Study of Policy Determination to Create A Healthy Watershed: A Case Study of Lepan Watershed In Langkat District, North Sumatera, Indonesia

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Abstract. Lepan watershed has declined in function over the past two decades. One of the contributing factors is unsustainable forest management and low public awareness in maintaining an ecosystem. Upstream damage occurs due to illegal logging and deforestation for agricultural purposes or exploitation of forest products. Meanwhile, the conversion of forest land into commercial or residential use occurs in the middle to downstream areas. The research used a descriptive analysis method based on Situation, Structure, Behavior, Performance (SSBP), and Analytical Hierarchy Process (AHP) method with data processing using the Expert Choice software. Research shows that the government's percentage of performance related to policies that have been implemented in the Lepan watershed is considered reasonable by the community, with a value reaching 62%. Alternatives in providing of Lepan watershed being healthy is returning of function by value weight 5.6, conservation by value weight 3.4, and planting by value weight 2.1

1   Introduction

During the last two decades, the failure of the Lepan watershed (DAS) management is caused by unsustainable forest management, residential development, industrial development, and others. The low level of public awareness in protecting the watershed ecosystem is one factor that has decreased the Lepan watershed's function. Prioritizing forestry investment by ignoring forest's function as a basis for people's welfare and environmental control by the community and the increasing forestry industry, are also noted as significant problems related to the decrease in watershed management [1].

Most of the watershed conditions in Indonesia are currently increasingly critical. Damage to the upstream area occurs due to illegal cultivation and logging for agricultural purposes or wood exploitation. An increase of poor people and opening up forest management rights for investors caused forest destruction. Besides, agricultural land conversion is converted to non-agricultural, especially in the middle and downstream, and the increasing population also makes downstream activities more intensive [2].

Watershed management has been implemented in order to achieve a healthy watershed. Woody species have been planted mainly in upstream areas and along river boundaries to regulate water management. For example, since 1950, the government has trained farmers to plant various trees beneficial for watershed conservation and the community's economy. However, these efforts have not been successful. The large area of critical land demonstrates the failure of this watershed management. The critical land reached 6,936,408 ha in 1980 and only decreased to 6,400,400 ha in 1994 [3]. It means a decreased rate of only 7.70% for 14 years. However, these improvements occurred outside forest areas (only 32%). In forest areas, the size of critical land has increased (16.30%) during the same period [4].

One of the critical and priority watersheds is the Lepan watershed in Sumatera Utara Province. As a result, new watershed management innovations are required for the Lepan watershed to become a healthy watershed. Watershed institutions play an essential role in achieving healthy watershed outcomes. It is necessary to look into the development of watershed management policies. The research objective is to analyze government policies in watershed management related to flood and drought control in the Lepan Watershed, Langkat district, Sumatera Utara.

2   Research Method

2.1   Material

This research was conducted in Padang Tualang sub-district, Gebang sub-district, Babalan sub-district, Sei Lepan sub-district, West Brandan sub-district, and Besitang sub-district. The tools and materials used in this research are GPS, writing instruments, a camera, a questionnaire for respondents, computers, and Expert Choice software.

2.2   Data collection method

The data collection methods used semi-structured interviews and surveys. A semi-structured interview was an interview (conversation) either conducted with individuals or groups for a purpose. This interview was performed using a list of question guides. The questions should be open-ended, not answered with a yes or no. The purposive sampling method determines respondent retrieval, the sampling technique with specific considerations. The samples were people who have jobs or activities and live in the Lepan Watershed, Langkat Regency.

Data sources used primary data and secondary data. Primary data was obtained through a questionnaire from direct interviews with the public and government officials. Secondary data was obtained from previous studies or agencies that provide this research data.

2.3 Data Analysis

Analyzed have to be conducted using Situation-Structure-Behavior-Performance (SSBP) approached [5]. The SSBP criteria and indicators are distributed into questions in the questionnaire. The Analytical Hierarchy Process (AHP) method is then used to analyze the questionnaire results. The SSBP analysis method is used to examine government policies, especially with regard to the Lepan watershed, particularly the upstream watershed management policy. The SSBP has organized into four (four) criteria, which are as follows:

1. Situation (environmental situation) is obtained by determining the state of a watershed area, whether the conditions and the surrounding environment are inextricably linked or vice versa.

2. Structure (government policy) is to understand how the government imposes the structure in watershed management.

3. Behavior is the community's reaction to implement government policies governing watershed management.

4. Performance (performance) is a data collection indicator on how the government's performance in order to know the watershed management functions in the community's welfare.

The analytical hierarchy process (AHP) is a process of "systemic rationality" to consider a problem as a whole and examine the simultaneous interaction of its various components in a hierarchy diagram (Figure 1). AHP handles a complex problem under the interactions on the problem itself [6]-[7]. Such processes can expose the complexity of the problem itself and expand its definition and structure through iteration [8]-[9].
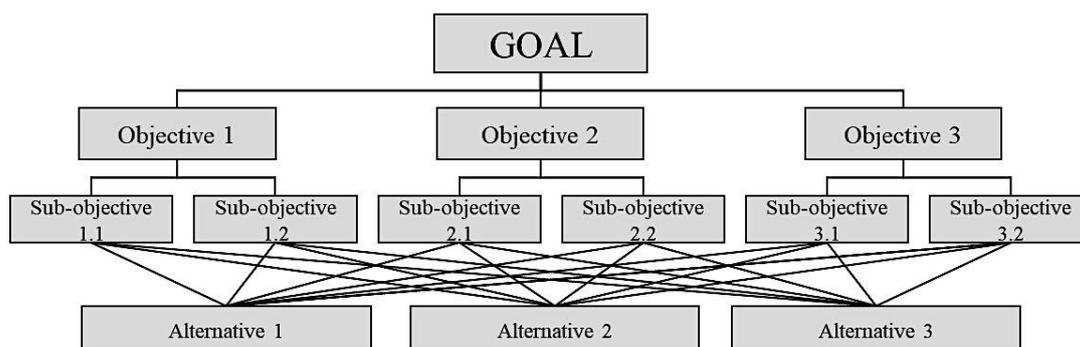

Figure 1 Hierarchy Diagram with AHP Approach

Expert Choice (EC) is data processing in the AHP method that uses EC software to determine each of the intended alternatives' weighted values. Each alternative value is smoothed to obtain the weighted value from the results of the comparison choice questionnaire. After smoothing each alternative value, enter the prepared alternative's value data in the EC tools application [10].

Inconsistency Ratio (CR) is data of expert respondents, which is a parameter to check whether the pairwise comparison has been carried out consequently or not. The data inconsistency ratio is considered good if the CR value is ≤ 0.1 [8].

Processing, analysis and interpretation of government institutions in creating healthy watersheds using data that are preceded by determining significant elements at each level in terms of the criteria and sub-criteria in the AHP method [11, 12] starting from, namely (1) Level 1, which is the determination of "Focus, namely creating healthy watersheds"; (2) Level 2 contains "Criteria, namely ecology, economy, and social"; and (3) Level 3 is determined that ecology's sub-criteria have derivatives of erosion level, vegetation, flood level, drought. The economic sub-criteria have a derivative of Community Income, Unemployment Rate, Added Value Distribution, Government Support, and the Social sub-criteria have derivatives of Welfare, Local Wisdom, and Public Facilities. 4. Level 4 contains alternatives to the strategic application of the AHP method in realizing healthy watersheds. This alternative is expected to create a healthy Lepan watershed. The alternatives are as follows:

Planting is an alternative to discover healthy watersheds. Planting is expected to improve almost damaged or damaged watersheds to improve the watershed ecosystem. Planting is carried out by distributing seeds to areas that have been damaged. Former agricultural land and abandoned settlements are prioritized for planting. Erosion will occur on ex-agricultural land or settlements that have been abandoned for a long time. As a result, because it has been gone for a long time, it will cause landslides, so that the alternative of planting is one way of realizing a healthy watershed.

Preservation Conservation is one of the alternatives in realizing healthy watersheds that are expected to rebalance the watershed ecosystem. Conservation aims to maintain tree canopy in nature. In that case, the root absorption capacity of the water will be maximized, and the river water discharge downstream is at the limit of standard height. So, the conservation alternative is one way of realizing healthy watersheds.

Re-Functioning is the last alternative to achieve a healthy watershed is to restore function. The restoration of the agricultural area to a forest, as it was before. Lack of awareness and insight of communities or companies is the first factor changing the watershed ecosystem. They only prioritize personal interests in order to meet financial needs without thinking about the negative impacts of converting forest areas to agricultural land. This alternative is expected to restore the

forest area to create a healthy watershed. Furthermore, a study is conducted to answer the proposed problem formulation based on the analytical hierarchy process.

3   Results and Discussion

3.1   Environmental situation of Lepan watershed

The downstream area condition of the Lepan watershed continues to decrease. This data is stated by people who have lived in the Lepan watershed for over 20 years. The community's utilization of the Lepan watershed is carried out as life support and daily necessities, such as farming, washing, and taking some fish catch (Table 1). The majority of people, up to 60%, do not use river water for their daily needs.

As a result of the worsening changes in the Lepan watershed, some people who live downstream no longer use it. People are afraid to use river water in the Lepan watershed as water suitable for consumption and bathing. According to public perception, the condition of the Lepan watershed is getting worse (Table 1), with a percentage of 89%.

Table 1 Percentage of the of Lepan watershed condition in utilization for the community

a	The assessment aspect in terms of utilization	Status	Percentage
1	Utilization of watershed area for daily needs (as sources of graze, wood fire, etc.)	Yes, use it	50%
		No use it	50%
2	Daily use of river water	Yes, use it	33%
		No use it	67%
b.	The assessment of Lepan watersheds condition		
1.	Lepan watershed conditions recently	Very good	1%
		Good	10%
		Poor	89%

3.2   Government policy structure in managing watersheds

Government efforts to develop watershed management policies in response to floods and drought in the Lepan watershed are rare. Because the government rarely pays attention to the condition of a watershed area, land development in the Lepan catchment area grows year after year. Following the [4] statement regarding the government's efforts to deal with environmental damage to dry land in the watershed started before the independence war. The Lepan Watershed Community also maintains the watershed's condition. However, due to the increasing condition and economic demands, some communities have converted forest areas located not far from the river as a planting area to fulfil their daily needs.

The questionnaire results showed that the percentage level of 63% was rare for the rehabilitation of Lepan Watershed (Table 2). The government policy in dealing with floods and drought nowadays is by distributing tree seedlings to the community. At the downstream part, sanitation

is carried out for rubbish dumped by the community or carried by rainwater flows into rivers. According to the claim, 50 percent of the community receives seed distribution, and 50 percent receives sanitation facilities, particularly in downstream areas, as shown in Table 2, to decrease flooding in the rainy season and drought in the dry season. These efforts must be carried out following the watershed's level of damage and criticality [12]-[13].

Table 2 Percentage of government policies managing Lepan watershed according to the community perception

No	Criteria	Status per year	Percentage (%)
1	Watershed rehabilitation	Frequently conducted	2%
		Very rare	63%
		Never	35%
2	Conducting of watershed system rehabilitation	Seedling distribution	50%
		Watershed sanitation	50%

3.3   Community response to policy formation

The government policy in managing the Lepan watershed is welcomed and fully supported by the community, especially in the downstream area (Table 3). The downstream community strongly agrees to carry out watershed rehabilitation either by distributing seeds or sanitation in line with the statement of [14]. Coordination carried out by the government received a good response from the downstream watershed community (Table 3), with up to 70%.

Community involvement in creating better watersheds is a positive indicator of the government's policy structure. From the data obtained, the structure of government policy is considered acceptable by the community with a percentage of 51% (Table 3). However, because the current watershed rehabilitation system is only a part of the total sub-districts, there has been no significant change in the downstream Lepan watershed. The percentage value of the community is obtained as much as 50% of the total respondents (Table 3).

Table 3 Percentage of public opinion on the government policy success

No	Public opinion on aspects of government policy	Status per	Percentage (%)
1	Public response to government policies	Deeply agree	70%
		Agree	30%
		Disagree	0%
2	The structure imposed by the government	Very good	30%
		Good	51%
		Poor	19%
3	Watershed environmental conditions correspond with government policies	Improved	25%
		Enough	25%
		No progress	50%

3.4 Performance of government policies in managing watershed

The government policy program outreach to the community in managing the Lepan watershed receives a good response. The community considers that activities to protect the watershed ecosystem are good, with 62%. The community's need for government action in preventing floods and drought also receives a good response from the community by getting a percentage of 60% (Table 4).

Table 4 Percentage of government policy performance against Public

No	The aspect of performance government policy	Status	Persentage
1	Determination of government program target	Very good	15%
		Good	60%
		Poor	25%
2	Determination of activities to obtain objective and target	Very good	20%
		Good	62%
		Poor	18%

3.5 The base of the ecological criteria are considered to create a healthy watershed in terms of the criteria and sub-criteria elements

For obtaining a healthy watershed, the essential criteria considered making it happen are reviewed from the ecological criteria on the following criteria and sub-criteria elements. In the alternative ecological criteria, the priority is the level of vegetation with a weight value of 0.347 (Table 5). Respondents prefer to increase vegetation diversity to create healthy watersheds. According to respondents' opinion, the vegetation diversity in the Lepan watershed has decreased due to the conversion of forest land to residential areas and agriculture. If vegetation diversity can be increased, some respondents thought it would reduce erosion rate, flooding, and drought in the Lepan watershed area.

Table 5 The priority weight value of alternative in ecological criteria realizing healthy watersheds

Criteria	Alternative	Weighted	Priority
	Vegetated area proportion	0.347	I
Ecology	Erosion level	0.246	II
	Flooding level	0.204	III
		0.204	III

Based on table 6, the strategic alternative for functional returns has a weighted value of 0.500 and is prioritized. Respondents believe that to create a healthy watershed by restoring the function of forest areas that have been converted into agricultural and residential areas. The return to forest areas' function can reduce the rate of erosion and increase biodiversity in the Lepan watershed.

Drought strategic alternatives to ecology (Table 6) show that the alternative function recovery has the highest weight value of 0.600 and becomes the priority. The return of the function of forest land can increase groundwater reserves so that there is no drought in the Lepan watershed during the dry season. Respondents hope that the government policy and preventing drought can also produce clean water for the daily needs of the Lepan watershed community.

Table 6 The value of priority weight for strategic ecological alternative

No	Strategy alternative	Weighted	Priority
A	Erosion and vegetation level		
1	Re-function of watersheds	0.500	I
2	Planting	0.250	II
3	Conserving	0.250	II
B	Drought level		
1	Re-function of watersheds	0.600	I
2	Planting	0.200	II
3	Conserving	0.200	II
C	Flood level		
1	Re-function of watersheds	0.400	I
2	Planting	0.400	II
3	Conserving	0.200	II

For the alternative level of flooding based on ecological criteria, respondents prioritized conservation with a weight value of 0.400 (Table 6). According to several respondents, the quickest thing to deal with flooding during the rainy season is based on ecological criteria: preserving the existing tree or plant populations in the Lepan watershed area, because if planting or returning the function will take a long time.

3.6 The basis of economic criteria, which is the consideration in realizing a healthy watershed, is in terms of the criteria and sub-criteria elements

The essential criteria for a healthy watershed are reviewed from the ecological criteria on the following criteria and sub-criteria elements. The economic criterion that must be considered in realizing a healthy watershed is community income, with a weighted value of 0.469 (Table 7). Respondents argue that if the economic income of the Lepan watershed meets their daily needs, creating a healthy watershed can be done quickly.

A strategic alternative to increasing community income is planting with a weight value of 0.528 (Table 8). It is in line with the strategic alternative to reduce the unemployment rate by obtaining a weight value of 0.594 (Table 8). According [15] also emphasized the significance of enrichment planting based on the legal function of the area for ecological and economic benefits. Planting is expected to help the Lepan watershed community's economy minimize the unemployment rate. It is supported by a strategic alternative to distributing added value to the economy with a weighting value of 0.600 (Table 8). According [16] noticed that community

participation in watershed management has a high level of satisfaction, a positive attitude, a high level of knowledge, and a high level of income increase.

Government support for the success of the planting program is vital. The weighted value of government support for the economy in planting is 0.500 (Table 8). Respondents believed that planting would be worked well with the government's support. It can directive the various stakeholders in integrated watershed management, particularly the community participation, which had previously been ignored [17]. Respondents also hope that the community will be more concerned about preserving the Lepan watershed ecosystem with government support.

Table 7 Value of priority weight for alternative economic criteria in realizing healthy

Criteria	Alternative	Weighted	Priority
Economics	Community income	0.469	I
	Unemployment level	0.300	II
	Added value distribution	0.116	III
	Government support	0.116	III

Table 8 Value of priority weight for strategic alternative income society towards the economy

Criteria	Strategic alternative		Weighted	Priority
a. Income alternative				
	1	Planting	0.528	I
	2	Conserving	0.332	II
	3	Re-functioning	0.140	II
b. Un employment alternative				
	1	Planting	0.594	I
	2	Conserving	0.249	II
	3	Re-functioning	0.157	II
c. Added value alternative				
	1	Planting	0.600	I
	2	Conserving	0.200	II
	3	Re-functioning	0.200	II

3.7 The foundation of social criteria is the consideration in realizing a healthy watershed in terms of the criteria and sub-criteria elements

The essential criteria for a healthy watershed are reviewed from the ecological criteria on the following criteria and sub-criteria elements. The social criteria is welfare alternatives with a weight value of 0.547 (Table 9). According to several respondents, the community welfare is able to create a healthy watershed. The government is expected to provide a policy following the community's needs, such as providing special land for crops or distributing MPTS plant seeds to the community in order to help the economy.

Table 9 Value of priority weight for alternative social criteria in realizing healthy

Criteria	Alternative	Weighted	Priority
Social	Social welfare	0.547	I
	Local wisdom	0.263	II
	Public facility	0.190	III

The community's welfare is still uneven, so people still open the land for agriculture as an alternative to their daily needs. The main priority of alternative social welfare is the return of functions with a weight value of 0.600 (Table 10). Respondents chose an alternative to restore function to create a healthy watershed. Public facilities for clean water or other things provided indirectly or directly by forest ecosystems that the government well manages get a positive response from the community. The weight value of public facilities to social with the priority is the return of function, namely 0.500 (Table 10).

Table 10 Strategic alternative priority weight values social welfare

Criteria	Strategic alternative	Weighted	Priority
a. Social welfare	Re-functioning	0.600	I
	Planting	0.200	II
	Conserving	0.200	II
b. Public facility	Re-functioning	0.500	I
	Planting	0.250	II
	Conserving	0.250	II
c. Local wisdom	Re-functioning	0.429	I
	Planting	0.429	II
	Conserving	0.142	II

Local wisdom of the community in daily life also helps maintain the watershed ecosystem. The culture of the Lepan watershed community that supports each other in daily life, both in agricultural activities, which are related to surrounding households, and activities related to the public interest, has been running since then until now. To maintain the local wisdom of the community in their daily lives, some respondents chose to carry out conservation and restore functions with a weight value of 0.429 (Table 10). Preservation and restoration of functions are intended to maintain and care for the watershed ecosystem to create a healthy watershed.

3.8   Inconsistency Ratio (CR)

After determining the weight value of each criterion of each ecological, economic, and social strategic alternative, the inconsistency ratio is below 0.1 of each weight value obtained. It can be said that the combined geometrical calculation results of the respondent's data are relatively consistent. The CR calculation results for each criterion have ranged from 0.00 – 0.06 for all requirements. It shows the consistency ratio value because the CR value is under 0.1. The following are the results of each criterion's CR calculation (Table 11).

Table 11 The inconsistency ratio of comparisons between elements of the merging matrix
expert respondent data

No	Matrix element comparison	CR
a	Ecological aspect	
1	Comparison of ECOLOGY level 2 criteria elements based on strategic target to realize a healthy watershed	0.02
1	Comparison of ECOLOGY level 2 based on ecology strategic criteria ; erosion level	0
2	Comparison of ECOLOGY level 2 based on ecology strategic criteria; vegetation	0
3	Comparison of ECOLOGY level 2 based on ecology strategic criteria; flood level	0
4	Comparison of ECOLOGY level 2 based on ecology strategic criteria; drought	0
b	Economics aspect	
1	Comparison of ECONOMY level 2 criteria elements based on strategic target to realize a healthy watershed	0.04
2	Comparison of ECONOMY level 3 based on : economic strategic; income community	0.05
3	Comparison of ECONOMY level 3 based on : economic strategic; un-employment level	0.05
4	Comparison of ECONOMY level 3 based on : economic strategic; added value distribution	0
5	Comparison of ECONOMY level 3 based on : economic strategic; government supporting	0
c	Social aspect	
1	Comparison of SOCIAL level 2 criteria elements based on strategic target to realize a healthy watershed	0.06
2	Comparison of SOCIAL level 3 based on : economic strategic; community welfare	0
3	Comparison of SOCIAL level 3 based on : economic strategic; local indigenous	0
4	Comparison of SOCIAL level 3 based on : economic strategic; public facility	0

3.9   The basis for strategic alternatives becomes ecological, economic, and social priorities in determining the realization of healthy watersheds

After going through the process of filling out the questionnaire by the respondent and through the geometric calculation of the combination of the respondent's data, the alternative weight value is the ecological, economic, and social priority in the strategy of "determining to create healthy watersheds". Based on the results of the respondent's data processing with the main priority order for ecology and social "Return function" with a weight value of 0.492 and social with a weight value of 0.525 (Table 12). Respondents hope that the alternative function of returning to function can create a healthy Lepan watershed in terms of ecology and maintain the level of the community's social welfare. In fact, the community lives and works in unfavorable watersheds. The community is also less responsible and concerned about watershed health. One option for watershed management is to give the community access to and rights to use the land and its plants. Because most of the watershed's forest areas are not healthy, using a social forestry system in forest land management may be the best choice. It corresponds with [18]-

[19], which states that social forestry's critical success is a cooperation between local people and the government to run planting activity in degraded areas.

Then the main priority for the economy is "planting" with a weight value of 0.550 (Table 11). Planting endemic tree seeds that can provide timber or non-timber forest products is expected to help the community in the Lepan watershed [20]. It will support the people's economic level and avoid converting the forest area into agricultural areas or anything else that can damage the watershed ecosystem. It should be remembered that to support the results of strategic alternatives to planting to help the community's economy, the selection of plant or tree species is very important. It is recommended that the types of plants or trees planted are Multi-Purpose Tree Species (MPTS) [21].

Table 12 Weights of alternative priority values from ecological criteria, economic and social

Criteria	Alternative	Weighted	Priority
Ecology	Re-functioning	0.492	I
	Conserving	0.279	II
	Planting	0.229	III
Economics	Planting	0.550	I
	Conserving	0.285	II
	Re-functioning	0.165	III
Social	Re-functioning	0.525	I
	Conserving	0.284	II
	Planting	0.192	III

3.10 The strategic alternative basis for ratios which becomes a priority in determining the realization of healthy watersheds.

After analysing the criteria, sub-criteria, and alternatives from an ecological, economic, and social perspective, the ecological to economic and social ratios are analysed. The ecological, economic, and social ratios analysis is shown in Table 13.

Table 13 Analysis of priority ratios in realizing watershed healthy

Criteria base	Alternatives		
	Planting	Conserving	Re-functioning
Ecology	0.229	0.279	0.492
Economics	0.550	0.285	0.165
Social	0.192	0.284	0.525
Ecology / Economics/ Social	2.168	3.446	5.679

Table 12 found that the alternative "return to function" is a strategic alternative chosen to implement a strategy to establish a healthy watershed in Lepan Watershed, Langkat Regency. According to the respondent's statement, forest areas have been converted into agricultural areas

and other uses. Respondents hope restoring the area's function will improve the ecosystem and result in a healthy Lepan watershed.

4   Conclussion

The first government policy implemented in the Lepan DAS is watershed rehabilitation with a working system, namely the distribution of tree seedlings to each sub-district. Then the second is sanitation or cleaning in the Lepan DAS. The public response to government policies has been considered acceptable, with a percentage value of 51%. The government's percentage of performance related to policies that have been implemented in the Lepan watershed is considered reasonable by the community, with a value reaching 62%. The alternatives for realizing a healthy Lepan watershed are the return of watershed function by weight of 5.679, conservation by weight of 3.446, and planting by 2.168.

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