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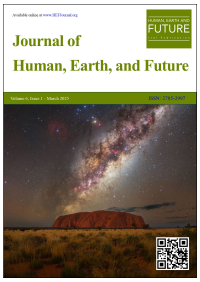

Assessing the Role of Social Networks in Sustainable Post-Fire Peatland Management

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Abstract

The recovery program for the peatland ecosystem in Sumatra, Indonesia, through Rewetting, Revegetation, and Revitalization (3R), requires social network value to enhance and support the program's objectives. Some interventions in various locations have aligned local policy, which is beneficial for peatland management. However, there is a lack of scientific publications examining whether this local policy effectively supports the value of peat ecosystem recovery. This study explores examines the role of social networks and values in post-fire peat management programs within a community governed by local policy. Jebus Village in Jambi Province, Sumatra Island, Indonesia, serves as the case study. Utilizing a validated combination of close-ended and open-ended questionnaires, respondents shared insights into their social networks. The results indicate that the social network value of Jebus Village is "High" across all three measured aspects, with an average score of 2.7 and a total of 82. Surprisingly, no significant correlation was found between these social networks and actual peat restoration efforts, suggesting a limited impact on the local economy. This raises questions about the effectiveness of current government-led restoration programs. Therefore, a deeper analysis of each program is necessary. Moving forward, the government should prioritize participatory assessments when developing peatland restoration policies, even in urgent situations, ensuring recovery programs align with local customs and traditions to enhance effectiveness.

Keywords: Community Engagement; Community Participation Levels; Jambi Peatlands Ecosystem; Local Policy Implementation; Village-Based Conservation.

1. Introduction

Tropical peatland ecosystems play a critical role in global climate regulation and biodiversity conservation, serving as significant carbon sinks and habitats for diverse species. However, these ecosystems are threatened bydegraded, converted to land, and frequently burned. In Indonesia, peatland fires occur almost annually and are often driven by anthropogenic activities, such as transmigration projects and land allocation for agricultural purposes, exacerbated by the intensifying El Niño events of the late Holocene [1–3]. Fires release vast amounts of carbon into the atmosphere and cause severe ecological damage, including biodiversity loss and the degradation of ecosystem services. The

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impacts of these fires are compounded by the large-scale conversion of tropical peatlands into oil palm plantations and smallholder agriculture, which have led to a substantial decline in healthy forest cover. For example, studies indicate that in Sumatra's peatland forests, healthy forest cover has declined from 95% to 73% within protected areas and from 86% to merely 25% outside these areas [4]. The Kumpeh District in Sumatra recorded 5,191 hotspots over a specific period, underscoring the high frequency of peatland fires in these regions [5].

To address these pressing issues, the Indonesian government has implemented the recovery program (the *3R* framework): Rewetting, Revegetation, and Revitalization in this area covering 18,140.32 ha by the Mangrove Peat Restoration Agency (BRGM) [6–8]. Rewetting focuses on restoring the water balance in peatlands to prevent fires and degradation [9, 10]. Revegetation emphasizes planting native species to rehabilitate ecological balance and biodiversity [8, 11, 12]. Revitalization aims to strengthen local economies and enhance the socio-economic well-being of communities living near peatlands [6, 7, 13]. Together, these strategies form the backbone of sustainable peatland management policies. In the theory of sustainable peat management, the 3R is the main policy of peat restoration in addition to the cessation of extraction in important areas [14]. The 3R (Rewetting, Revegetation, Revitalization) framework necessitates collaboration among key actors, businesses, and communities [8].

While technical solutions are integral to peatland restoration, the role of social systems cannot be overlooked. Social networks are a critical component of community capacity, facilitating resource mobilization, promoting collective action, and strengthening the implementation of restoration policies [15, 16]. For instance, social networks play a key role in the dissemination of knowledge and the engagement of stakeholders in environmental management programs. They are particularly important in post-fire recovery efforts, where collective action is essential for addressing ecological and socio-economic challenges [17, 18].

However, scientific data related to social networks and their values are still very limited for sustainable peatland restoration, especially in the context of Indonesian tropical peatlands. The few available studies that exist have highlighted the importance of social networks in peatland rehabilitation in areas such as Kalimantan [19, 20] and Riau [21–24]; research on the specific relationship between social networks and sustainable peatland management in post-fire contexts remains limited. Most existing studies focus on community participation [25], policy dissemination [15], or poverty alleviation efforts in peatland areas [26]. This underscores a significant gap in the literature, particularly in understanding how social networks can be mobilized to support peatland restoration in the aftermath of fire events.

This study addresses this gap by examining the value of social networks in supporting sustainable peatland management in post-fire settings. Specifically, it explores two key questions: (1) What role do social networks play in advancing sustainable peatland restoration? (2) How can social networks be effectively mobilized to enhance restoration outcomes? By addressing these questions, this research aims to contribute to the existing body of knowledge and provide actionable insights for developing more effective and sustainable peatland management policies.

2. Material and Methods

2.1. Research Approach and Study Area

This study employed a mixed-methods approach, integrating qualitative and quantitative data. Qualitative data were used to examine the status and conditions of community social networks, while quantitative methods analyzed the correlation between these networks and peatland restoration efforts. The research was conducted in Jebus Village, Kumpeh District, Jambi Province, of Sumatra, Indonesia (102.0108°E - 104.0330°E), of which 94.9% (21,914.42 ha) of the total area (23,072.71 ha) comprises peatland (Figure 1).

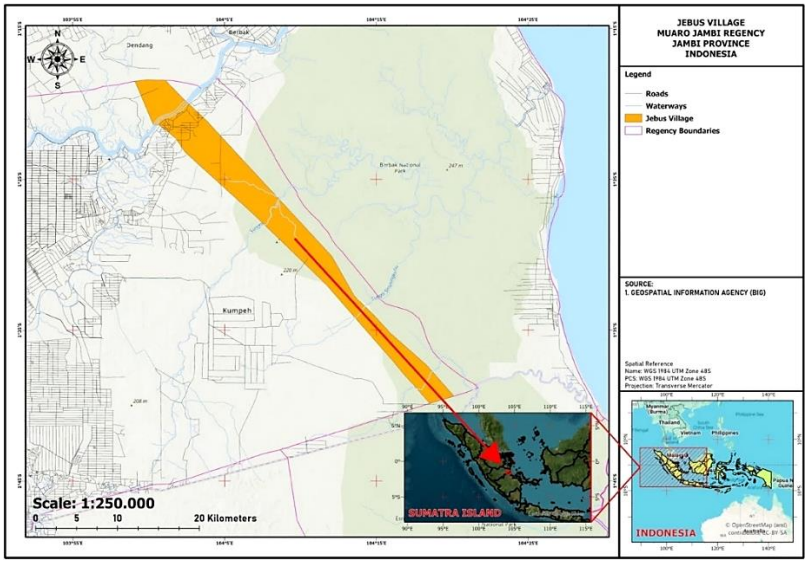

Figure 1. The location of Jebus Village in Jambi Province, Indonesia

Jebus Village is a peatland-dominated area characterized by immature peat (21,056.43 ha) with a reddish-brown hue, predominantly classified as conservation forests (e.g., Berbak National Park and Tahura OKH) and production forests. The village is a significant ecological area, acting as a buffer zone for surrounding protected areas and contributing to biodiversity conservation. Jebus Village is also rich in biodiversity, both flora and fauna (Figure 2). The natural regeneration of peatland vegetation in Jebus Village has been recorded, with reports of 26 plant species regenerating naturally, including fast-growing pioneer species [27, 28]. This village is home to a variety of fauna, including birds [29, 30] and mammals [31, 32].

Socially, Jebus Village demonstrates strong social capital through the implementation of a local regulation (*Peraturan Desa*, *Perdes*) aimed at protecting peatlands for agriculture, food crops, and sustainable plantations [33]. This regulation has effectively curbed peatland degradation and conversion, supported by community-led initiatives such as awareness campaigns and the installation of "prohibition boards" to increase compliance (Figure 3). These efforts underline the community's active role in environmental conservation and its potential for supporting peatland restoration initiatives.

Figure 2. Birds (left) and frogs (right) are some of the forms of biodiversity that exist in the peat landscape around Jebus Village

Figure 3. The Jebus Village Regulation's content is socialized as an "information board" that can be seen and read at any time by the community

2.2. Data Collection Technique

Field data collection uses interview techniques with 30 people from Jebus village. The determination of the number of data sources or respondents follows the central Limit Theorem, which is close to the normal distribution of data in statistics, according to Creswell & Creswell [34]. They consist of village officials, traditional leaders, youth leaders, and community groups determined based on age, education, income, and livelihood criteria. Furthermore, certain respondents were interviewed personally to gain in-depth insight into the purpose of the study.

The questionnaire used is a combination of close-ended and open-ended questions that contain data on 1) the extent of participation (which includes the desire, willingness, and activeness of the community in carrying out recovery activities), 2) the extent of kinship relationships, and 3) inter-community relations. The Likert Scale with three options (see Table 1) is used as a reference in compiling answers to close-ended questions in the questionnaire. This simplicity can make it easier for respondents to make quick decisions without feeling overwhelmed by too many options [35].

The simplicity of fewer options can also reduce the cognitive burden on respondents, potentially leading to higher response rates and more consistent data collection [36].

Table 1. Classification of scores on the Likert scale on answers in questionnaires

Score	Answer Type		
1	Disagree	or	No answer
2	Nervous	or	Not
3	Agree	or	Yes

All question items in the questionnaire have been tested for validity and reliability so that the feasibility and validity of the question items can be known. The questionnaire is valid if the significance value (α) is < 0.05 and the r calculation > r table, while it is reliable if *the Cronbach Alpha* value is more significant than 0.60. The test results stated that all questions were valid and reliable, completely presented in Table 2. There are no limitations in implementing the validity and reliability test of the questions method.

Table 2. Results of the validity and reliability test of the questions in the questionnaire

Aspects	Sign	R-table	R-count	Validity	α	Reliability
• Community's desire to carry out recovery activities	0.000	0.2126	0.936	Valid	0.877	Reliable
• Community's willingness to participate in recovery activities	0.000	0.2126	0.959	Valid	0.877	Reliable
• Community's activeness	0.000	0.2126	0.542	Valid	0.623	Reliable
• Community's kinship	0.000	0.2126	0.636	Valid	0.623	Reliable
• Community's participation and association with other communities	0.000	0.2126	0.569	Valid	0.623	Reliable

2.3. Data Analysis

The level of social networks owned by the community in this study is categorized into three types, namely high, medium, and low social networks (see Table 3). The categorization of social network levels into high, medium, and low can be understood through the lens of social hierarchy, user profiles, and network structure. These levels are influenced by various factors, including social status, user behavior, and the structural nature of the network. Social hierarchy plays an important role in determining the level of social networks [37].

Table 3. Classification of social network levels according to Ahuja et al. (2019) [37]

Score	Criterion
< 1.5	Low
1.6-2.,5	Keep
> 2.5	High

Furthermore, the data is presented in a descriptive statistical manner illustrated using Tableau. Meanwhile, to find out whether social networks have a partial influence between the independent variables of social networks and the dependent variables, namely, the community's desire to carry out recovery activities (Y1) and their willingness to participate in recovery activities (Y2) in efforts to restore peat ecosystems, a regression test was conducted.

3. Results

3.1. Respondent Characteristics

Figure 4 illustrates the relationship between respondents' age and their levels of education using a bubble chart. The bubble chart presents the relationship between the respondents' age and education level. Each bubble represents an individual, and its size can indicate the frequency or significance of a particular data point. The horizontal axis indicates the different levels of education, while the vertical axis indicates the age of the respondents.

Data analysis in Figure 4 shows that most of the respondents in this study are productive people between the ages of 21-50 years. The age groups of 31-40 and 41-50 dominate the distribution, respectively, 34% and 30%. The youngest and oldest respondents were only 3% of the total respondents. Based on age, respondents who pursued higher education were in the 21-40 years old group, while respondents who took Senior High School (graduated) were spread across all ages. Less than 5 respondents who were the source of the data did not complete their education in elementary and junior high school.

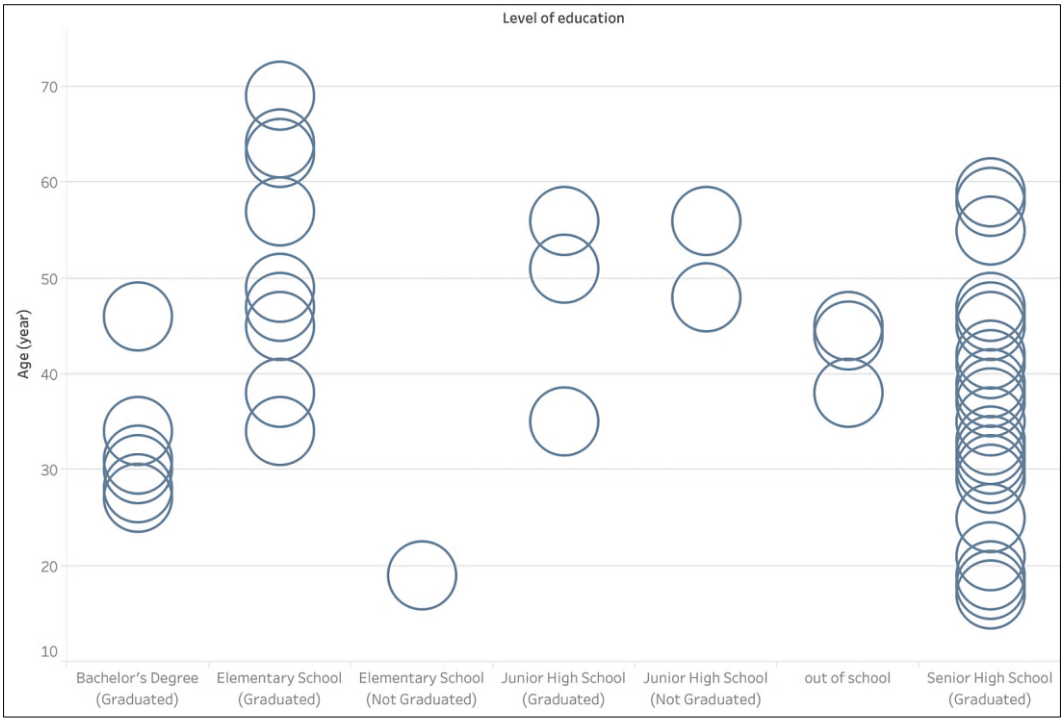

Figure 4. The education level of respondents per age distribution.

Interestingly, fewer than five respondents did not complete elementary or junior high school, and these cases are predominantly found among older respondents, suggesting historical limitations in education access during earlier decades. Conversely, the younger cohorts are largely concentrated in Senior High School or higher levels of education, indicating an upward trend in educational attainment. This distribution provides valuable insights into the community's educational structure, with younger, more educated respondents contributing potentially innovative ideas and perspectives to local development efforts. The presence of older respondents with limited formal education reflects a reliance on experiential knowledge and traditional practices in their roles within the community.

Figure 5 presents the distribution of respondents based on their main occupations, age, and length of residence in the community. Respondents are involved in 14 main job categories, ranging from agricultural roles such as "Peasant or Farmer" to administrative positions like "Village Officials" and "Village Consultative Council (BPD)." Other occupations include "Forest Park Security," "Preschool Teachers," and "Palm Oil Company Security", reflecting the socio-economic diversity of the community.

The length of residence among respondents varies significantly, ranging from less than 10 years to over 60 years. Occupations such as "Peasant or Farmer," "Housewife," and "Village Official" are associated with longer tenures, often exceeding 30 years, suggesting deep-rooted ties to the community. On the other hand, jobs like "Palm Oil Company Security" and "Other Company Staff" show a broader range of tenure, indicating that these positions may be occupied by individuals who recently settled in the area.

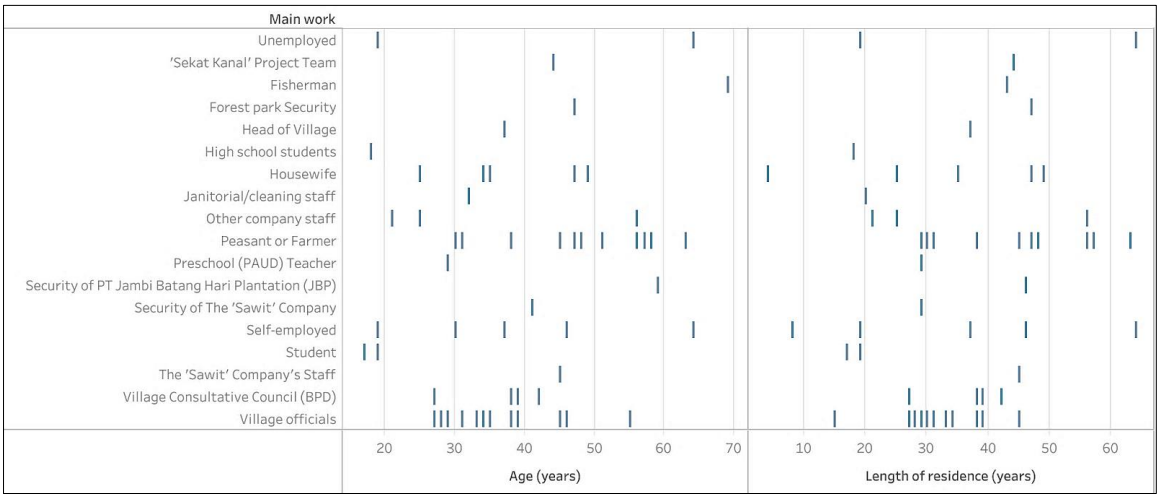

Figure 5. The distribution of the respondents' main occupations based on age and length of residence in Jebus village

Together, Figures 4 and 5 provide a comprehensive overview of the socio-demographic and educational landscape of the study community. The intersection of age, education, and occupation highlights the community's capacity for both continuity and change. Older respondents with long tenures and traditional knowledge form the backbone of community leadership and stability. Simultaneously, younger, better-educated individuals bring new perspectives and a capacity for innovation to local development and environmental management. This blend of traditional knowledge and modern education creates a unique dynamic that supports the social networks essential for sustainable peatland restoration and governance. The findings underline the importance of leveraging these complementary strengths to drive community-led initiatives effectively.

3.2. Community Social Networks

Table 4 provides an evaluation of the community social networks in Jebus Village based on three primary aspects: Community's Activeness, Community's Kinship, and Community's Participation and Association with Other Communities. Each aspect was measured using a scoring system, and the results were categorized as "High," "Medium," or "Low" based on the average score and percentage. The analysis indicates that all three aspects of social networks fall within the "High" category, reflecting a robust social structure within the community. Community's Activeness recorded the highest average score of 2.8 (83%), followed by Community's Participation and Association with Other Communities with a score of 2.9 (87%), and Community's Kinship, which scored 2.6 (76%). The overall average score across the three aspects was 2.7, corresponding to an average percentage of 82%. Based on the classification of social network levels according to Ahuja et al. (2019) [37] (see the levels in Table 3), this score is categorized as "High."

Table 4. The value of the social network of the Jebus Village community

Aspects of social networking	Score	Average per Aspect	Category
Community's activeness	2.8	83	High
Community's kinship	2.6	76	High
Community's participation and association with other communities	2.9	87	High
Average	**2.7**	**82**	**High**

These results suggest a strong and interconnected social network in Jebus Village, characterized by high levels of community engagement, close interpersonal relationships, and active collaboration within and beyond the community. The consistency in the scores across all three aspects indicates the absence of significant disparities in the social network structure, which further supports the classification of Jebus Village as having a resilient and cohesive community network. The strong social networks identified in Jebus Village play a critical role in fostering community resilience and collective action, particularly in the context of environmental and restoration initiatives. These findings highlight the community's capacity for maintaining internal cohesion while actively participating in broader social and environmental efforts.

3.3. Correlations of Community Networks with Ecosystem Restoration Efforts

Table 5 summarizes the regression analysis results between social network variables and the dependent variables in efforts to restore peat ecosystems. The dependent variables include Y1 (Desire to carry out recovery activities) and Y2 (Willingness to participate in recovery activities).

Table 5. The regression test value between social network variables and bound variables in efforts to restore peat ecosystems in Jambi, especially Tahura OKH

Bound variable (Y)	Sign	t-count	t-table	R	R-adj
Desire to carry out recovery activities (Y1)	0.582	0.553	2.000	0.072	0.005
Willingness to participate in recovery activities (Y2)	0.216	1.252	2.000	0.162	0.026

For Y1, the analysis produced a significance value (*p*) of 0.582, indicating no statistically significant relationship between the social network variable and the desire to engage in restoration activities. The *t-count* value of 0.553 is considerably lower than the critical *t-table* value of *2.000*, and the correlation coefficient (*R*) of 0.072 demonstrates a negligible relationship. The adjusted R-squared (*R-adj*) value of 0.005 confirms that the social network variable accounts for only 0.5% of the variance in the desire to carry out restoration activities.

For Y2, the significance value (*p*) is 0.216, also exceeding the 0.05 threshold, suggesting no significant relationship between the social network variable and the willingness to participate in restoration activities. The *t-count* value of 1.252 remains below the critical *t-table* value of *2.000*. The correlation coefficient (*R*) of 0.162 suggests a weak relationship, while the adjusted R-squared (*R-adj*) value of 0.026 indicates that the social network variable accounts for only 2.6% of the variance in willingness to participate.

4. Discussion

Networks, or social networks, are an integral component of social capital, formed through the interaction of beliefs and norms that affect various aspects of life, including economic outcomes, social behaviors, and organizational dynamics. Practically, social networks are complex structures that provide insight into how relationships and interactions influence individual and collective actions within a given entity, emphasizing the importance of relational patterns over individual attributes in understanding social dynamics [38]. In this study, the entity in question is the participation of individuals as representatives of group members in various peat restoration efforts or programs.

Social networks play an important role in the success of peat ecosystem restoration efforts, especially post-fire in the Jambi region, including in Jebus Village. This study found that the people of Jebus Village have a strong social network, indicated by high average scores for activeness, kinship, and participation in community life. However, regression analysis revealed no statistically significant correlation between the social network and the community's desire or willingness to participate in peat ecosystem restoration efforts.

These findings align with previous research suggesting that strong social networks do not automatically lead to increased participation in environmental initiatives. It is perhaps triggered by another factor, such as trust in governance and perceived relevance of programs, playing critical roles, as the Klenk et al. [39] was studied. Similarly, in a meta-analysis of conservation efforts, another study also found that even communities with well-developed social networks often exhibit low engagement levels unless there is a perceived direct benefit or alignment with local priorities [40].

Then, the findings of this study raise the question of why strong social networks have not been able to encourage community involvement in peat restoration programs. Jones found that the effectiveness of social networks largely depends on how involved and how the community feels about owning the program [18]. Twenty years ago, Sabatini stated that social networks tend to be more effective when they are associated with tangible economic benefits for community members, which are often their top priority [41].

Participatory management strategies, as demonstrated in mangrove restoration projects in the Philippines, exemplify the effectiveness of integrating local communities into restoration initiatives [42]. Such projects provide financial incentives while simultaneously enhancing social capital, thereby improving access to information and services essential for the sustainability of community livelihoods. In the context of conservation, network structures that are less connected to important aspects of conservation lead to less optimal conservation actions [43].

The findings can be attributed to several factors, as reflected in the majority of responses from the community. One notable cause appears to be a lack of understanding within the community regarding the significance of peat ecosystem restoration and its long-term benefits. This perspective is further supported by in-depth interviews with key local actors. Additionally, the existing social network within Jebus Village has not been effectively integrated into government-managed peat restoration programs or those led by related institutions. These programs often fail to align with local customs, and collaborative learning is typically introduced only after the program is underway. Consequently, insufficient time is allocated to achieve the intended goals or expectations within the annual project cycle.

Some community members have observed that projects often arrive and depart without fostering the necessary awareness or willingness to engage. However, integrating local social structures into conservation efforts is crucial for such programs' success [44]. Restoration initiatives are unlikely to secure community support without this integration, particularly in areas where economic challenges take precedence over environmental concerns. This suggests that the government has not fully leveraged the community's social capital, resulting in perceptions that these programs are irrelevant or fail to deliver tangible benefits.

As revealed by Wulandari et al. [45] in their publication relevant to this study, community involvement in conservation efforts and adaptation to climate change is essential to ensure sustainability. Thus, restoration programs should be more participatory and able to provide space for communities to be actively involved from the planning stage to implementation so that social networks can serve as a tool to disseminate information and raise awareness about the importance of peat ecosystems.

Criticism of the program design, which may restrict broader participation and reveal capacity weaknesses, is further compounded by another key factor contributing to the disconnect between the strong social network value and low participation rates. The social character of the community appears to play a significant role, as evidenced by demographic data. Most respondents are peasants or farmers, whose priorities naturally focus on activities that offer direct economic benefits to their livelihoods. Additionally, relatively low levels of education among respondents may hinder their understanding of the importance of peatland restoration and its relevance to ecosystem sustainability.

Research by Albizua et al. [46] highlights that while social networks strongly influence agricultural practices and sustainability, they may be less effective in driving participation in peat ecosystem restoration, particularly when such activities fail to provide immediate economic benefits. Bridging this gap requires additional mechanisms, such as financial incentives or cross-scale collaboration platforms. These could be effectively disseminated through continuous social media campaigns to attract and engage stakeholders [47–49].

This study confirms that peatland restoration can succeed with community support, as the government alone cannot manage the vast, remote areas. To foster this collaboration, the government aims to provide economic benefits through initiatives like agroforestry training and enhancing social capital, as has been successful in similar studies involving communities [50–52]. Strong social networks alone are insufficient for successful restoration; additional factors such as trust, norms, personal values, ecological awareness, economic incentives, and effective program implementation are critical. Inclusive programs that actively involve communities in decision-making are essential for optimizing social networks' potential. Further research is needed to address barriers hindering collective environmental efforts and ensure restoration programs align with local customs, accelerating peatland recovery.

5. Conclusion

The study concludes that strong social networks are not the only factor in the success of peat ecosystem restoration. Moreover, although peat restoration programs have considered various physical and ecological aspects of the landscape and local economy, their implementation is still running partially and individually. The high value of social networks is the main capital that must be integrated holistically with other aspects such as awareness, understanding, economic incentives, and program effectiveness, which must be further tested. Moving forward, the government should prioritize participatory assessments when developing peatland restoration policies, even in urgent situations, ensuring recovery programs align with local customs and traditions to enhance effectiveness.

6. Declarations

6.1. Author Contributions

Conceptualization, C.W.; methodology, C.W.; software, E.R.N.S.S.; validation, C.W., D.I., and N.N.; formal analysis, E.R.N.S.S.; investigation, C.W., D.I., E.R.N.S.S., and N.N.; resources, A.D.; data curation, A.M.R.; writing—original draft preparation, N.N. and E.R.N.S.S.; writing—review and editing, N.N.; visualization, E.R.N.S.S.; supervision, C.W.; project administration, N.N.; funding acquisition, C.W. All authors have read and agreed to the published version of the manuscript.

6.2. Data Availability Statement

The data presented in this study are available in the article.

6.3. Funding

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6.5. Institutional Review Board Statement

Not applicable.

6.6. Informed Consent Statement

Not applicable.

6.7. Declaration of Competing Interest

The authors declare that there are no conflicts of interest concerning the publication of this manuscript. Furthermore, all ethical considerations, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

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