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# Development Methods for the Formulation of Community Empowerment-Based Oxbow Stream Utilization Models in Citarum River

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**Abstract.** Citarum River stretches wide and long through village and city lands with straight, winding paths, and meanders. In the meander section, sediment deposits occur which result in the stunted flow causing floods or overflowing water out of the river. To overcome this problem, river shortcuts were constructed to straighten the stream, which results in disconnected reaches called oxbow rivers. This study presents a method development of a community empowerment-based oxbow rivers utilization which taking a case study on one of the ten oxbow rivers located along the Citarum River. The selected oxbow river is the one that located in Cibarangbang, Baleendah Village of West Java province with a length of 860.36 m, 10 m width, river bank height of 4.97 m and area of 100 ha. The utilization of oxbows is aimed to address technical and socio-economic problems through either of these three main approaches: 1. oxbow river as a means of conservation/revitalization of rivers by maintaining the function of oxbow lakes as a water reservoir, e.g., by making an impoundment, an inlet and outlet structures, a maintenance road, etc; 2. utilizing the area for public infrastructure and facilities through land reclamation; 3. using the area as a tourism site.

## 1. Introduction

Oxbow rivers or lakes formed due to the straightening of river bends, either naturally or artificially constructed [7]. The artificial forming of oxbow river is a result of creating straight segments of a bend which is a mean of river normalization effort, mainly to manage flood in the area [1, 3]. In Citarum and Cisangkuy River there are a number of straightened river segments which results in the formation of oxbow lakes [8]. However, these oxbow lakes are not well managed, often overgrown with wild vegetation and unintentionally used as wasteland or landfill site [2]. This miserable condition of oxbow lake utilization raises health and environment concerns [5]. Another aspect of interest is the legal ownership of the land. As the oxbow lake formed and sediment deposited over time, a new plot of land emerged. The local people take the land to expand their settlement. Even sometimes nearby factories use the area as free land, either levelling the lake to expand their factory or as a waste dumping site. In a need to address this concern, a previously studied oxbow lake is selected. The oxbow lake is located in Cibarangbang, Baleendah, Bandung Regency, West Java.



Some formed Oxbow River at locations along the Citarum River, which arises problems to the life of the community. Oxbow as the river of dead make the behaviour of community living around him became influential not comfortable. Looks like the slums and did not develop. Then there needs to be an effort of public participation to resolve the issue. So, the problem can be completed and either permanently [6].

If oxbow is built will change the situation and conditions of life of surrounding community to be bright and better. Will arrange to fix the shelter that is better. Public knowledge about the oxbow river increasingly understand and can be beneficial to keep the river from negative impacts

## 2. Methods

The methods carried out included data collection/measurement, investigation, planning, and design which results in maps, reports, drawings and illustrations that adhere to the related laws and regulations. The scope of the problems taken in this study are as follows:

- a. The study area is the oxbow river in the Cibarangbang Village, Baleendah, Bandung Regency, West Java,
- b. This study is based on the results of identification carried out using existing data (secondary data) and measurement data. The data were taken from the agencies involved and authorized to issue this data.
- c. The study conducted according to the needs of infrastructure and basic facilities needs based on the identification of the study area,
- d. Field activities and laboratory analysis related to studies include topographic measurements, engineering geological investigations, laboratory analysis, hydrological analysis and socio-economic analysis of local communities,

The steps of study are

- a. Preparatory work,
- b. Data collection
- c. Survey and investigation and socio-economic community, including:
  - Measurement work for making maps of the oxbow lake and the surrounding area
  - Measurement of the detailed situation of existing buildings and bridges
  - Measurement of river bases to downstream and upstream in inlets and outlets
  - Measurement of the situation of the inundation area
  - Survey of geological and soil mechanics investigations
  - Soil Mechanics laboratory test
  - Making reports on supporting measurement, inventory and geological investigations
  - Socio-economic survey of local communities
- d. Work Analyses the results of surveys and investigations as well as a social study:
  - Analyse the results of geological measurements and investigations
  - Analyse the results of socio-economic surveys
  - Make a concept of utilization
  - Preparation of reports



**Figure 1.** The location of the Dead Cibarangbang River

### 3. Results And Discussion

#### 3.1. Condition of the Cibarangbang Oxbow Lake

The Cibarangbang Oxbow Lake is administratively located in Cibarangbang Village, Bojongsoang District, Bandung Regency, West Jawa. Geographically located at coordinates  $X = 792164.84$ ,  $Y = 9224617.95$  and  $Z = +660,78$  MSL elevation. The site can be reached by using a four-wheeled vehicle from Sukanegara Rd, Antapani, then to Terusan Jalan Jakarta, then head to the Jalan Buahbatu Canal, then go to Bojongsoang Rd, and finally enter the Bojongsari area. Recorded existing conditions of the Cibarangbang Oxbow Lake shows the inlet and outlet sections covered by heaps so that there is no flow

in and out of the Citarum River. In the middle, there is a pool of water that forms the letter "U" while in the middle there is plant vegetation that is neatly arranged.



**Figure 2.** Existing condition of Cibarangbang Oxbow Lake

### 3.2. Data Collection

Data collection, identification, inventory and preliminary investigations on the area is one of the essential stages in carrying out this activity. This section presents the results of the identification and inventory of oxbow lakes which are the primary objects of this work

#### 1. Hydrological Data Obtained

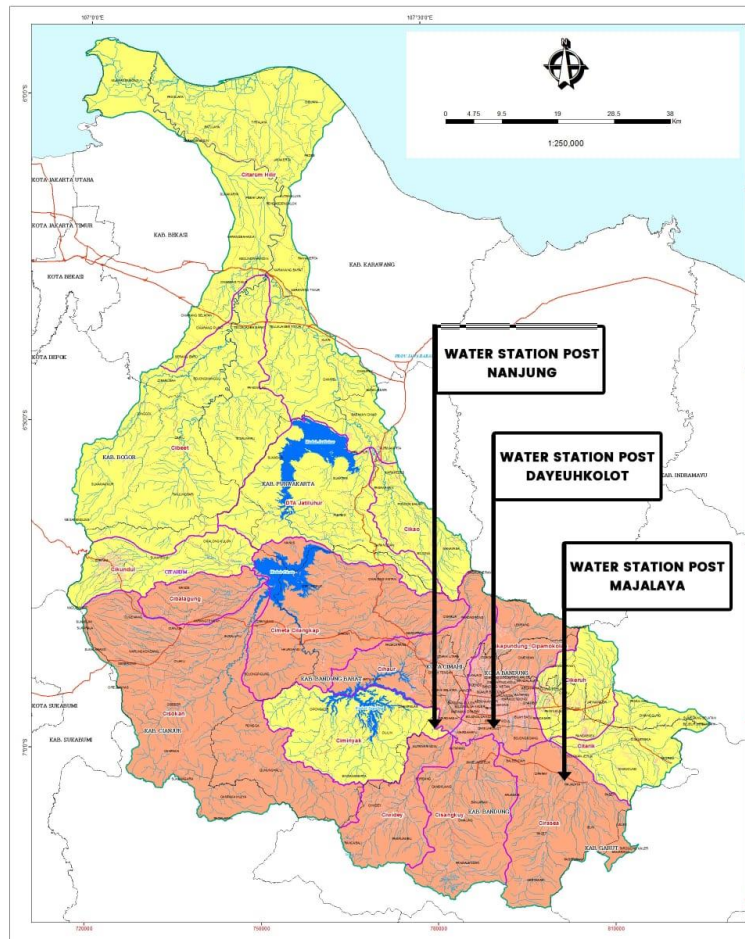
A hydrological analysis was carried out in the context of utilizing the oxbow lake. An investigation, however, is strongly influenced by the availability of data, especially flow data. If there is a sufficiently long flow data, the hydrological study is carried out using a statistical approach (frequency analysis). If flow data is not available or available with the limited length of data, a hydrological analysis is carried out using a rainfall-runoff model approach that requires rainfall data, land use, topographic maps, geological maps, and topographic data. The available hydrological data for this area is daily flow data, annual maximum discharge and rainfall data in the form of annual maximum daily rainfall data at several station locations representing the study area

#### 2. Flow Data

Hydrologically, the study area is part of the Citarum River region which is on the Upper Citarum River. The Citarum River flows from the slopes of Mount Wayang to the south of Bandung, heading north and empties into the Saguling reservoir. Throughout the flow, there are tributaries from hilly slopes from the north, east and south of Bandung. The tributaries come from the north of Bandung (Lembang and Tangkuban Perahu), including the Cimahi River, Cibeureum, Cikapundung and Cipanjalu from the Manglayang Mountain Slope. From the eastern part of Bandung flows the Citarik River. From the southern part of Mount Malabar, the western region and Gunung Geulis.



Flow data is needed to calculate the planned flood discharge based on flow data (annual maximum discharge) available at each suspected post in the study location (Citarum Hulu watershed), i.e., Majalaya, Dayeuhkolot, and Nanjung gauge station from 1999 - 2010. The availability of flow data can be seen in figure 3.



**Figure 3.** Location of Gauge Station in Upper Citarum

1

### 3. Rainfall Data

Rainfall data is used for analysis of planned flood discharge when the available flow data is limited [4]. In the hydrological study of this activity because the flow data available for frequency analysis was not carried out hydrological analysis using rain-flow.

### 4. Data on Topographic Maps and Land Use

In the Topographic Map in the form of Map of Indonesian Earth with a scale of 1: 25,000 in hard copy format obtained from Bakosurtanal (The National Survey and Mapping Coordination Agency). By referring to this map, an investigation of all watersheds (DAS) for each of the tributaries in the study area is following the geographic location and height contour in the basin. In the hydrological analysis of this activity because flow data is available for frequency analysis hydrological analysis is not carried out using flow streams. Data on topographic maps collected are only used to support analysis activities

**Table 1.** Recapitulation of Planned Flood Discharge

Return Period	Haspers - Haspers	Haspers - Gumbell	Haspers – Log Person III
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(Years)			
2	0,66	0,66	0,68
5	0,87	0,99	0,94
10	1,05	1,21	1,08
25	1,28	1,48	1,22
50	1,46	1,69	1,30
100	1,64	1,89	1,38

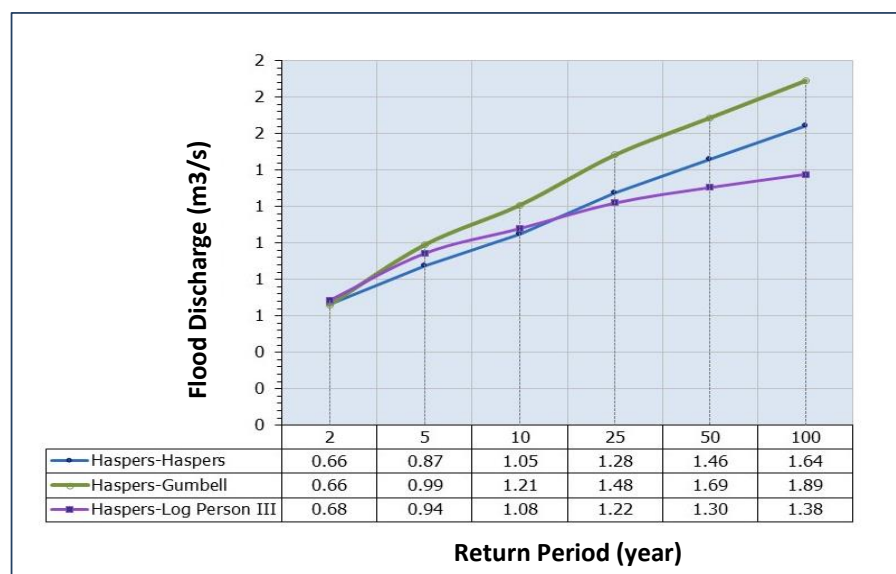


Figure 4. Graph The Flood Discharge in the Return Period

- (2) Do revitalization/rehabilitation for existing network, so that optimal performance can be achieved. This is in accordance with Regulation of PUPR No 12/PRT/M/2015. After that, irrigation modernization can be done continuously. Thus, effective and efficient services can be created.
- (3) The implementation and elaboration of Law No 41/2009 concerning the protection of sustainable agriculture.

### 3.3. Results of Hydrological Analysis

Hydrological surveys and analyzes are generally intended to estimate the flood discharge that will occur in a certain period of return to the area observed. This kind of discharge is known as design discharge. Design discharge is usually calculated by processing daily debit data. But because the daily debit data of a river is difficult to obtain, the calculation of the design discharge is done by transferring the rain design to the design debit. The hydrological analysis will be followed by hydraulic analysis to compare the amount of discharge with the capacity of the channel or body of water. Can be seen in Figure 4.

### 3.4. The Empowerment of Human Resources in Managing Irrigation

The purpose of this topography measurement is to get a picture of the existing situation map, both the location of the buildings, roads, drainage system, the boundary area, as well as the longitudinal section and cross section of the oxbow lake. The results this topographic measurement are images and

calculations that can be used for further works (implementation work). The scope of the topographic measurement activities in this study is as follows:

- a. Preparatory work
- b. Early field orientation work
- c. The work of making wooden pegs
- d. Making and installing benchmarks (BM) and control points (CP).
- e. Determination of starting point (tie point)
- f. Horizontal base frame measurement
- g. Vertical base frame measurement
- h. Detailed situation measurement
- i. Measurement of cross section and length
- j. Calculation and depiction
- k. Making report

### 3.5. Results of Geological Analysis

Investigation of engineering geology and soil mechanics carried out at the location by sampling undisturbed samples that were tested using standard ASTM and SNI methods. The parameters of the soil properties index examined included water content test, soil specific gravity test, grain distribution analysis (sieve analysis test and hydrometer analysis test), unit weight (unit weight test), and Atterberg consistency limits (Atterberg limit test).

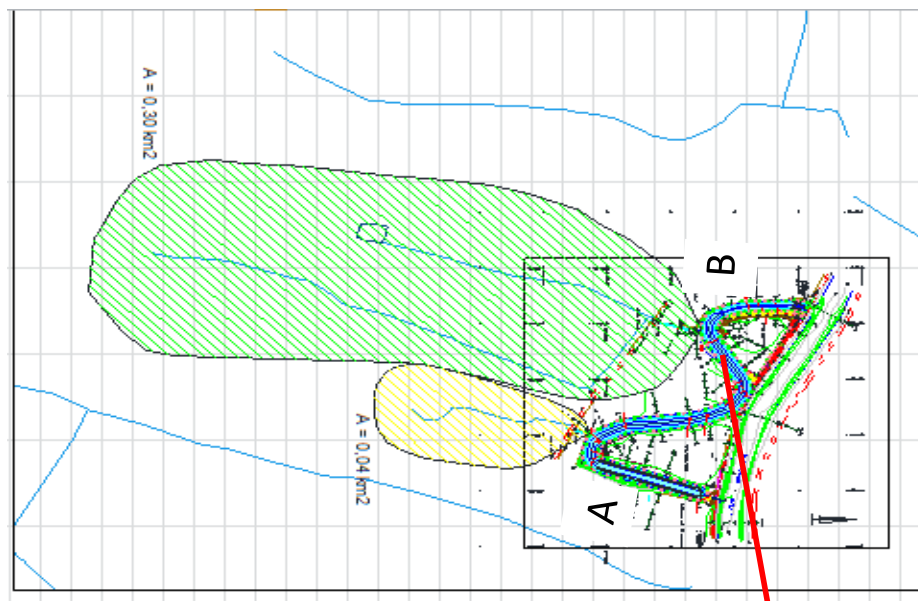
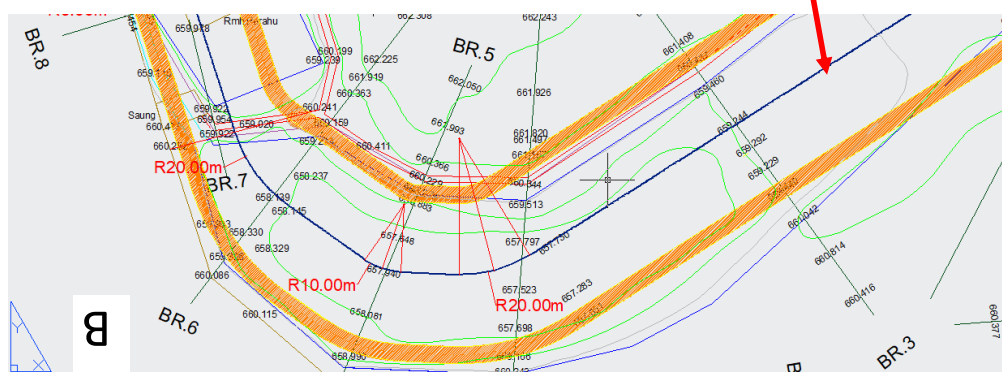
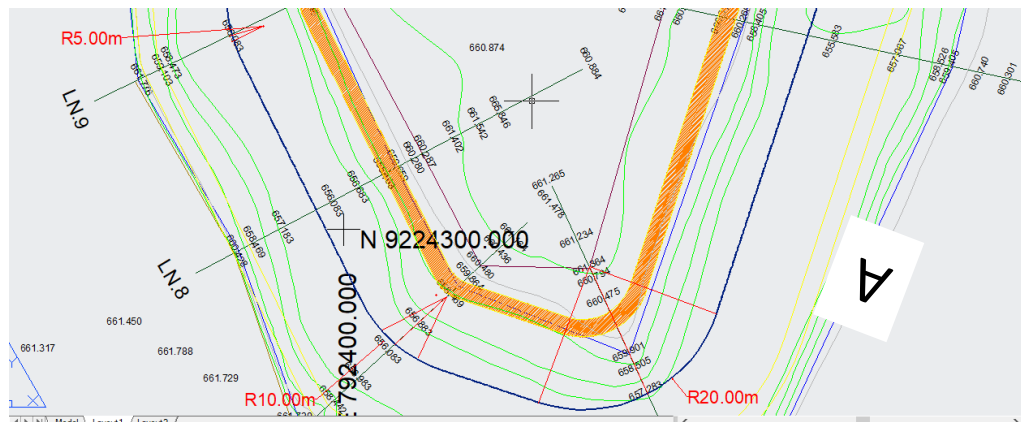


Figure 5. Site plan of the oxbow lake







### 3.6. Concept of Utilizing the Oxbow Lake

The concept of the design of oxbow lake utilization is intended to formulate alternative uses which allow further development in this chapter to discuss the identification of problems, alternative use of oxbow lakes and analysis of the determination of oxbow lake basin recommendations [9, 10]. Based on the survey results of identification of oxbow lakes (physical and non-physical aspects), topographic measurement results, geotechnical and soil mechanics measurements, results of hydrological analysis, results of social and economic studies and community consultation meetings and environmental and water quality studies, formulation of problem identification can be done specific oxbow lake utilization in the Bandung Basin, as follows:

1. The studied oxbow lake in the occur due to natural factors or the impact of river normalization projects [11].
2. Most of the oxbow lakes in the Bandung basin have not been utilized properly. Some have been abandoned without being used, others have been used by the community for farming, fishing, duck farming, garbage disposal, waste disposal, and brick making.
3. The particularly studied oxbow lake has changed partially into a reclaimed land,
4. Some environmental conditions and sanitation are in poor condition due to garbage and waste disposal activities

Besides causing problems, the existence of oxbow lakes can be used as potential water resources if adequately utilized. Based on a study of Government Regulation No.38 of 2011 concerning Rivers, in paragraph (1) article 75 it is stated that the former river is controlled by the state. In paragraph (2) it is stipulated that the former river location can be used for

- Building water resources infrastructure
- Replacement land for landowners whose land is affected by a new river channel
- Cultivation areas or protected areas

Further at the end of paragraph (2) article 75 it is stated that the use of the location of the former river must be following the provisions of the applicable legislation.

Minister of Public Works Decree 18 / PRT of 2009 concerning Guidelines for Transfer of River Flow and or Utilization of Former Oxbow Lake Sectors, among others, contains general provisions, authority and responsibility, technical provisions, compensation, licensing and management, financing, supervision, other provisions, and closing. Furthermore, in the technical provisions, the guideline stipulates that the transfer of river flow can only be done after obtaining permission based on technical recommendations. The implementation of river channel diversion must also meet the following requirements:

- River protection and preservation
- The function of river drainage regarding aspects of hydrology, hydraulics, and the

environment.

- Must consider the overall morphological aspects of the river
- Paying attention to the interests of existing river water users
- Sustainability of the river flow function

Based on these normative rules, in general, there are 2 (two) choices in handling the problems of the oxbow lakes, i.e., (1) the revitalization of the oxbow lake (2) the reclamation of oxbow lakes

#### 1. Revitalization of the oxbow lake

In the context of oxbow lake utilization, river revitalization is an effort intended to restore the function of the river as a water body [11]. Some of the initiatives that can be made in the use of oxbow lakes through revitalization are as follows:

- Reconnecting oxbow lakes and the main river (Citarum River), among others through the construction of inlet and outlet buildings that are intended to utilize it as a reservoir
- Arranging the flow of oxbow lake through river dredging (normalization) and structures.
- Constructing embankments as a protector of standing water, bicycle lanes, walking trails and planting trees around oxbow lakes to emphasize oxbow lake boundaries
- Making sanitation and waste infrastructure and facilities around oxbow lakes,
- Community empowerment to increase community awareness and participation.

#### 2. Reclamation of the oxbow lake

Oxbow lake reclamation can be taken if river revitalization is deemed too complicated. Some of these considerations are because the oxbow lake has been partially reclaimed, either intentionally or unintentionally. For example, a part of the studied oxbow lake has No. more connection to the main river. Moreover, some of the river areas have already converted into residential land. In addition to the technical considerations, the local village community has been using the oxbow lake as a trash dumping site. Unknowingly, due to lack of health and environmental risk knowledge, the unintended sanitation and health effect of the trash dumping affects them negatively. Because of this, they aspired the land to be reclaimed completely and converted to a more useful utilization. Some efforts that can be made in the use of the reclaimed oxbow lake are as a green open space/urban forest, playground and outbound, or as a green river barrier.





**Figure 6.** Planning for Utilization of the Cibarangbang Oxbow lake Concept

#### 4. Conclusion

Based on technical aspects and socio-economic considerations, the proposed oxbow lake utilization approaches are oxbow lake as a means of conservation/river revitalization, which is carried out by maintaining the function of the water body by constructing a reservoir and its regulating facilities, e.g., inlets, outlets, tree barriers, and community amenities (jogging tracks or bicycle tracks) if needed. oxbow lake reclamation into a more useful infrastructure and public facilities, concerning the conditions of morphology, hydraulics, hydrology of the oxbow lake.

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