Analysis Of The Effectiveness Of The Retention Pool As Flood Control

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Abstract. Flooding is a condition where there is no water in the drainage canal (times) or impeded flow of water in the drainage canal. Flooding is part of the management of more specific water resources to control flood discharge generally through flood control dams, or improvement of carrier systems (rivers, drainage) and prevention of potentially damaging things by managing land use and flood areas. Retention pool is one of the ways that is used to overcome flooding, but with the existence of retention ponds it does not guarantee that the area is protected from flooding, so it needs to be seen the effectiveness of the retention pool to control flooding. The purpose of this study is to obtain alternative flood control handling from the retention pond and obtain the value of the effectiveness of the reservoir for flood control, and the accuracy in the placement of the location of the retention pool. The steps that will be taken to carry out this research are: 1) Looking for supporting theories about retention pools, 2) Determine the parameters of the value of effectiveness of the retention pool that has been made boundary, 3) namely (the volume of storage and determining the location of the placement of retention pools), 4) Look for available data that has been available in previous planning, 5) Analyze the value of the effectiveness of the retention pool which is then written in the form of a thesis.

1. Introduction
Indonesia is a country with a tropical climate where it experiences a dry and rainy season, in the dry season in some areas and also rivers often occur in drought and in the rainy season in some areas frequent flooding occurs due to overflowing of the river or high rainfall that falls in the catchment area, clogged drainage, or because of the lack of water catchment areas. Flood is a condition where water is not accommodated in the drainage channel (times) or obstructed the flow of water in the drainage channel. one of the areas that are often flooded areas, namely in the Bandung Regency area which is passed by the Citarum river flow. Until now, the problem of flooding is a problem that cannot yet be overcome and remains a thought for its control. One of the efforts in flood control is by creating a retention pond. The retention pond serves to temporarily store and store water from the drainage channel before flowing into the river so that the peak of the flood can be reduced. Also in the dry season the water in the retention pond can be used as a water resource. The degree of flood reduction depends on the characteristics of the flood hydrograph, the pool volume and the dynamics of some outlet buildings. The area used for the construction of reservoirs is usually in a low area. With good land use planning and implementation, retention ponds can be used as temporary rain water reservoirs and water distribution or distribution.
In the Bandung Regency area there are several points of flood-prone areas, most of the locations are prone to flooding due to the overflowing of a number of tributaries of the Citarum River, flooding is part of the management of more specific water resources to control flood discharge generally through flood control dams, or improvement of the system carriers (rivers, drainage) and prevention of potentially damaging things by managing land use and flood areas. Retention ponds are one of the methods used to deal with floods, but the presence of retention ponds does not guarantee that an area is protected from flooding so it needs to be seen the effectiveness of these retention ponds to control flooding. The purpose of this study was to analyze the maximum flood discharge that occurred in the Citarum River in the Baleendah - Dayeuhkolot area with a retention pond.

2. Methods

Research Population / Obek
Population is the sum of all objects whose characteristics are determined beforehand. For the object of this Final Project research is the retention pool whose main function is flood control.

Research Samples / Locations
The sample is part of the population consisting of a number of members selected from the population. The research location to complete the data in completing this Final Project is at Cieunteung Retention Pool in Kec. Bendahendah Kab. Bandung can be seen in Figure 1 below

![Figure 1. Location](image)

Research Instruments / Tools and Data Collection Materials
The research instrument is a tool used to measure phenomena that occur to be observed. In conducting this research, we need the tools that will be used in primary and secondary data collection, as follows: 1) Stationery, to record existing conditions in the field, 2) Measuring instrument, to measure the calculation of discharge. 3) Cameras, to document research. 4) Laptops, to process data obtained from secondary data and primary data. While the materials used in this study are secondary data, primary data and related literature.

Research methods
In this study using a comparative causal method, where this method describes a causal relationship. With the aim to investigate the causal relationship by observing the effects that exist and look for factors that might be the cause of a problem through certain data.

3. Result And Discussion

Data Collection Results
The data that has been collected consists of primary data including cross-channel measurement data with existing gauges and secondary data including Hydrological data and Retention Pond Design.

Primary data
The existing channel measurement data used in this study is the result of direct measurements in the field using a measuring instrument. Based on the results of data collection, measurements were obtained in the form of the width of the cigado river and Citarum river channels. As Table 1 and Table 2 below.

### Table 1. Cross section of Cigado Channel

| Sungai Cigado |   |   |
|--------------|---|---|
| b            | 2.2|   |
| S            | 0.04442|   |
| m1           | - |   |
| l/n          | 28.57|   |
| n            | 0.035|   |

Source: Survey Results, 2019

### Table 2. Section of Citarum Channel

| Sungai Citarum |   |   |
|----------------|---|---|
| b              | 22.35|   |
| S              | 0.04442|   |
| m1             | 1 : 1.5|   |
| l/n            | 20|   |
| n              | 0.050|   |

Source: Survey Results, 2019

Secondary Data
1. Annual Debit and Plan Debit
Based on the data obtained, data on water discharge conditions for one year in the Citarum River can be seen in Table 3 and the re-plan discharge for the Citarum Watershed can be seen in Table 4 below.
Tabel 3. Debit Plan for Sub Das Citarum

| Kala Ulang | Debit Banjir Rencana (m3/det) |
|------------|-------------------------------|
| 5          | 18.80                         |
| 10         | 21.49                         |
| 25         | 24.75                         |
| 50         | 27.07                         |
| 100        | 29.32                         |

Source: Calculation results, 2014

Table 4. Citarum River Discharge in 2018 Location of Dayeuhkolot

| Tanggal | Jan | Feb | Mar | Apr | Mei | Jun | Jul | Agi | Sep | Okt | Nop | Des |
|---------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1       | 34.29 | 26.2 | 89.04 | 36.87 | 28.87 | 20.24 | 17.36 | 13.84 | 16.53 | 11.22 | 54.25 | 77.22 |
| 2       | 34.23 | 24.16 | 89.04 | 35.06 | 26.92 | 19.62 | 16.78 | 15.13 | 14.84 | 11.26 | 33.06 | 87.63 |
| 3       | 56.73 | 23.84 | 90.16 | 57.79 | 26.28 | 20.83 | 17.24 | 13.44 | 17.67 | 12.11 | 22.74 | 46.98 |
| 4       | 58.83 | 25.31 | 115.12 | 61.72 | 28.05 | 21.77 | 15.73 | 12.9 | 15.19 | 13.05 | 20.84 | 63.4  |
| 5       | 69.52 | 29.37 | 117.02 | 45.17 | 28.24 | 20.74 | 15.75 | 12.82 | 13.91 | 11.63 | 18   | 64.75 |
| 6       | 58.2  | 44.17 | 96.78 | 59.5  | 24.83 | 20.23 | 14.87 | 12.92 | 13.47 | 10.78 | 20.63 | 50.84 |
| 7       | 38.53 | 52.67 | 69.79 | 48.37 | 23.65 | 19.54 | 14.43 | 11.93 | 13.33 | 10.67 | 24.69 | 52.85 |
| 8       | 36.94 | 42.37 | 95.05 | 84.26 | 26.82 | 19.6  | 14.62 | 12.46 | 12.82 | 10.13 | 74.33 | 47.22 |
| 9       | 36.27 | 39.1 | 130.2 | 52.25 | 33.93 | 18.67 | 15.46 | 13.01 | 12.72 | 10.31 | 85.44 | 32.61 |
| 10      | 37.63 | 38.78 | 109.05 | 54.39 | 26.17 | 17.98 | 15.02 | 13.86 | 12.25 | 10.55 | 76.12 | 31.71 |
| 11      | 50.82 | 32.79 | 100.34 | 40.12 | 23.82 | 17.87 | 14.98 | 13.47 | 12.04 | 10.48 | 83.61 | 52.89 |
| 12      | 35.95 | 29.5 | 96.68 | 34.34 | 22.86 | 17.58 | 14.3 | 13.13 | 11.86 | 10.08 | 101.21 | 43.95 |
| 13      | 30.12 | 28.91 | 99.85 | 33.21 | 28.36 | 17.28 | 13.53 | 13.34 | 11.3 | 10.06 | 75.04 | 34.81 |
| 14      | 29.06 | 28.55 | 80.6 | 36.66 | 22.57 | 16.5 | 13.81 | 12.97 | 10.76 | 11.34 | 60.22 | 39.62 |
| 15      | 28.87 | 31.76 | 65.09 | 35.17 | 20.15 | 18.06 | 13.98 | 12.18 | 10.75 | 10.31 | 42.96 | 62.25 |
| 16      | 26.55 | 42.76 | 58.78 | 38.37 | 21.71 | 21.33 | 14.17 | 11.79 | 10.74 | 11.2 | 41.21 | 82.7 |
| 17      | 25.98 | 29.5 | 73.07 | 66.99 | 21.03 | 19.09 | 14.39 | 11.58 | 10.37 | 11.74 | 30.95 | 66.28 |
| 18      | 24.73 | 26.92 | 77.72 | 46.2 | 19.59 | 19.38 | 14 | 12.61 | 10.79 | 12.58 | 23.63 | 42.26 |
| 19      | 24.82 | 34.69 | 67.81 | 51.8 | 26.84 | 17.32 | 13.71 | 13.37 | 10.83 | 17.53 | 21.06 | 34.19 |
| 20      | 24.11 | 61.75 | 75.33 | 80.84 | 27.66 | 16.33 | 14.37 | 12.79 | 11.55 | 13.56 | 21.9 | 33.08 |
| 21      | 24.05 | 62.66 | 66.64 | 81.97 | 37.21 | 16.13 | 13.28 | 12.01 | 12.79 | 12.61 | 43.01 | 34.99 |
| 22      | 25.29 | 74.91 | 49.54 | 65.57 | 40.85 | 16.57 | 14.73 | 12.21 | 15.86 | 11.91 | 42.71 | 29.02 |
| 23      | 25.32 | 124.86 | 44.25 | 61.36 | 32.77 | 16.92 | 15.14 | 12.32 | 14.93 | 13.1 | 35.7 | 26.62 |
| 24      | 24.99 | 121.72 | 54.68 | 47.31 | 36.76 | 16.95 | 14.55 | 12.36 | 12.73 | 16.96 | 28.33 | 30.49 |
| 25      | 25.97 | 117.99 | 59.55 | 42.98 | 32.59 | 18.28 | 14.52 | 12.29 | 11.93 | 14.58 | 38.39 | 30.74 |
| 26      | 25.54 | 118.3 | 79.19 | 60.94 | 32.45 | 25.13 | 13.26 | 11.75 | 11.92 | 13.78 | 60.34 | 43.13 |
| 27      | 25.77 | 104.13 | 46.15 | 47.82 | 27.86 | 34.84 | 12.96 | 12.16 | 13.87 | 14.91 | 42.37 | 38.28 |
| 28      | 22.56 | 93.28 | 44.32 | 39.76 | 23.9 | 23.17 | 12.48 | 13.93 | 12.01 | 17.82 | 43.57 | 42.16 |
| 29      | 11.18 | 38.41 | 40.9 | 21.49 | 19.94 | 12.53 | 14.29 | 11.23 | 53.66 | 35.91 | 45.45 |
| 30      | 20.29 | 37.69 | 32.34 | 21.68 | 17.83 | 12.5 | 14.59 | 11.14 | 56.34 | 79.92 | 34.53 |
| 31      | 21.56 | 43.71 | 21.53 | 12.7 | 15.2 | 55.6 | 28.19 |
Retention Pool Design
Based on the data obtained, data on the design capacity of retention ponds and topography are seen in Table 5 and the picture can be seen in the attachment sheet.

Table 5. Cieunteung retention pond storage capacity

| No | Elevasi (m) | Contour Area (inundation area) (m²) | Average area between contours (m²) | Reservoir Volume (m³) | Information |
|----|-------------|-----------------------------------|-----------------------------------|----------------------|-------------|
| 1  | 653,7       | 42.827,24                         | 0                                 | 0                    | Base-level  |
| 2  | 654         | 43.456,89                         | 43.142,07                         | 12.942,62            |             |
| 3  | 654,7       | 44.934,63                         | 44.195,76                         | 43.879,65            |             |
| 4  | 655         | 45.567,94                         | 45.251,29                         | 57.455,04            | Operational Water-level |
| 5  | 656         | 47.697,81                         | 46.632,88                         | 104.087,92           |             |
| 6  | 656,2       | 48.126,04                         | 47.911,93                         | 113.670,30           |             |
| 7  | 656,2       | 52.784,34                         | 47.911,93                         | 113.670,30           | First trap  |
| 8  | 656,5       | 53.440,26                         | 53.112,30                         | 129.603,99           |             |
| 9  | 657         | 54.537,21                         | 53.988,73                         | 156.598,36           |             |
| 10 | 657,4       | 54.977,30                         | 54.757,25                         | 178.501,26           | MAB         |
| 11 | 657,5       | 55.638,86                         | 55.308,08                         | 184.032,07           |             |
| 12 | 658         | 56.745,22                         | 56.192,04                         | 212.128,09           |             |
| 13 | 658,4       | 58.079,08                         | 57.412,15                         | 235.092,95           |             |

Source: Survey Results, 2019
### Table 6. Recap of the Cigado river flow calculation results

| No | Segment | A (m²) | P (m) | R (m) | V (m/dt) | b (m) | h (m) | 1/n | i | n | Q capacity m³/sec | Q 25 years m³/sec | KET |
|----|---------|--------|-------|-------|----------|-------|-------|-----|---|---|-----------------|------------------|-----|
| 1  | Section S 4 | 2.58   | 6.030 | 0.427 | 3.41     | 2.50  | 1.03  | 29  | 0.044420 | 0.035 | 8.79         | 24.75            | OVERFLOWED |
| 2  | Section S11 | 2.03   | 4.870 | 0.417 | 3.36     | 1.90  | 1.07  | 29  | 0.044420 | 0.035 | 6.84         | 24.75            | OVERFLOWED |
| 3  | Section S 16 | 3.37   | 5.930 | 0.568 | 4.13     | 2.20  | 1.53  | 29  | 0.044420 | 0.035 | 13.90        | 24.75            | OVERFLOWED |
| 4  | Section HP 2 | 2.27   | 4.860 | 0.467 | 3.62     | 1.80  | 1.26  | 29  | 0.044420 | 0.035 | 8.22         | 24.75            | OVERFLOWED |
| 5  | Section HP 8 | 3.92   | 6.180 | 0.634 | 4.44     | 2.20  | 1.78  | 29  | 0.044420 | 0.035 | 17.40        | 24.75            | OVERFLOWED |

Source: Calculation Results, 2019

From the calculation of the channel cross section geometry and flow velocity, in the Cigado river the discharge capacity in the river will overflow if the discharge is used during the Q25 year plan so that additional height is needed so that the water flow does not overflow.

**Retention Pool Pool Volume Calculation**

Based on the Planning Standard for the folder and retention pond system issued by the Ministry of Public Works Republic of Indonesia number 12 / PRT / M / 2014 that the urban drainage handling system is by isolating areas affected by rainwater / sea water runoff and runoff, which consists of ponds container, system drainage and pumping system. From the previous study data in retention pool planning, channel geometry calculations and channel discharge capacity, then to calculate the storage volume used equation 2.12

\[
Q_{kolam} = Q_{banjir} - Q_{kap}
\]

\[
Q_{kolam} = 24.75 \text{ m}^3/\text{dtk} - 13.90 \text{ m}^3/\text{dtk}
\]

\[
Q_{kolam} = 10.85 \text{ m}^3/\text{dtk}
\]

Dan untuk menghitung volume efektif kolam digunakan persamaan 2.13

\[
\text{Volume eff kolam} = (Q_{kolam}(t) + Q_{kolam}(t+1))/2 \times \Delta\text{Waktu} \times 60 \times 60
\]

So that the recapitulation results obtained from the calculation of the effective retention pool volume are in Table 4.7 below.
Table 7. Results of recap of the Effective storage volume of retention ponds

| Waktu (Jam) | Debit (m³/dtk) | Kondisi | Qkolam (m³) |
|------------|----------------|----------|-------------|
| 0.00       | 0.000          | Tidak Meluap | 0.000     |
| 0.50       | 9.980          | Tidak Meluap | 0.000     |
| 1.00       | 55.271         | Meluap | 27.821     |
| 1.50       | 53.750         | Meluap | 26.300     |
| 2.00       | 33.933         | Meluap | 6.483      |
| 2.50       | 27.200         | Tidak Meluap | 0.000     |
| 3.00       | 28.985         | Meluap | 1.535      |
| 3.50       | 22.350         | Tidak Meluap | 0.000     |
| 4.00       | 19.526         | Tidak Meluap | 0.000     |
| 4.50       | 17.038         | Tidak Meluap | 0.000     |
| 5.00       | 15.569         | Tidak Meluap | 0.000     |
| 5.50       | 14.116         | Tidak Meluap | 0.000     |
| 6.00       | 15.397         | Tidak Meluap | 0.000     |
| 6.50       | 12.885         | Tidak Meluap | 0.000     |
| 7.00       | 11.894         | Tidak Meluap | 0.000     |
| 7.50       | 11.091         | Tidak Meluap | 0.000     |
| 8.00       | 10.407         | Tidak Meluap | 0.000     |
| 8.50       | 9.813          | Tidak Meluap | 0.000     |
| 9.00       | 9.291          | Tidak Meluap | 0.000     |
| 9.50       | 8.830          | Tidak Meluap | 0.000     |
| 10.00      | 8.419          | Tidak Meluap | 0.000     |
| 10.50      | 8.052          | Tidak Meluap | 0.000     |
| 11.00      | 7.721          | Tidak Meluap | 0.000     |
| 11.50      | 7.423          | Tidak Meluap | 0.000     |
| 12.00      | 7.151          | Tidak Meluap | 0.000     |

Total: 62.138 m³, 111,849.24 m³

Source: Calculation Results, 2019

From the recap result of the calculation of the volume of the above reservoir, it can be made a graph of the relationship between the flood discharge and the capacity of the river basin in Figure 2 below.

Figure 2: Sungai Correlation between flood debit and river capacity
Elevation 1 = 656 Pond Volume 1 = 104,087.92 m³
Eff elevation = x Pond Volume eff = 111,849.24 m³
Elevation 2 = 656.2 Pool Volume 2 = 113,670.30 m³
thus obtained for an effective storage volume with 111,849.24 at an elevation of ± 656.16

Elevation 1 = 656 inundation area 1 = 47,697.81 m²
Eff elevation = ± 656.16 inundation area = x
Elevation 2 = 656.2 inundation area 2 = 52,784.34 m²
And for the area of inundation with elevation ± 656.16 is obtained 51,767.03 m²

Retention Pool Location Placement
For the location of the Cieunteung retention pond, it is located in a river body or downstream of the Cigado river. When viewed from the perspective of the retention pond, it is located in the lowest area with a base elevation ± 653, and the position of the retention pond is adjacent to the Citarum river channel, so that the flow of water from the Cigado river can be accommodated to cut off the peak of the flood discharge before being flowed into the Citarum river.

Handling
By looking at the results of the calculation of the storage volume and location of the retention pond location, it can be ensured that for the effectiveness of this cieunteung retention pond, it has been effective for cutting flood discharge from the Cigado river with 4 pumps from the retention pond consisting of 3 flood pumps and 1 daily pump with a broadcast capacity:
- Flood pump = 3.5 m³/ sec
- Daily pump = 2.0 m³/ sec
So the discharge that can be flowed into the Citarum river from the Cieunteung retention pond via a pump is:
Flood pump = 3.5 m³/ sec * 3 = 10.5 m³/ sec
Daily pump = 2.0 m³/ sec +
Debit Out flow = 12.5 m³/ sec

4. Conclusion
Flooding is a condition where there is no water in the drainage canal (times) or impeded flow of water in the drainage canal. Flooding is part of the management of more specific water resources to control flood discharge generally through flood control dams, or improvement of carrier systems (rivers, drainage) and prevention of potentially damaging things by managing land use and flood areas. Retention pool is one of the ways that is used to overcome flooding, but with the existence of retention ponds it does not guarantee that the area is protected from flooding, so it needs to be seen the effectiveness of the retention pool to control flooding.

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