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Exploring Social, Physical, and Mental Risks of Ecological Modernization Through Dam Construction: A Case Study of PT. Vale Indonesia's Mining Activities

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ABSTRACT

Mining activities can have a significant impact on ecology, either directly or indirectly. From 1977 to 2011, PT. Vale Indonesia had continuously carried out ecological modernization to produce a supply of energy for production. Even though it has carried out ecological modernization through the construction of dams, it still poses some bad risks. This study aims to analyze the impacts and risks arising from ecological modernization through the dam construction. Data collection included interviews, observations, focus group discussions, and documentation. This study also leveraged the Nvivo 12 Plus analysis tool for coding the data. The findings of this study indicate that ecological modernization through dam construction has significant impacts and risks. Physical impacts and risks include flood portraits that impact the activities of the surrounding community, including residents' settlements and plantations. The social impacts and risks include the loss of people's livelihoods, particularly in the agricultural and plantation sectors. The worst conditions of this social risk tend to erode social feelings, thus leading to the birth of a society without feelings, sensitivity, togetherness, and social responsibility in the social community. Mental risks include the community's mental health due to the accumulation of physical and social risks. Important implications of these findings for policymakers, practitioners, and other stakeholders are involved in the ecological modernization and construction of dams. These findings highlight the importance of considering ecological, physical, social, and mental impacts in the planning and implementing of projects such as dam construction. Stakeholders should focus on protecting the environment, physical security, and the social and mental well-being of the community.

1. INTRODUCTION

Ecological modernization is considered to help reduce the negative impacts that threaten environmental damage by developing technologies and practices that are more environmentally friendly [1]. Ecological modernization is a concept that combines modernization with efforts to protect and preserve the environment [2]. This concept also highlights the importance of economic growth and technological development [3]. Ecological modernization includes efforts such as the use of renewable energy [4], reduction of waste [5], use of more efficient technologies [6], and development of environmentally friendly products [7]. This concept also includes principles such as sustainability [8]. In ecological modernization, sustainability is a top priority.

Through efforts to apply the concept of ecological modernization, it is hoped that sustainable economic growth will occur [9], natural resources can be maintained [10], and the environment can be improved [11]. However, several studies have found aspects that can hinder the idea of ecological modernization, one of which is resistance to change. The changes needed to achieve ecological modernization can be difficult if people are not open to change [12]. Currently, the adoption of ecological modernization is being considered by many parties [13], including companies [14]. Ecological modernization by companies is very important in achieving sustainable economic growth and reducing negative environmental impacts [15].

Adopting ecological modernization can help improve a company's image in the eyes of consumers, investors, and society [16]. Currently, consumers and investors tend to choose products or companies that are environmentally friendly, which can enhance the company's reputation and generate financial benefits [17]. Adoption of ecological modernization can also help reduce company operating costs through more efficient use of energy and reducing waste [18]. This can result in savings in the long term and help increase the company's profits. Adopting ecological modernization is also considered to help improve the company's operational performance [19]. This can increase production efficiency [20].

Ecological modernization is now also starting to be associated with the construction of dams. It is considered an

effort to utilize natural resources more efficiently and sustainably [21]. Dam construction can provide benefits in terms of water management [22], power plants [23], agricultural irrigation [24], and increasing the availability of clean water [25]. However, the construction of dams can also harm the environment and surrounding communities. The construction of dams can damage aquatic ecosystems, change river flow patterns, destroy fish habitats, and affect water and soil quality [26].

Many studies on ecological modernization have been carried out. However, there are still very few studies that specifically relate the topic of ecological modernization to its impacts and risks in mining activities through the construction of dams, especially in Indonesia. However, there is some relevance from the results of previous studies, which are considered quite relevant. *First,* many countries have issued stricter environmental regulations to comply with requirements regarding ecological modernization [27]. *Second,* if managed properly, ecological modernization can also help the environment and society [28]. *Third,* efforts must be made to minimize negative impacts by good planning, involving the community, and paying attention to environmental impacts [29].

This study aims to fill the gaps in previous research by analyzing the impacts and risks of ecological modernization. This research case was conducted at a mining company in Indonesia, PT. Vale Indonesia. This research question is mapped as follows. (a) What are the risks posed by ecological modernization? (b) What efforts are needed to reduce these risks? Both of these questions make it possible to find out how the impacts and risks are caused and how efforts are needed to reduce the impact of these risks. The results of this research have an important contribution to understanding and overcoming environmental problems and human welfare, especially in areas around mining activities. In addition, the urgency of this research is to understand the social, physical, and mental impacts and risks of ecological modernization through the construction of dams, especially in the context of the mining activities of PT. Vale Indonesia, to guide more sustainable management and wiser policies in the future.

2. METHOD

The research method used is an in-depth qualitative analysis. This study chose a qualitative approach because it prioritizes an in-depth understanding of the impacts and risks of ecological modernization through the construction of dams in the context of the mining activities of PT. Vale Indonesia. The choice of qualitative method is also due to the complexity of this study's social and psychological phenomena. In the process of analysis, collecting data from various sources such as interviews, observations, focus group discussions, and documents allows investigators to approach this phenomenon carefully and thoroughly, thus providing a comprehensive understanding of the implications of ecological modernization in the mining activities of PT. Vale Indonesia.

The informants in this study were selected carefully to ensure various views and understanding regarding the ecological, physical, social, and mental risks the parties face. Informants involved community elites, who had experience and in-depth knowledge about the impact of ecological modernization projects, the government as the holder of social regulations and responsibility, the company as the main actor in the project, as well as other parties deemed relevant, such as environmental agencies and the people who were directly affected. The number of informants selected in this study was sufficient to provide diverse and in-depth perspectives on the impacts and risks involved.

Observations were carried out by making direct visits to research sites to observe community phenomena, especially those related to the processes and impacts of ecological modernization risks. This documentation was carried out by examining several related documents, including the Karebbe Dam Emergency Response Plan (RTD), flood compensation documents, Laskap Village residence documents, and other documents. The data obtained is then coded and visualized using an analysis tool in the form of Nvivo 12 Plus. Using analysis tools such as Nvivo 12 Plus in qualitative research is essential to aid in efficient data coding and analysis. Nvivo 12 Plus is software specifically designed for qualitative data analysis, enabling researchers to organize, classify, and analyze data better. Maximizing this analysis tool makes it possible to visualize and analyze data to answer research questions.

3. RESULT AND DISCUSSION

3.1 Ecological modernization risks: Mining activities with dam construction

Mining activities can have a significant impact on ecology, either directly or indirectly. The mining company (PT. Vale Indonesia) from 1977 to 2011 has continuously carried out ecological modernization to produce a supply of energy for production. Ecological modernization was first carried out since the construction of the Larona Dam in 1977 and became operational in 1979. Then it continued with the construction of the Balambano Dam in 1995, which became operational in 1999. The last Dam, the Karebbe Dam, was built in 2007 and operated in 2011. Even though it has been through ecological modernization in its activities, some impacts and risks are still found. Some of the impacts and risks found are seen as follows:

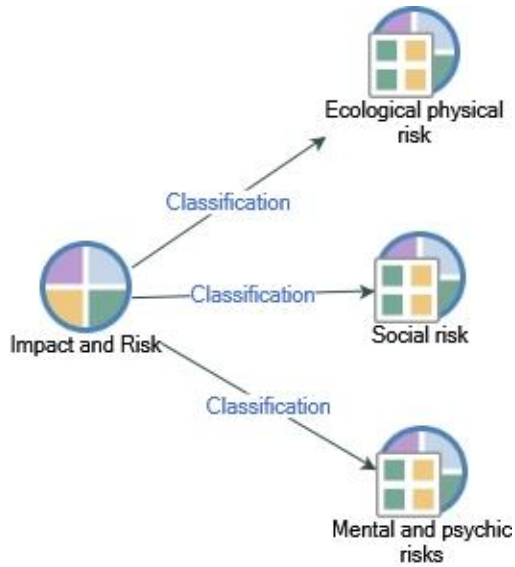

Figure 1. Impacts and risks of ecological modernization in PT Vale Indonesia's mining activities through the construction of dams
Source: Processed by researchers using Nvivo 12 Plus, 2022

Figure 1 shows several risks in ecological modernization in the mining activities carried out by PT. Vale Indonesia. These include ecological, physical, social, and mental risks. Ecological and physical risks are physical hazards that occur to humans and nature. From the data obtained, information was found related to physical risks that have occurred or have not occurred but have an impact on the daily life of the people around the mining area carried out by PT. Vale Indonesia, especially in Laskap Village.

To support its activities, PT. Vale Indonesia is known to have built dams around residential areas. However, the dam's existence could create a new disaster threat in the form of major flooding. The formation of this disaster threat is currently the direct concern of many parties. In detail, the threat of flooding that can occur is described as follows:

Table 1. Calculation of the arrival of water in the event of a dam collapse

Number	Flood-Effected Areas		Flood Arrival Time	Population		Flood Receding Time (hour)
	Village	Sub-District		(Life)	(Head of Family)	
1	Laskap	Malili	30 minutes	1.871	428	24 hours
2	Pongkeru	Malili	35 minutes	1.807	467	24 hours
3	Pasi-pasi	Malili	45 minutes	1.189	285	24 hours
4	Puncak Indah	Malili	50 minutes	5.477	1.192	24 hours
5	Malili	Malili	70 minutes	4.390	1.071	24 hours
6	Baruga	Malili	75 minutes	3.257	1.862	24 hours
7	Wewangriu	Malili	50 minutes	3.038	745	24 hours
8	Balantang	Malili	90 minutes	2.234	602	24 hours
Total				**23.263**	**6.652**	

Source: PT. Vale Indonesia, 2022

Table 1 shows the potential for direct threats from the dam (PLTA) owned by PT. Vale Indonesia. This extraordinary event has never happened, but the risk can still occur at any time. Nonetheless, other physical impacts have become a new problem in the Laskap Village community. The results of interviews with the Head of Laskap Village explained that the potential and impact of flooding had already hurt the community.

> "Currently, the community is in a state of worry because frequent small earthquakes and floods occur. There have been floods, but not as often as now. It used to flood only a matter of hours and then recede. However, right now, flooding is difficult to predict because floods are usually caused by sudden spilling (opening of the mouth of the dam), especially when heavy rains are added to the upstream and the tides in the surrounding rivers increase, which has the potential to cause flooding. The current floods took a long time, about a week. The flood affected the residents' houses, rice fields, and plantations" (interview, 30/09/2022).

In addition, this study also found portraits of floods that impacted the activities of the surrounding community, including settlements and plantations of residents.

Figure 2. The impact of physical damage to the mining activities of PT. Vale Indonesia through dam construction
Source: Processed by researchers from observations, 2022

The data trend in Figure 2 shows that there are bad potentials and risks posed by mining activities with the existence of dams belonging to PT. Vale Indonesia. This is consistent with the results of several other studies where the construction of dams and ecological modernization can have different impacts on flooding and physical damage depending on various factors such as location, design, and implemented policies [30]. Dam construction can also affect river flow and prevent downstream flooding but can also cause upstream flooding due to water retention [31]. Floods can impact the environment [32], agriculture [33], and significantly hinder human activities [34].

Another impact of mining activities is the emergence of social risks. Social risk in this context is defined as a condition where the community's social life is disrupted due to various factors, including natural disasters caused by PT Vale Indonesia's activities. Ecological modernization through the development of dam construction has consequences for the loss of people's livelihoods, especially in the agricultural and plantation sectors, due to flooding due to dam damage. Thirty-seven families suffered losses due to floods in 2020. In addition, events contributed to social diseases, such as ignorance of the environment and indifference among community members. The worst conditions of this social risk tend to erode social feelings, which leads to the birth of a society without feelings, sensitivity, togetherness, and social responsibility within the social community.

In addition to the physical, ecological, and social impacts and risks, there are also other risks, namely mental risks. Impact of ecological modernization of PT. Vale Indonesia was identified as contributing to the disruption of people's mental health due to the accumulation of physical and social risks as part of the impact of ecological modernization through the construction of dams. The research findings are the same as the results of previous studies where ecological modernization can impact people's mental health, such as stress and anxiety [35]. In addition, the construction of dams often forces people to move from their homes [36]. This can cause prolonged stress and anxiety in the community because they have to leave their familiar environment and change to a foreign environment, especially the impact that has damaged the results of their previous job searches, such as agricultural and plantation products. The construction of dams often creates social injustice in society, especially for more vulnerable groups such as people with low incomes and minorities [37],

especially those who feel that they have no control over the situation. This can worsen an individual's mental health and even lead to self-harm.

3.2 Efforts needed to reduce risks

On the other hand, ecological modernization aims to repair or restore damaged ecosystems and reduce the risk of flooding [38]. However, ecological modernization can also physically damage the environment if it is not carried out properly or if there are errors in planning and implementation [39]. In this regard, it is very important to carry out an environmental and social impact evaluation before carrying out dam construction and ecological modernization. In addition, it is also necessary to carry out good monitoring and management to minimize negative impacts and maximize the benefits generated [40].

To reduce physical risks due to ecological modernization through the construction of dams, several actions can be taken, one of which is to pay attention to nature conservation [41]. Before building a dam, it is necessary to conduct an environmental impact and nature conservation study to identify environmental risks and determine the steps needed to reduce these impacts. The selection of dam construction sites also needs to consider natural and environmental conservation factors.

In addition, in managing water in dams, it is necessary to regulate it so as not to damage the surrounding environment and ensure that the water resources are used efficiently and sustainably. This can be done by regulating water management and determining water use quotas [42]. After construction, it is necessary to continuously monitor and maintain the dam to avoid damage and reduce potential impacts [43]. Environmental awareness education and development also need to be carried out for the people living around the dam. This is intended so that people can understand the impact of dam construction and take appropriate action to protect the surrounding environment [44]. Through these actions, the physical and ecological risks due to ecological modernization through the construction of dams can be reduced so that the environment and surrounding ecosystems are maintained and sustainable.

Ecological modernization involving the construction of dams can also cause significant social impacts on the surrounding communities. Several steps can be taken to reduce social risks due to ecological modernization through dams, one of which is by consulting local communities [45]. It is important to ensure that local communities are involved in planning and implementing a dam construction project. This consultation must be carried out openly and transparently so that the community can understand the impact of the dam construction and provide input and suggestions. In addition, affected communities must be given fair compensation in financial and non-financial forms, such as replacing land or public facilities [46]. This compensation should be decided through a fair and transparent process involving local communities.

In the future, dam construction projects must be designed and implemented by considering ecological sustainability and minimizing the environmental impact. It is also important to regularly monitor and evaluate the ecological impact of dam construction projects. To reduce social and mental risks to the community due to ecological modernization through the construction of dams, it is necessary to carry out proper management and monitoring from the beginning of construction until after the construction has been completed. In addition, it is also necessary to carry out psychological handling and rehabilitation of the people affected by the dam construction.

In addition, cooperation and response from various parties are required to deal with the ecological, physical, social, and mental risks associated with ecological modernization through dam construction, including policymakers, practitioners, and other stakeholders. This approach has been widely used, especially in human activities and the environment [47]. Policymakers should integrate comprehensive environmental and social impact evaluations into dam construction projects' approval and planning processes. In addition, strict regulations governing water management and use must be enforced so as not to damage the surrounding environment and ensure efficient and sustainable use of water resources. Practitioners must carry out projects with due observance of the principles of nature conservation and ecology by local environmental conditions.

Stakeholders, especially local communities, must be invited to participate actively in the planning process, with open and transparent consultations and providing fair compensation. In addition, ongoing monitoring of dam construction's ecological and social impacts should be carried out, and psychological and rehabilitation approaches should be provided to affected individuals to address the mental risks that may arise. Through this collaboration, negative impacts can be minimized, and efforts towards development that is sustainable and responsive to the environment and local communities can be strengthened.

4. CONCLUSIONS

Ecological modernization through the construction of dams is an effort to utilize water resources more efficiently and sustainably. However, the construction of dams can also have adverse impacts and risks on the environment and the surrounding community, such as physical, social, and mental risks. The findings of this study indicate that ecological modernization through the construction of dams contributes to the high potential for flooding, which damages residents' homes, agricultural land, and plantations. As a result of the flood, which had a bad impact, also gave rise to other social risks, such as indifference among community members. This condition of social risk tends to erode social feelings, which leads to the birth of a society without togetherness and social responsibility within the social community. Other impacts and risks were also identified as contributing to the community's mental health disruption due to the accumulation of physical and social risks.

Efforts are needed to reduce the risks posed by evaluating environmental and social impacts before dam construction and ecological modernization. To reduce these risks, actions are also needed, such as paying attention to nature conservation to identify environmental risks and determine the steps that need to be taken to reduce these impacts. It is also important to regularly monitor and evaluate the ecological impact of dam construction projects. It is also important to regularly monitor and evaluate the ecological impact of dam construction projects. These efforts also require the involvement and cooperation of many parties, including governments, companies, and the general public.

This study has several limitations that need to be considered. First, the main focus of this study is on PT Vale

Indonesia, so the results may not be directly applicable to different mining contexts. Second, the qualitative analysis in this study is descriptive, so further research with a quantitative approach may provide further insight. This study opens opportunities for further research. Future research can dig deeper into the effectiveness of various risk mitigation strategies in the context of ecological modernization through the construction of dams. In addition, research can consider more in-depth economic aspects related to the impacts and benefits of ecological modernization projects. Follow-up studies can also compare ecological modernization projects in different locations to understand contextual differences in impacts and risk reduction strategies.

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