Priority development of smalldam in Wonogiri regency

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Abstract. The province of Central Java often experiences floods during the rainy season and drought in the dry season. To support the program, BBWS Bengawan Solo participated in building some small-dams in Solo basin watershed. For this plan to be realized there needs to be a preceded study to determine the locations of potential dams. The paper aims to identify potential small-dams in the Solo River Basin, particularly in the Wonogiri District, and to determine priorities for the sequence of development. The potential of the small-dams is roughly derived from public information, topographic maps, and ground surveys. Initially, based on public information and local government officials, 39 locations of small-dams were obtained. After analyzing the topographic map and ground checking, the potential locations were cut down to 13 sites. Five small-dams will be selected as the first priority. The priority is determined based on multiple criteria, which consisted of technical criteria (topography, geology, and hydrology) and non-technical criteria (drought, economy, social and environment). Assessment method was based on the scoring system on all criteria. The result found that the five most potential small-dams in Wonogiri District are Glimbung, Gompyong, Wungu, Weru, and Waru.

Keywords: multi criteria, smalldam, development priority.

1 Introduction

Wonogiri regency experiences frequent drought and water shortage especially during dry season where rain fall is inadequate. One way to cope is with the construction of smalldams. In line with the policy of Central Java Province Government, to build 1000 smalldams, the BBWS Bengawan Solo conducted a study to identify the potential sites of smalldams within the Bengawan Solo catchment area, as well as to prioritize the 5 top potentials. Hence, we conducted a study to get some locations that could be used for development of the smalldams. As a body responsible for drought problems in Wonogiri district, BBWS Bengawan Solo should survey smalldams development on potential areas. The entire smalldams are incapable of being built simultaneously because of the limited

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budget. So, it is necessary to formulate the direction of priority of the small dam developments following the amount of the available budget. Having a lot of potential locations of the small dams available, it is necessary to prioritize and analyze its development by considering several factors.

Fig. 1. Map of the drought-prone at Wonogiri regency.

Determining the highest priority of a small dam development is essential because of the availability of fund and human resources, the multi-criteria model is indispensable [7]. Quantitative and qualitative data and expert judgments can contribute to make decisions in cases of incomplete data. Multi-criteria analysis allows decision-making when alternate numbers or criteria are usually conflicting.

Some of the known methods such as WEIGHTED AVERAGE, AHP, ELECTRE and PROMETHEE method are applicable in some of the different fields, even on the field of water resources management [4, 5, 6, 8]. The models are different based on the mathematics and function as a rank determines.

[2] explained the strength and weakness of the MCDA method, described the model of the Weighted Sum Method-WSM, Analytic Hierarchy Process-AHP, ELECTRE, PROMETHEE.

Some of the researchers got attracted to applying the PROMETHEE method because it was designed to be perceivable [3]. This method is used in the various fields to determine the partial rank or complete rank from the alternative [1].

1.1 Purpose and direction

The purpose of this study is to conduct initial diligence from the preparation of decision-making tools to determine development priorities of Smalldam potential using multi-criteria analysis with the scoring method.

Based on the purpose of this study, it can be prepared for each stage of the study as follows:

- Determine the location potential smalldams with a land-based status.
- Analyze the water balance.
- Give weight to each criterion based on importance level.
- Analyze the value of the catch for each criterion.
- Determine the development priorities of potential smalldams.

2 Method and materials

Methodology of study or research implementation was carried out to achieve the objectives and purpose of the research. The study covers three steps:

- 1). Identification of the potential smalldams sites.
- 2). Collection of basic information data.
- 3). Analysis to determine the prioritization.

The method to be used in this study is a multi-criteria model since various aspects must be compared to each potential smalldam to obtain the top-five priority smalldams.

At first, we have to enter all the available data about potential smalldam in an inventory. Data on potential smalldams can be obtained from the local communities and agencies such as: water resources management office (Dinas PSDA); energy and mineral resources office (Dinas ESDM); local water company (PDAM); Department of Agriculture; Public Works Service. From the several agencies that have provided data, we can run analysis based on the data they provide.

They also provide data about the land status. This means that the land status is the significant factor in determining the potential smalldams to be the priority smalldams. If the land status of the location is the village treasury, it will not be part of the smalldams priority.

Aspects to be considered include technical and non-technical aspects, from which each aspect can be divided into several criteria and redeveloped into several sub-criteria. According to the sub-criteria, it will be scored from each sub-criterion. From each sub-criterion also weighted by considering the importance of the sub-criteria.

3 Analysis

3.1 Inventory of potential smalldams

Inventory of Potential Smalldams is the first step to determine priority smalldams. From the inventory, the result of all the locations will be known and the areas with the potential to become Smalldams. The result is not only from the just analysis, rather, relevant information gathered from the other stakeholder who will build and exploit the smalldams. Many potential smalldams were found at the location of the study and they numbered about 39 pieces gathered from the Water Resources Management Office in Central Java and Energy and Mineral Resources Office in Wonogiri Regency.

3.2 Check land status

From the inventory result, the data of land ownership from the location plan of smalldams and the access roads shall be cleared. If the village treasury owns the land, then the smalldams will be removed from the list of priority smalldams. Due to this, it will be difficult to implement. So, the land to be used is the land of the society. According to land ownership status, the number of potential smalldams decreased from 39 to 13 pieces. Here are the potential smalldams:

Table 1. List of the potential smalldams.

Number	Potential of Smalldams
1	Smalldam of Bangkan
2	Smalldam of Bowong
3	Smalldam of Seruni
4	Smalldam of Waru
5	Smalldam of Wungu
6	Smalldam of Glimbung
7	Smalldam of Gompyong
8	Smalldam of Weru
9	Smalldam of Baksari
10	Smalldam of Gunung Bromo
11	Smalldam of Jalakan
12	Smalldam of Pogog
13	Smalldam of Simpar

Fig. 2. Location of the potential smalldams (13 smalldams).

3.3 Identification

Based on the data from the inventory, there are some technical data that have to be noted from each smalldams potential: the depth of the smalldams, area of the inundation, volume of the storage. Not just the technical data but also non-technical data should also be prioritized and collected.

3.4 Scoring

Firstly, define criteria through a review of relevant literature. From initial identification of these criteria, then interviews with experts, i.e. people who are considered to be a true understanding of the problem discussed, those directly feeling the effects of a problem and those who have interests about the problem. In this study, interviews were conducted with the experts (universities), practitioners from technical institutions related. The results of this discussion were then carried out from the formulation of the criteria that will subsequently be used in making questionnaires. A questionnaire is designed in such a way that the answer choice will be generated based on the level of its importance to the substance of the question questionnaires using Likert scale i.e.:

- Score 3 to declare a very level important
- Score 2 to state an important level
- Score 1 to declare the level sufficient important
- Score 0 to declare no level important

Below are some scoring of some aspects:

Table 2. Scoring of the geology structure.

Number	Sub-criteria	Scoring
1	Cannot be repaired	0
2	need repaired	1
3	Fault	2
4	No fault	3

Table 3. Scoring of the drought.

Number	Sub-criteria	Scoring
1	None drought	0
2	Slight drought	1
3	Drought	2
4	Heavy drought	3

Table 4. Scoring of the soil type.

Number	Sub-criteria	Scoring
1	High permeability	0
2	Middle permeability	1
3	small permeability	2
4	Waterproof	3

Table 5. Scoring of the landslide symptoms.

Number	Sub-criteria	Scoring
1	Avalanche	0
2	High Avalanche Potential	1
3	Small Avalanche Potential	2
4	Non-permeability	3

Table 6. Scoring of the high embankment.

Number	Sub-criteria	Scoring
1	>15.00	0
2	10,01 up to 15,00	1
3	5.01 up to 10.00	2
4	< 5.00	3

Table 7. Scoring of the storage volume.

Number	Sub-criteria	Scoring
1	>500	0
2	<100	1
3	100 up to 300	2
4	300 up to 500	3

Table 8. Scoring of the number of beneficiaries.

Number	Sub-criteria	Scoring
1	< 100 family head	0
2	100 – 499 family head	1
3	500 – 999 family head	2
4	> 1000 family head	3

3.5 Weighting

After the scores were obtained from each sub-criterion, the next was the weighting. This weighting uses the Weighted Average method because it is easy in application and can be adjusted with an important aspect. Here's the weight of each sub-criteria from an expert.

Table 9. Weighted for each sub-criteria.

Aspect	Criteria	Sub-criteria	Weight
Technical (40 %)	Topography	Volume ratio	5
		High Embankment	5
		Storage	5
	Geology	Geology structure	3
		Soil type	5
		Landslide Symptoms	2
		Ground Water	5
	Hydrology	water balance	3
		erosion	3
		Existing system	4
Non-technical (60 %)	Material and Infrastructure	Material Availability	2

Aspect	Criteria	Sub-criteria	Weight
		Access Distance	2
		Accessibility	2
		Length of Embankment	2
		High Embankment	2
	Social and Environment	Community Support	10
		Resettlement	5
		Existing Buildings	5
	Drought	Drought	30

3.6 Smalldam priority

After the scores obtained from each sub-criteria is multiplied by the weight that has been given based on the consideration of the experts, the result will be the total score when ranking from the highest overall score to the lowest. According to the check land status result, 13 smalldams will be analyzed to become top five priorities. Following this methodology, here is the result for smalldam's priority list:

Table 10. Result of the smalldam's ranking.

Number	Potential of Smalldams	Total Score	Ranking
1	Smalldam of Bangkan	0.493	6
2	Smalldam of Bowong	0.492	7
3	Smalldam of Seruni	0.479	9
4	Smalldam of Waru	0.543	5
5	Smalldam of Wungu	0.556	3
6	Smalldam of Glimbung	0.563	1
7	Smalldam of Gompyong	0.556	2
8	Smalldam of Weru	0.553	4
9	Smalldam of Baksari	0.469	12
10	Smalldam of Gunung Bromo	0.473	10
11	Smalldam of Jalakan	0.486	8
12	Smalldam of Pogog	0.423	13
13	Smalldam of Simpar	0.476	11

From the calculated results, it can be concluded that from 13 smalldam taken only 5 topped smalldam, such as:

- 1). Smalldam of Glimbung
- 2). Smalldam of Gompyong
- 3). Smalldam of Wungu
- 4). Smalldam of Weru
- 5). Smalldam of Waru

4 Conclusion

Prioritization analysis uses the simplest method for communities and various stakeholders to easily follow the analytical process. Multi-Criteria Method is the easiest method to understand. The conclusions from this study are:

- Weights for each criterion based on their importance here is the influence of the subjectivity of the decision maker or by the expert.
- Priority of the development of smalldams is determined based on the total rank/score multiplied by the weight of each criterion.
- From several locations that have been analyzed, here are the five smalldams that will be the top priority to be built:
 - o Smalldams of Glimbung
 - o Smalldams of Gompyong
 - o Smalldams of Wungu
 - o Smalldams of Weru
 - o Smalldams of Waru

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