The Effect of River Meanders on River Morphology

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Abstract. Meander is a change in the flow of a river that forms a Semicircle or like the letter S whose fingers are irregular or irregular due to horizontal and centrifugal pressure. One of them that has a meander river is in citarum watershed, located in Majalaya Sub-district, Kab. Bandung. There is a change in the morphology of the river so that the geometry of the river changes from its original shape. The purpose and purpose of the Research to analyze the value of speed, meander fingers, and the morphological influence of rivers so that the problems that arise can be reduced and the benefits/potential possessed can be optimized. The research method used comparative causal methods (causal relationships). The results suggest meander river like the letter S is quite Ideal. Materials along the meander section contain clay, gravel, sand and macaques, clay stones and ash and black stones. Meander River with a length of ± 975 m is divided into five segments, namely. It was then concluded that \( V^<, Q^< \Rightarrow R_c^> \) and \( V^>, Q^> \Rightarrow R_c^< \) as well as morphological types A, E, G, F & DA.

1. Introduction

The river is a naturally formed channel, not to hold water but to drain water from upstream (source) to the downstream (estuary). Rivers can be divided by different points of view such as morphology, ecology, and anthropogenic (with human intervention). In 2011 stated that Indonesia has more than 5,950 Watersheds, one of which was reviewed in this study, namely citarum watershed. After being searched through Google Earth the citarum river has several types of river meander that is familiar called Meander River. Meander is a change in the flow of the river that forms a Semicircle or forms like the letter S whose fingers - the fingers are irregular or irregular due to horizontal and centrifugal pressure. [1][2] [3]

River Morphology changes also affect the size and shape of the river, so that the river will be free in adjusting its size and shape either in the form of geometry or river roughness [4]. Citarum River Majalaya area in existing conditions is a river that has a width ± 3.5 - 6 meters which in its cross-section is filled with water and ± 6 - 35 meters which in its cross-section is not filled with water and one of the sections of the form of Meander River has a length of ± 975 meters. The form of meander river is very close to the rice fields of residents and people's gardens, it is feared to be dangerous also to the assets in the area around the river because it will affect the borderline of the river as stated in [5] concerning The River About The River Border Line. [6][7]
2. Method
This study uses the comparative causal method, this method describes the causal relationship. The purpose of this method is to investigate the causal relationship struck by observing and looking for factors that may be the cause of a problem in the field through certain data.

This research is located in Meander Sungai Pacet - Majalaya, Majalaya Village, Kec. Majalaya, Kab. Bandung. This research is to find out the speed, size of the fingers, and the effect on the morphology of the river because the condition of the cross-section of the river has changed from the initial shape and the river has also widened and it is mostly very close to the rice fields of the residents and the gardens of the residents, related to it certainly affects the borderline of the river. In this case, the river meander is located in Majalaya village to the south of Pacet sub-district. To reach the location of Meander Citarum if from Bandung direction to Jl. Ciparay overtime awi next if from Cicalengka to Jl. Padasuka-Maruyung Pacet. Can be seen in figure 1, figure 2, figure 3, figure 4, figure 5, and figure 6.

![Figure 1. Getting there](image1)

![Figure 2. Research sites](image2)
3. Result and Discussions

The data collected consists of Primary Data including photos of existing circumstances, river geometry size, river border-width size, and river plan and Secondary Data including Citarum River Map, River Border Act, and Long Section. Can be seen in figure 3, figure 4, and figure 5.

![Figure 3. Long section](image3.png)

![Figure 4. Citarum river plan](image4.png)
The results of the survey in the field showed the material of the valley's constituent rocks in the area varies. There are two kinds in the eastern and southern parts of the claystone and there are chunks of sandstone in gray, black and there is an orange clay that is easily eroded, snarling, and avalanche. After seeing the existing conditions that indeed the borderline of the river is 3 - 5 meters long, even almost completely invisible. Whereas the function of the River Border as an environmental asset for flora and fauna, filters effectively capture sediment and pollutants so that water quality will be maintained from murky effects and pollution, river borders strengthen the structure of the soil so that it is not easy to landslide, erode and be eroded by water flow, and the riverfront area that borders is arranged to make the harmony of life between nature and society. But seeing real conditions in the field has a very detrimental negative impact such as decreased water quality due to the loss of filter function that withstands pollution, increased river cliff scour, river morphology changes as the geometry of the river becomes wider and shallower.

3.1 Cross-sectional geometry, speed, and discharge calculations
Here is the Calculation of Cross-section geometry, speed, discharge, and fingers - fingers divided into segments a, b, c, d, &e. below are only sample calculations of segments a, and segments b,c, &e are poured in table 1.
### Table 1. Cross-sectional geometry recapitulation, speed, and discharge

| Name   | B (m) | b (m) | h (m) | T (m') | A (m²) | P (m³) | R (m') | D (m') | V (m/s) | Q (m³/s) |
|--------|-------|-------|-------|--------|--------|--------|--------|--------|---------|----------|
| Segment A | 22,000 | 4.50  | 0.88  | 5      | 4.18   | 6.39   | 0.65   | 0.84   | 9.63    | 40.26    |
| Segment B | 25,000 | 4.10  | 1.00  | 4.6    | 4.35   | 6.30   | 0.69   | 0.95   | 9.98    | 43.43    |
| Segment C | 35,290 | 5.30  | 1.66  | 5.8    | 9.21   | 8.84   | 1.04   | 1.59   | 16.47   | 157.20   |
| Segment D | 15,000 | 4.80  | 1.60  | 5.3    | 8.08   | 8.07   | 1.00   | 1.52   | 12.79   | 103.33   |
| Segment E | 20,000 | 4.00  | 0.90  | 4.5    | 3.82   | 5.92   | 0.65   | 0.85   | 9.55    | 36.54    |

Based on the table above, the respective Rc for segment A 25m; segment B 135m; segment C 84m; segment D 96m; and segment E 120m.

### 3.2 River morphology calculations

The following River Morphology Calculations are divided into segments a, b, c, d, & e. Below are only sample calculations of segment a, and segment b, c, & e are poured in the table.

Flood Width (Wfpa) = 5.50 m; Channel Width = 22.00 m; Flow Width (Wbkt) = 4.50 m; and River Depth (Dbkf) = 0.88 m

**Description:**

A. Ratio of the relationship between the width of the flood and the width of the river

B. Ratio of the relationship between the width between the river to the depth of the river

### Table 2. River morphology recapitulation

| Location | Flood Width (Wfpa) (m) | Channel Width (Wbkt) (m) | Flow Width (Wbkt) (m) | River depth (Dbkf) (m) | Entranchment Ratio (Wfpa/Wbkt) | Width/Depth Ratio (Wfpa/Dbkf) | The slope (%) | Morphology |
|----------|------------------------|--------------------------|-----------------------|-----------------------|-------------------------------|-------------------------------|---------------|------------|
| Segment A | 5.5                    | 22.00                    | 4.50                  | 0.88                  | 1.2                           | 5.11                          | 0.2           | A, E, G, F & DA |
| Segment B | 4.00                   | 25.00                    | 4.10                  | 1.00                  | 0.98                          | 4.10                          | 0.2           |            |
| Segment C | 5.00                   | 35.29                    | 5.30                  | 1.66                  | 0.90                          | 3.19                          | 0.3           |            |
| Segment D | 3.50                   | 15.00                    | 4.80                  | 1.60                  | 0.70                          | 3                            | 0.2           |            |
| Segment E | 4.00                   | 20.00                    | 4.00                  | 0.90                  | 1                             | 4                            | 0.2           |            |

Based on its dominant slope, the river can be divided into:

a). Rivers with a dominant slope above 10%, generally owned by Aa+ rivers

b). Rivers with a dominant slope between 4% and 10% are generally owned by A-type rivers.

c). Rivers with a dominant slope between 2% and 4% are generally owned by rivers of type B and G.

d). Rivers with a dominant slope smaller than 2%, generally owned by rivers of type C, E, and F.

e). Rivers with a dominant slope smaller than 4%, generally owned by d-type rivers.

f). Rivers with a dominant slope smaller than 0.5%, are generally owned by DA-type rivers.

The entrenchment Ratio on the river is divided into three criteria:

a). 1-1.4 represents river types A, F, and G.

b). 1.4-2.2 represents river type B.

c). Approximately 2.2 and above represents river types C, D, and E.

Width / Depth on the river is divided into three criteria:

a). For river types A, E and G represent w/d ratio smaller than 12.

b). For river types, B, C, and F represent a W/D ratio greater than 12.

c). For the river, type DA represents W/D ratio smaller than 40.

d). For the river, type D represents a W/D ratio greater than 40.

The results of River Morphology can be as follows:
A = Glide basin or Plunge Flow (Super Critical)
E = Wide, permeating, and winding channels
G = Sequined Multilevel Channels, and with High Sinoustias
F = High channel deepening width ratio
DA = System of each channel with varying flow width

4. Conclusion
Citarum River Meander Section ± 975 meters. Divided into 5 segments, among others: The meander of the river has an indentation such as the letter S. Material along the meander segments varies, such as clay, gravel, sand, and apes. There are two kinds on the bend in the form of clay stones and there are stones of gray and black. The river borderline is only 3–5 meters away. Obtained Speed, Discharge and Morphology include: Then : \( V <, Q < \frac{1}{2} Re > \) Morphology River influential into \( V >, Q > \frac{1}{2} Re < A, E,G,F \) & DA.

Based on the research that has been done, then researchers have suggestions, as follows:
a) Installed DPT / Sheet Pile to hold cliffs so as not to damage river banks and avoid erosion, grinding, and landslides.; b) Locked Concrete Block Technology. This technology is demonstrated to prevent onsanion. This technology can be installed quickly and is able to withstand large water fiber power. This technology is suitable to be applied to rivers whose morphology changes, and c) To counsel the community to participate in maintaining the sustainability of the area around the river.

References
[1] M. Islami, “Analisis Perubahan Meander Saluran Tanah Akibat Variasi Debit (Uji Model Laboratorium),” J. Tek. Sipil dan Lingkungan, vol. 2, no. 3, pp. 314–319, 2014.
[2] A. Amandanu, “Perubahan Radius Meander Saluran Akibat Variasi Debit,” Jur. Tek. Sipil, Univ. Sriwijaya, 2013.
[3] K. P. Pusat Pendidikan dan Pelatihan Sumber Daya Air dan Konstruksi, Modul Pengelolaan Sumber Daya Air Terpadu PELATIHAN PERENCANAAN TEKNIK SUNGAI. 2017.
[4] R. Kurniawan, S. Sutikno, and B. Sujatmoko, “Analisis Perubahan Morfologi Sungai Rokan Berbasis Sistem Informasi Geografis Dan Penginderaan Jauh,” JOMFTeknik, vol. 4, no. 1, 2017.
[5] K. PUPR, “Peraturan Menteri Pekerjaan Umum Nomor 28/PRT/M/2015 Tentang Sungai mengenai Garis Sempadan Sungai,” 2015.
[6] R. Rauf and M. N. Sufiah, “Analisis Perubahan Dasar Saluran Terbuka Akibat Variasi Debit pada Tingkat Aliran Kritis dan Super Kritis,” J. Tek. Hidro, vol. 12, no. 1, pp. 25–33, 2019.
[7] Kuntjoro, B. Mohammad, M. Aniek, and S. Agus, “Analisis Parameter Sungai Bermeander Untuk Mendapatkan Pergerakan Alur Akibat Fluktuasi Debit,” in Prosiding Seminar Nasional Aplikasi Teknologi Prasarana Wilayah, 2012, pp. 89–96.