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Sustainability analysis of Upper Brantas Sub-watershed

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Abstract. Watersheds play an essential role in the sustainability of water resources, facing challenges such as pollution and unintegrated management. The Brantas River, especially the Upper Brantas sub-watershed, is one of the primary water sources in East Java that is threatened by pollution due to household waste disposal. This study aims to analyze the sustainability of the Upper Brantas sub-watershed. Secondary data were collected from various sources between 2018-2022, including water quality, the Human Development Index, and analysis of natural vegetation cover. Primary data on policy implementation were collected using questionnaires. Data analysis used the watershed sustainability index. The results showed that the Upper Brantas sub-watershed had a sustainability index value of 0.54, which is classified as moderate.

1 Introduction

Watersheds have a central role in maintaining water resources' sustainability and addressing the increasingly pressing challenges of clean water availability. In this context, DAS is home to all organisms and implementers of ecosystem functions such as water absorption, flood control, and the provision of other natural resources that are useful for humans and the environment. The reciprocal relationship between biotic and abiotic components in the ecological concept is in line with the concept of watershed management, which is managed spatially in regional development and spatial planning (1).

Watershed management is an integral part of regional development; until now, various complex problems closely related to each other are faced. DAS problems include declining watershed conditions, floods, droughts, erosion, sedimentation, river water pollution, unintegrated management, weak coordination, low public awareness, limited government funds, weak institutions, overlapping regulations, conflicts between sectors/activities, inconsistencies between upstream and downstream, and lack of synergy in the development of natural resources with conservation (2).

One of the water resources that has a very significant role in Indonesia, especially in East Java, is the Brantas River. The Brantas River, which flows into Sumber Brantas Village,

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1 Bumiaji District, Batu City, is the second longest river in East Java. The sanitation system in regencies and cities in the Brantas watershed still relies on rivers as final disposal, this can be seen from the rainwater drainage channels that are still mixed with or with household wastewater. Almost all households dispose of their waste in drainage channels, which ultimately end up in rivers. This method of wastewater disposal causes river pollution. This needs attention, considering the increasing population; the need for raw water is also increasing (3).

Watershed problems are worsening as population growth, environmental damage, and imperfections in policies can threaten the sustainability of watersheds in the future. According to Núñez-Raso et al. (4), watershed sustainability is a significant factor in
3 achieving a sustainable future and maintaining human welfare. However, achieving watershed sustainability cannot be considered merely a technical problem. This involves the complex interactions between ecological processes, socio-economic factors, and policies that play an essential role. Based on this, it is necessary to assess the sustainability index of the Upper Brantas Sub-watershed through a case study in the Batu City area, East Java. Thus, it is helpful for watershed conservation by providing information on sustainability indicators as a new source of information in education and providing information materials for BPDAS Brantas Sampean for more effective resource management and conservation planning.

2 Method

2.1 Time and Location

1 The research was conducted from January to April 2024, with the focus of the research being on the Upper Brantas sub-watershed. Geographically, the Upper Brantas Sub-DAS is located between 7045'36” South Latitude - 8003'00” South Latitude and 112034'12” East Longitude - 112025'48” East Longitude. The Upper Brantas Sub-DAS is administratively located in East Java Province (Batu City, Malang City, and Malang Regency).

2.2 Data collection

Data were obtained from various sources in the period 2018-2022. Secondary data were obtained from the Perum Jasa Tirta I in Malang, East Java, through water quality recordings. Data from the Batu City Central Statistics Agency in the form of the Human Development Index (HDI) and HDI components covering education and per capita expenditure, which measures the quality of life and the growth rate of HDI. Meanwhile, data from the KLHK Statistical Information System in expenditure management, watershed rehabilitation evolution, and analysis of natural vegetation cover through NDVI (Normalized Difference Vegetation Index) and Environment Pressure Index (EPI) analysis. Primary data were collected through field surveys and questionnaires to the Brantas Sampean Watershed Management Center and the community around the watershed to obtain more detailed information.

2.3 Data analysis

3 This study uses the watershed sustainability index method. The watershed sustainability index was developed by Chaves and Alipaz (5), which analyzed the sustainability of a watershed. The watershed sustainability index is divided into four indicators: hydrology, environment, life/social, and policy. Systematically formulated as follows:

$$\text{Watershed Sustainability Index} = (H+E+L+P)/4 \qquad (1)$$

Where:
H= Hydrology
E = Environment
L = Life
P = Policy

According to Núñez-Raso et al. (4), each index is characterized by pressure, condition, and response. The pressure-condition-response model integrates cause-and-effect relationships, providing a more comprehensive understanding than indices examining only one parameter (Appendix 1).

The analysis of watershed sustainability uses hydrological, environmental, life, and policy indicators that will be measured and expressed on a scale of 0 to 1. To facilitate the determination of the values of these parameters, both quantitative and qualitative, they are divided into five equivalent value scales (0, 0.25, 0.50, 0.75, and 1.0) (5). Data analysis is presented in several tables according to the pressure, condition and response models (Appendix 2).

Pressure parameters refer to the impacts generated by human activities on the environment and natural resources in a watershed area (Appendix 3). Condition parameters describe the quality of the environment and natural resources in the river basin. Response parameters show the community's reaction in dealing with impacts on the environment and natural resources through implementing policies or projects to mitigate damage (Appendix 4).

In the final stage of data analysis, the grouping of watershed sustainability indices follows the UNDP (United Nations Development Programme) HDI classification pattern, which is categorized as low if the watershed sustainability index is <0.5, medium if the watershed sustainability index is between 0.5 and 0.8, and high if the watershed sustainability index is >0.8. (5).

3 Result and Discussion

3.1 Upper Brantas Sub-Watershed

The Upper Brantas Sub-Watershed is the upper part of the Brantas Watershed which is located at an altitude of around 1000-3000 meters above sea level and has an area of around 2,382.48 km². Geographically, the Upper Brantas sub-watershed is located at 115017'0" to 118019'0" East Longitude and 7055'30" to 7057'30" South Latitude. This sub-DAS is located in the Batu City area, which includes 3 sub-districts, namely Junrejo, Batu, and Bumiaji. In terms of geological structure, the Upper Brantas sub-watershed is located in a quaternary mountainous area consisting of two types of mountains, namely the ancient Anjasmana mountains, which have older geological material, and the Arjuno mountains, which have younger geological material. The climate in the Sumber Brantas sub-watershed, especially the rainfall level, significantly impacts the conditions and amount of water in the watershed (6).

The upstream area of the watershed is often seen as a rural ecosystem. The upstream watershed ecosystem consists of four main components: villages, agricultural land, rivers, and forests. In the watershed ecosystem, there is an interdependent relationship between these components. The function of the watershed is the result of various factors and components in the area, so that if there is a change in one element, the watershed ecosystem will be

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affected, and vice versa, changes in the ecosystem will also disrupt the function of the watershed (7).

3.2 Hydrology Indicator

Hydrological indicators show water quality in 2018-2022, including analysis of BOD_5 variation relative to the long-term, long-term average BOD_5 (mg/L) and developments in liquid waste management in the Upper Brantas sub-watershed. The values of the related hydrological indicators are presented in Table 1.

Table 1. Hydrological Indicators

	Pressure		Condition		Response		Average Score
	Score	Value	Score	Value	Score		
Hydrology	7,65	0,50	8,65	0,25	good	0,75	0,50

From the data listed in the table, it was found that the pressure parameter obtained a value of 7.65% with a score of 0.50. In the results of this study, there was a significant increase in Biochemical Oxygen Demand (BOD), which indicates significant pressure on water quality. The increase in BOD shows how much microorganisms need dissolved oxygen to decompose organic matter in water under aerobic conditions (8). Bacteria are microorganisms that have a crucial role as decomposers in the ecosystem (9).

The primary role of bacteria as decomposers of organic matter is to provide nutrients at the bottom of the waters, including organic matter that settles as sediment. Therefore, the total number of bacteria at the bottom of the waters can be used as an indicator of water fertility, especially in terms of providing nutrients (10). This reflects that climate change and human activities significantly impact hydrological indicators in river basins (5). BOD_5 levels in water are influenced by temperature, plankton abundance, microbial presence, and the type and amount of organic matter (11).

This shows that high-pressure values indicate the need for better water resource management to reduce pollution and improve water quality. The condition parameters related to the long-term average BOD_5 (mg/l^{-1}) produced a value of 8.65 mg. $l^{-}$with a score of 0.25. The results of this study illustrate the presence of moderate BOD_5 levels in water, which indicate significant potential for the quality of aquatic ecosystems.). Previous research conducted by Núñez-Raso et al. (4) showed similar environmental quality conditions, showing a long-term average BOD_5 of 0.21 with a zero value. The results of this previous study indicate poor conditions in the area, with high pollution levels hurting the aquatic ecosystem. The higher the BOD value in the waters indicates that the waters are increasingly polluted (12). In this study, getting a reasonably low score indicates that the conditions in the Upper Brantas sub-watershed are slightly poor. Knowing the BOD value in water can provide helpful information about how much pollution is caused by domestic or industrial waste in the waters, and this can be used to design biological treatment systems in areas polluted by the waste (13). This is reflected in the resulting score, which is 0.25.

Water pollution control involves prevention and control efforts to restore water quality to meet established standards. Efforts are also made by regulating communities living along the river, tightening supervision of waste disposal, and implementing water pollution control (14). Three main aspects of this control are interrelated: management planning, environmental or ecological aspects, and socio-institutional aspects (15).

The response parameter received a good rating with a score of 0.75. This score indicates progress in waste management, reflecting the effectiveness of the policy; this is by the research of Firdaus et al. (16), who obtained a score of 0.50, which indicates a medium-scale

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increase in waste management. This assessment of the Brantas River water quality can be a reference for stakeholders to limit the amount of liquid waste discharged into the river. This assessment can also be used to design effective liquid waste treatment from sources such as industry, hospitals, and households. This helps identify locations that contribute to pollution and propose the construction of liquid waste treatment facilities (17). The hydrological indicator of the Upper Brantas sub-watershed has an indicator score of 0.50.

3.3 Environmental Indicators

Environmental indicators include several vital parameters: pressure that measures the EPI (Environmental Stress Index), which calculates the percentage of watershed area covered with natural vegetation during the study period, and response that assesses the effectiveness of watershed rehabilitation or conservation practices. The values of these environmental indicators are presented in Table 2

Table 2. Environmental Indicators

	Pressure		Condition		Response		Average Score
	Value	Score	Value	Score	Value	Score	
Environment	-6,48	1,00	6,86	0,25	-7,83	0,25	0,50

The results of the study showed that the Brantas Hulu sub-watershed had a pressure parameter value of -6.48% with a score of 1.00. According to Chaves and Alipaz (5), a positive value indicates high pressure on the remaining natural vegetation, while a negative value indicates lower pressure. With a value of -6.48%, the Brantas Hulu sub-watershed experiences low pressure on its natural vegetation. Watershed dynamics are influenced by human activities and natural processes that put pressure on the watershed. If this pressure exceeds the limit, environmental problems such as flooding, drought, and others can arise caused by excessive use of natural resources. Watershed carrying capacity is essential for understanding the watershed's ability to meet human and natural resource needs (18). The condition parameters in the Brantas Hulu sub-watershed produced a value of 6.86% with a score of 0.25.

This shows that the Brantas Hulu sub-watershed still maintains its natural vegetation, with a relatively small percentage. Previous research by Firdaus et al. (16 in the Batang Merao watershed found that in 2011, the sub-watershed maintained 18.13% of its original vegetation cover, with a score of 0.50. The decrease in the percentage of natural vegetation in the Brantas Hulu sub-watershed compared to previous studies was caused by differences in regional characteristics, levels of human activity, and land management policies in each sub-watershed. A score of 0.25 in Brantas Hulu indicates a more significant challenge in maintaining natural vegetation. Vegetation shows an integral part of the watershed ecosystem. Its roles include maintaining water, preventing soil erosion, and maintaining moisture, which is crucial to protecting the watershed's ecology (19). The response parameter obtained a value of -7.83% with a score of 0.25. Rehabilitation of forest areas is an effort to restore, maintain, and improve the productivity function of the watershed so that the life support system is maintained (20). The overall score for environmental indicators in the Brantas Hulu Sub-watershed is 0.50.

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3.4 Life Indicator

5 The parameters of the life indicators are related to the population's quality of life around the watershed. The pressure parameters include variations in community income based on per capita expenditure data. The selected condition parameter is the Human Development Index (HDI) from 2018-2022. The response parameter is the percentage change in the HDI rate that describes the development (good or bad) of the community's quality of life around the watershed. The values of these life indicators are presented in Table 3.

Table 3. Life Indicators

	Pressure		Condition		Response		Average Score
	Value	Score	Value	Score	Value	Score	
Life	-0,22	0,25	0,70	0,50	-0,01	0,25	0,33

The life indicator values are shown in Table 3, the pressure parameter of the Upper Brantas sub-watershed obtained a score of 0.25, with a value of -0.22%. The data shows that the pressure parameter in the Upper sub-watershed produces a negative value and a low score. Previous research conducted by Núñez-Raso et al. (4) the pressure parameter score was 0.75, indicating a high level of economic pressure in each sub-watershed. This difference shows variations in the level of economic pressure between this study and previous studies due to differences in local conditions. This study is in line with the theory of Chaves and Alipaz (5), which states that negative values of the pressure parameter indicate a decrease in population income, while positive values indicate an increase. This highlights the complexity of the relationship between population income and watershed sustainability. Changes in average population income can significantly impact social indicators such as health and education, ultimately affecting the watershed's overall sustainability. Per capita expenditure is used to measure human living standards. Per capita expenditure describes people's purchasing power and is one of the components used to assess the status of human development in a region (21).

In the condition parameter, the study's results in the Upper Brantas Sub-DAS showed a human development index (HDI) value of 0.70 with a score of 0.50. Previous research by Núñez-Raso et al. (4) in the studied river basin found an HDI value of 0.796 with a score of 0.75. Núñez-Raso et al. [4] explained that the HDI reflects economic growth and other aspects, such as individual access to resources and opportunities to improve quality of life. A high HDI level will increase economic growth by increasing community productivity and creativity (22).

The response parameter has a value of -0.01% and produces 0.25. Previous research conducted by Núñez-Raso et al. (4) showed that the Response parameter obtained from the variation of the HDI growth rate produced a value of -0.11%, equivalent to a score of 0.25. These results also show attention to the low and medium levels in each sub-watershed, highlighting the importance of understanding changes in the quality of life in the watershed. This is in line with the theory of Chaves and Alipaz (5); the response parameter is used to measure the percentage of the HDI growth rate in the watershed in a certain period compared to the previous value. This helps identify positive and negative changes in the quality of life in the watershed. Thus, the life indicator of the Upper Brantas sub-watershed has a score of 0.33.

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3.5 Policy Indicators

Policy indicators related to the HDI components are education as a pressure parameter. Condition parameters assess institutional capacity in integrated water resource management. Response parameters are analyzed based on changes in expenditure in watershed management that reflect how stakeholders in decision-making handle water resource issues. The following is a table of policy indicators.

Table 4. Policy Indicators

	Pressure		Condition		Response		Average
	Value	Score	Value	Score	Value	Score	Score
Policy	-0,31	0,50	Very good	1,00	66,7	1,00	0,83

The policy indicator value is shown in the table above, showing a pressure parameter value of -0.31% with a score of 0.50. This shows that the Upper Brantas Sub-DAS area community influences participation in watershed management. Based on the theory of Chaves and Alipaz (5), the population's education level affects the level of participation in watershed management. The higher the level of education, the greater the likelihood of participation, which encourages decision makers to manage the watershed more effectively. Education is a structured, planned, and sustainable effort throughout life to foster humans or students to become better individuals in living their lives, including maturity and culture (23). The education level significantly impacts community behavior and knowledge in watershed management (24).

The condition parameter obtained an excellent value with a score of 1.00. The theory of Chaves and Alipaz (5) emphasizes that the condition parameter reflects the ability of institutions in the watershed to manage water resources effectively, depending on the support of the legal framework and institutions in the area. Previous research results by Firdaus et al. (16) showed that the policy score on the condition parameter largely depends on the capacity and performance of institutions in the watershed, with a score of 0.50. This analysis shows that the excellent assessment of the condition parameter in the current study shows that BPDAS Brantas Sampean has a strong capacity and good performance in managing water resources in the Brantas Sampean watershed. This is in line with previous findings that highlight the importance of institutional capacity in influencing the performance of water resource management in the watershed. Collaboration between various stakeholders is vital in successfully managing forest areas, including watersheds (25). The role of stakeholders is crucial in the decision-making process and in making regulations for sustainable regional management (26). Regulations related to watershed management need to be clearly regulated as a legal basis for implementing watershed management in Indonesia so that the role of stakeholders can run optimally (27). The study results showed a positive evaluation of the response parameter, which measures the evolution or change in expenditure for watershed management. The value obtained was 66.7% with a score of 1.00. This is in accordance with Chaves and Alipaz (5); this parameter reflects the response of stakeholders to changes in expenditure related to water resource management. The greater the allocation of expenditure for water resource management, the higher the potential for success in achieving water-related goals in the area.

In contrast to previous research by Núñez-Raso et al. (4), which recorded a meager response value, namely 15.83. This shows a significant difference in stakeholder response to changes in expenditure in watershed management between that study and the results of this study. This shows that increasing expenditure for watershed management can potentially increase stakeholder response and success in achieving water-related goals in the river basin,

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based on theoretical findings and differences in results from previous studies. Thus, the life indicator of the Upper Brantas sub-watershed has a score of 0.83.

3.6 Sustainability of the Upper Brantas Sub-watershed

The integrated watershed sustainability index includes socio-economic, environmental, and policy aspects, which can assess the level of watershed sustainability, identify constraints, and serve as a comparison tool. The periodic use of this index provides an overview of the development of watershed conditions. This index serves as a guideline for planning, decision-making, and implementing sustainable development strategies effectively (5). The sustainability value index of the Upper Brantas Sub-watershed is listed in Table 5.

Table 5. Watershed Sustainability Index

	Hydrology	Environmental	Life	Policy
Indicator Score	0,50	0,50	0,33	0,83
Sustainability Score	0,54			

Overall, the sustainability index of the Brantas Hulu Sub-watershed is 0.54, and it is included in the medium sustainability level category. The indicator with the lowest score is the life indicator with a score of 0.33. The indicator with the highest score is the policy indicator, with a score of 0.83. This is due to the low per capita expenditure of the community in the Brantas Hulu sub-watershed area, which affects the HDI value and its growth rate. The average per capita expenditure reflects a decent standard of living and economic improvement of the community (28). In addition, the components of education, health, and per capita expenditure are used to assess the effectiveness and characteristics of social and economic development in various countries, directly affecting the HDI score (29). Increasing the HDI will increase the population's productivity in earning income, accelerating economic development and creating stable economic growth (30). The score of the policy indicator is influenced by the presence of a good education component, the institutional capacity of stakeholders, and relatively good watershed management. Effective stakeholder governance is needed in natural resource management to achieve watershed management goals. This concept refers to the effective management of various parties to achieve strategic goals (31). Therefore, in developing watershed management, it is essential to regulate the role of stakeholders so that natural resource management can be carried out comprehensively and collaboratively (32). The indicators of the Upper Brantas sub-watershed show that it is still experiencing high pressure, and the response to this pressure is quite good, but the overall condition is still less than optimal. Sustainability parameters are of concern to the community as water users, stakeholders, and decision-makers in order to improve the sustainability of the watershed as a whole, both in the short term and sustainability, which emphasizes the importance of efficient water management (33). This means that watershed conditions do not fully support sustainability despite good efforts to manage and respond to existing pressures. The condition of the ecosystem and natural resources in the watershed area has deteriorated due to the extensive damage to natural vegetation cover, as indicated by the percentage of the watershed area still having natural soil and vegetation. Land use changes in the watershed area have an impact (4).

To improve the sustainability of the Upper Brantas Sub-watershed, various strategies need to be implemented. First, the protection and preservation of water resources are carried out by maintaining water catchment and infiltration areas, building infiltration wells, and providing green open spaces in urban areas. Regulations regarding the use of water sources are also necessary through strict licensing and supervision of their extraction. In addition,

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efforts need to be made to replenish dry water sources by building sanitation infrastructure to treat household wastewater so that it does not pollute the environment. Protecting water sources from destructive activities and managing agricultural land upstream wisely is also part of this strategy, including establishing and protecting water source boundaries and increasing the budget for forest and land rehabilitation. Preserving protected forests and conservation areas through optimal protection and rehabilitation is also very important. Second, water preservation can be done by building water reservoirs such as dams and infiltration wells, educating the community about the importance of saving water, utilizing groundwater, and involving the community in water storage. Third, water quality management and pollution control must be improved, including improving river water quality, prohibiting waste disposal into rivers, building centralized wastewater treatment plants, and regulating industrial areas (34).

Watershed Management aims to regulate land use optimally by considering various interests wisely and adopting sustainable practices from an environmental perspective (35). Cooperation between the central and regional governments in watershed management is based on the division of responsibilities and authorities by the government structure in Indonesia (36). Watershed management involves various levels of government to ensure the achievement of practical conservation goals and sustainable development (37).

Awareness of the community, government, and other stakeholders about the importance of watersheds as strategic natural resources is crucial. Effective watershed management requires specialized expertise, in-depth knowledge, and adequate financial support to implement management and conservation programs. All parties must have the same vision about the importance of sustainable watershed management and its benefits to the community and the environment. Effective collaboration requires active participation from local governments, non-governmental organizations, local communities, academics, and the private sector. The more parties involved, the more perspectives are accommodated, and the greater the potential for finding holistic solutions (38).

4 Conclusion

The sustainability of the Upper Brantas Sub-Watershed has an index value of 0.54, which is included in the moderate sustainability level category. The low Human Development Index still causes this condition.

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Appendix

Appendix 1 Watershed Sustainability Indicators and Parameters

Indikctors	Pressure	Condition	Response
Hydrology	BOD variation, relative to long-term average	Long-term average BOD (mg.l^{-1})	Developments that have occurred in the adequate management of liquid waste in the watershed
Environment	Environment Pressure Index (EPI)	Percentage of watershed area covered by natural vegetation (Av)	Conservation evolution that occurs in the watershed area
Life	Variation of Expenditure per Capita	Human Development Index (HDI)	Human Development Index growth rate in the watershed area
Policy	Variations in community education around the watershed	Institutional Capacity in Integrated Water Resources Management	Developments in Water Resources Management expenditure in the watershed area

Source : Chaves and Alipaz (2007)

Appendix 2 Description of Pressure Parameters

Indicators	Pressure Parameters	Level	Score
Hydrology	BOD variation relative to long-term average	$\Delta > +20\%$ $+10\% < \Delta < +20\%$ $0\% < \Delta < +10\%$	0,00 0,25 0,50

Indicators	Pressure Parameters	Level	Score
		-10% < Δ < 0% Δ< -10%	0,75 1,00
Environment	Environment Pressure Index (EPI)	EPI > +20% +10% < EPI <+ 20% +5% < EPI < +10% +0% < EPI < +5% EPI < 0%	0,00 0,25 0,50 0,75 1,00
Life	Variation of Expenditure per Capita	Δ < -20% -20% < Δ < -10% -10% < Δ < 0% 0% < Δ < +10% Δ1 > +10%	0,00 0,25 0,50 0,75 1,00
Policy	Variations in community education	Δ < -20% -20% < Δ < -10% -10% < Δ < 0% 0% < Δ < +10% Δ > +10%	0,00 0,25 0,50 0,75 1,00

Source : Chaves and Alipaz (2007)

Appendix 3 Description of Condition Parameters

Indicators	Condition Parameters	Level	Score
Hydrology	Long-term average BOD ($mg.l^{-1}$)	BOD_5 > +10 +10 < BOD_5 < +5 +5 < BOD5 < +3 +3 < BOD_5 < +1 BOD_5 < +1	0,00 0,25 0,50 0,75 1,00
Environment	Percentage of watershed area covered with natural vegetation (Av)	Av < +5 +5 < Av < +10 +10 < Av < +25 +25 < Av < +40 Av > +40	0,00 0,25 0,50 0,75 1,00
Life	Human Development Index (HDI)	IPM < +0.50 +0.50 < IPM < +0.60 +0.60 < IPM <+0.75 +0.75 < IPM < +0.90 IPM> 0.90	0,00 0,25 0,50 0,75 1,00
Policy	Institutional capacity in Integrated Water Resources Management, both in legal and organizational terms	Very bad Bad Average Good Very good	0,00 0,25 0,50 0,75 1,00

Source : Chaves and Alipaz (2007)

Appendix 4 Description of Response Indicators

Indicators	Response Indicators	Level	Score
Hydrology	Developments that have occurred in the adequate treatment/management of liquid waste	Very bad Bad Average Good Very good	0,00 0,25 0,50 0,75 1,00
Environment	Conservation evolution that occurs in the watershed area	Δ < -10% - 10% < Δ < 0% 0% < Δ < +10% + 10% <Δ < +20% Δ > +20%	0,00 0,25 0,50 0,75 1,00

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Indicators	Response Indicators	Level	Score
Life	Changes that occur in the Human Development Index in the watershed area	Δ < -10% - 10% < Δ < 0% 0% < Δ < +10% + 10% <Δ < +20% Δ > +20%	0,00 0,25 0,50 0,75 1,00
Policy	Developments that have occurred in the expenditure of Water Resources Management	Δ < -10% - 10% < Δ < 0% 0% < Δ < +10% + 10% <Δ < +20% Δ > +20%	0,00 0,25 0,50 0,75 1,00

Source : Chaves and Alipaz (2007)