali Menganti  | 68                       | 3                 | Kali Donan     | 82                       | 2                 |
| Kali Irigasi   | 49                       | 6                 | Kali Watu      | 41                       | 6                 |
| Kali Ciglagah  | 45                       | 6                 | Kali Beji      | 56                       | 5                 |
| Kali Tanjung   | 57                       | 5                 | Kali Sendangsari| 59                      | 5                 |
| Kali Karangwaru | 55                      | 5                 | Kali Cidapuri  | 57                       | 5                 |
| Kali Cinyemeh  | 53                       | 5                 | Kali Sendang   | 45                       | 6                 |
| Kali Sentul    | 88                       | 2                 |                |                          |                   |

Table 8. Weight scale of Estimate Cost

| Estimate cost in billion | Weight Scale | Estimate cost in billion | Weight Scale |
|--------------------------|--------------|--------------------------|--------------|
| 0-10                     | 10           | 51-60                    | 5            |
| 11-20                    | 9            | 61-70                    | 4            |
| 21-30                    | 8            | 71-80                    | 3            |
| 31-40                    | 7            | 81-90                    | 2            |
| 41-50                    | 6            | 91-100                   | 1            |

Priority Scale with AHP method indicates that the lowest priority scale value is 5.667 in Sentul and Kali Kodok, meaning First Priority of rehabilitation of Cilacap City drainage system is done in Sentul and Kali Kodok, second priority in Kali Sabuk, Kali Yasa, Kali Menganti, Kali Tanjung, Kali Karangwaru, Kali Gubed, Kali Donan, Kali Beji. Third Priority in Cinyemeh River. Fourth Priority in Ciglagah River, Kali Watu, Sendangsari River. Fifth Priority in Kali Irrigasi. The Sixth Priority in Kali Sendang. Shown in Table 9.

Table 9. Results of Priority Scale Determination with AHP Method

| No. | River         | Weight Criteria | Result | Priority Scale |
|-----|---------------|-----------------|--------|----------------|
| 1   | Kali Sabuk    | 7               | 6.000  | 2              |
| 2   | Kali Yasa     | 8               | 6.000  | 2              |
| 3   | Kali Menganti | 6               | 6.000  | 2              |
| 4   | Kali Irigasi  | 7               | 7.000  | 5              |
| 5   | Kali Ciglagah | 6               | 6.667  | 4              |
| 6   | Kali Tanjung  | 6               | 6.000  | 2              |
| 7   | Kali Karangwaru | 6            | 6.000  | 2              |
| 8   | Kali Cinyemeh | 7               | 6.333  | 3              |
| 9   | Kali Sentul   | 7               | 5.667  | 1              |
4. Conclusion
Based on the survey and analysis of drainage conditions in Cilacap overall is good, although drainage rehabilitation must be done in several places to cope with flooding. This can be seen from the percentage of drainage condition weight, that is Sentul 68% and 77% Kali Kodok. Rehabilitation of damaged drainage network should be implemented gradually based on priority scale sequence with priority order, first priority of rehabilitation is done in Sentul and Kodok. This is based on the high weight of Condition Values, Debit Plans and Rehabilitation Costs.

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