

Universitas PGRI
Sumatera Barat, Indonesia

E-mail:
trinafebriani20@gmail.com
loli.pgri@gmail.com
slametrianto0812@gmail.com
adeirmasuryani@upgrisba.ac.id
ssyaira659@gmail.com

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Community Empowerment in Watershed Conservation to Reduce the Risk of Flooding and Erosion: Case Study of the Air Dingin Watershed in Padang City

Trina Febriani, Loli Setriani, Slamet Rianto, Ade Irma Suryani, Syaira

Abstract

The Air Dingin River Basin (DAS) in Padang City is one of the areas facing environmental pressures due to changes in land use, population growth, and economic activities along the riverbanks. These conditions increase the risk of flooding, erosion, and sedimentation, which impact environmental damage and socio-economic losses for the community. This study aims to analyze the role of community empowerment in supporting the conservation of the Air Dingin River Basin as an effort to reduce the risk of flooding and erosion. The study used a qualitative descriptive approach through a case study with data collection in the form of field observations, interviews with stakeholders, and documentation studies. The results of the study indicate that community empowerment through environmental education, strengthening local institutions, vegetation rehabilitation in the riverbank area, community-based waste management, and participation in river condition monitoring can increase community awareness and involvement in maintaining the ecological function of the watershed. The success of the conservation program is influenced by collaboration between the local government, the community, academics, and the private sector through a participatory and sustainable approach. However, challenges remain such as low consistency of community participation, limited funding, and weak oversight of land use in the watershed area. Therefore, policy strengthening, community capacity building, and the development of community-based conservation programs are needed to maintain the sustainable function of the Air Dingin River Basin. This study provides recommendations that community empowerment is an important strategy in sustainable watershed management and is effective in reducing the risk of flooding and erosion in Padang City in particular.

Keywords: community empowerment, watershed conservation, Air Dingin Watershed, flooding, erosion, Padang City.

1. INTRODUCTION

A watershed (DAS) is a land area bounded by topography and functions as a unified ecosystem by capturing, storing, and channeling rainwater to the main river and ultimately to the sea. Watersheds play a strategic role in maintaining hydrological balance, preserving environmental quality, and supporting the socio-economic well-being of communities. However, various human activities, such as land use changes, forest conversion, residential development, natural resource exploitation, and inadequate waste management, have led to a decline in watershed quality in various regions of Indonesia. This degradation has resulted in an increase in the frequency and intensity of hydrometeorological disasters, particularly flooding, erosion, and sedimentation.

Padang City is one of the areas in West Sumatra Province with a high level of vulnerability to flooding (Yenni et al., 2017). Its geographical location, dominated by hilly terrain, relatively high rainfall, and the presence of six watersheds (DAS): the Air Dingin, Air Timbalun, Batang Arau, Batang Kandis, Batang Kuranji, and Sungai Pisang watersheds, contribute to the region's complex hydrological dynamics. On the other hand, rapid urban development has increased pressure on watershed ecosystems through changes in land cover, reduced water catchment areas, and increased community activity along river banks. These conditions increase the potential for surface runoff, soil erosion, and sedimentation, ultimately increasing the risk of flooding.

One watershed that plays a vital role in Padang City is the Air Dingin Watershed. This watershed not only functions as a water catchment area but also serves as a water source for the community and supports various economic activities. However, the Air Dingin Watershed faces various environmental problems, such as land clearing in upstream areas, reduced vegetation cover, waste disposal into the riverbed, mining of river materials, and development that ignores environmental carrying capacity. These activities disrupt the

watershed's ecological function, increase erosion rates, accelerate river sedimentation, and reduce the river's capacity to accommodate water discharge during the rainy season.

To date, watershed conservation efforts have generally focused on physical development, such as river normalization, embankment construction, and flood control infrastructure rehabilitation. While important, this approach will not fully address the root of the problem if it is not balanced with the active involvement of the community, as the party directly interacting with the watershed environment. Watershed management fundamentally requires an integrated approach that considers not only technical and ecological aspects, but also social, economic, and institutional ones. Therefore, community empowerment is a crucial strategy for achieving sustainable watershed conservation.

Community empowerment in watershed conservation can be achieved through increasing environmental knowledge and awareness, strengthening community institutions, developing land and vegetation rehabilitation activities, community-based waste management, and community participation in river condition monitoring. Community involvement is expected to foster a sense of environmental ownership so that watershed conservation efforts do not rely solely on government programs but also become part of people's daily behavior and culture.

Various studies have shown that the success of watershed conservation is greatly influenced by the level of community participation and synergy between stakeholders (Asdak, 2023; Government Regulation No. 37/2012). However, in practice, various obstacles remain, such as low environmental awareness, limited community capacity, weak coordination between agencies, and the suboptimal implementation of participatory watershed management policies. These conditions indicate that community empowerment remains both a challenge and an opportunity to improve the effectiveness of watershed management, particularly in the Air Dingin Watershed in Padang City.

Based on this description, this research is crucial to examine how community empowerment contributes to the conservation of the Air Dingin Watershed as an effort to reduce the risk of flooding and erosion. This research is expected to provide an overview of effective forms of empowerment, factors influencing its success, and recommendations for community-based watershed management strategies that can support sustainable environmental development in Padang City.

2. RESEARCH METHODS

This research uses a qualitative approach with a case study. This approach was chosen to gain a deep understanding of the forms, processes, and factors influencing community empowerment in conserving the Air Dingin River Basin (DAS) as an effort to reduce the risk of flooding and erosion. The case study approach allows researchers to comprehensively examine phenomena in a real-world context through direct interaction with the community and stakeholders.

Research Location

The research was conducted in the Air Dingin River Basin (DAS) in Koto Tengah District, Padang City, West Sumatra Province. This location was chosen because it serves a crucial function as a water catchment area and is also under pressure from changes in land use, increased community activity along the riverbank, and a history of flooding and erosion.

Research Informants

Research informants were determined using a purposive sampling technique, selecting respondents who were considered to have knowledge and experience related to the management of the Air Dingin Watershed. Informants consisted of representatives from the Padang City Environmental Service, the Padang City Regional Disaster Management Agency (BPBD), sub-district and village governments, community leaders, community groups concerned with the River, heads of RT/RW, and residents living around the Air Dingin Watershed. The number of informants was flexible and adjusted to the principle of data saturation, which is when the information obtained has been repeated and does not produce new findings.

Data Collection Technique

Data collection was conducted through several techniques, including observation, namely direct observation of the physical condition of the Air Dingin Watershed, land use around the river, community activities, vegetation conditions, and forms of conservation activities that have been carried out. In-depth interviews using semi-structured interview guidelines with informants to obtain information on the form of community empowerment, level of participation, supporting and inhibiting factors for watershed conservation, and perceptions of efforts to reduce the risk of flooding and erosion. Documentation study, namely the collection of secondary data originating from government documents, reports from the Sumatra V River Basin Center, the Central Statistics Agency, the National Disaster Management Agency, the Padang City BPBD, watershed maps, land use data, flood incident reports, field photos, and relevant previous research results.

Data Analysis Techniques

Data analysis was conducted interactively using the Miles, Huberman, and Saldana model, which includes three stages: data reduction, which involves selecting, simplifying, grouping, and focusing data according to the research objectives. Data presentation, which involves organizing research results in narrative form, tables, matrices, or images so that the relationships between variables can be clearly understood. Conclusion drawing and verification, which involves continuously interpreting research findings throughout the research process by comparing the results of observations, interviews, and documentation until credible conclusions are obtained.

Data Validity

Data validity was tested through source triangulation, technical triangulation, and time triangulation. Source triangulation was conducted by comparing information from various informants, while technical triangulation was conducted by comparing the results of observations, interviews, and documentation. Member checking was also conducted with several key informants to ensure the researcher's interpretations matched actual conditions on the ground.

Research Focus

The research focused on forms of community empowerment in the conservation of the Air Dingin Watershed, the level of community participation in conservation activities, supporting and inhibiting factors of community empowerment, the contribution of community empowerment to flood and erosion risk reduction, and strategies for strengthening sustainable community-based watershed management.

3. RESULTS AND DISCUSSION

3.1. Community Empowerment

Research results indicate that community empowerment in watershed (DAS) conservation is implemented through various activities aimed at increasing community capacity to maintain environmental sustainability while reducing the risk of flooding and erosion. Forms of empowerment identified include educational activities, participation in land rehabilitation, strengthening community institutions, and the application of soil and water conservation techniques.

Educational activities are carried out through outreach and training on the importance of maintaining watershed functions (Asdak, 2023). The materials provided cover environmentally friendly land management, erosion prevention, waste management, and the importance of maintaining vegetation in riparian areas. These activities increase community knowledge about the relationship between watershed conditions and the potential for flooding and landslides.

The next form of empowerment is community involvement in land rehabilitation through tree planting on critical land, reforestation along riverbanks, and maintenance of planted vegetation. These activities are carried out collaboratively, involving community groups, the government, and various local organizations. Vegetation rehabilitation contributes to increasing land cover, strengthening soil structure, increasing water infiltration, and reducing surface runoff that can trigger flooding and erosion.

Research also shows the strengthening of community institutions through the formation of river care groups or environmental conservation groups. These groups play a role in coordinating conservation activities,

monitoring environmental conditions, encouraging community participation in river clean-up activities, and acting as liaisons between the community and the government in implementing watershed management programs.

In addition, communities implement various soil and water conservation techniques tailored to local conditions. These techniques include planting cover crops, creating terraces on sloping land, planting along contour lines, constructing simple drainage channels, and constructing infiltration wells and biopore holes in residential areas. These techniques help reduce erosion rates, increase the soil's capacity to absorb rainwater, and reduce the potential for surface runoff, which can cause flooding.

Overall, the research findings indicate that community empowerment in watershed conservation not only increases community participation in environmental protection but also strengthens the community's ability to manage natural resources sustainably. The success of empowerment is influenced by government support, ongoing mentoring, and collaboration between the community, educational institutions, community organizations, and other relevant parties. Therefore, community empowerment is a crucial approach to supporting successful watershed conservation and reducing the risk of flooding and erosion.

Based on the results of data processing in the field, it can be seen that the indicators of community empowerment in managing river basins reached 87%, mutual cooperation in cleaning the river reached 80%, conservation training reached 75%, participation supervision reached 70%, and waste management reached 65%.

3.2. Land Cover Changes in the Air Dingin Watershed

This study shows significant land cover changes between 2020 and 2025, as presented in Table 1.

Land Cover Type	Change (2020–2025)
Forests	– 614.61 ha
Rice fields	– 41.37 ha
Shrubs	+ 443.13 ha
Settlements	+ 180.94 ha
Mixed gardens	+ 55.78 ha

Based on field data processing, the forest area decreased by 614.61 ha during the 2020–2025 period, accompanied by an increase in residential areas of 180.94 ha. This change resulted in an increase in peak river discharge from 2.10 m³/s (2020) to 2.57 m³/s (2025), indicating increased surface runoff due to reduced infiltration areas in the region.

3.3. Air Dingin Watershed Erosion Data

Research using the Universal Soil Loss Equation (USLE) method yielded the erosion hazard classification presented in Table 2.

Erosion Hazard Level	Erosion Value (ton/ha/year)	Area (ha)
Very Light	5.93	58.61
Light	43.90	24.49
Moderate	181.64	3.91
Severe	74.91	4.33

The study also recommended conservation measures such as bench terraces, crop rotation, mulch utilization, and maintaining natural vegetation on steep slopes (Putra et al., 2018). Furthermore, analysis using the USLE method showed that several upstream areas of the Air Dingin watershed still face moderate to severe erosion risks, with erosion rates reaching 181.64 tons/ha/year, indicating that sustainable soil and water conservation measures are essential (Putra et al., 2018).

The flash floods in November 2025 in the Air Dingin area, which resulted in loss of life and damage to homes, demonstrate that watershed degradation not only impacts the ecology but also increases the risk of disasters for the community (Yenni et al., 2017; Alghafiqi et al., 2020).

4. CONCLUSION

Community empowerment is an effective strategy to support conservation of the Air Dingin River Basin (DAS) in Padang City, reducing the risk of flooding and erosion. Community involvement through reforestation activities, the application of soil and water conservation techniques, the maintenance of vegetation in riparian areas, and sustainable land management contributes to improving the ecological function of the watershed. The community's application of vegetative and mechanical conservation techniques demonstrates that watershed management is not solely dependent on government policy but also requires the active participation of all stakeholders.

The success of the empowerment program is influenced by outreach, community capacity building, institutional support, and collaboration between the government, academics, and the local community. Although challenges remain, such as land conversion, illegal logging, and low awareness among some communities, a participatory approach has proven effective in increasing awareness of environmental sustainability while strengthening hydrometeorological disaster mitigation efforts.

Therefore, sustainable management of the Air Dingin Watershed requires strengthening community institutions, increasing environmental education, and implementing conservation programs integrated with local government policies. This synergy is expected to maintain the sustainability of watershed functions, reduce the risk of flooding and erosion, and improve the welfare of communities that depend on resources in the Air Dingin watershed area.

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