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RESEARCH ARTICLE

Revamping the Process of Selecting the Appropriate Plant Species for Restoring Peat Ecosystems in South Kalimantan, Indonesia, Through the Implementation of A New Approach

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ABSTRACT

This study aims to examine the appropriate type and size of seedlings for revegetation activities and the community's willingness to participate in the restoration of peat ecosystems. The research was conducted in Pulantani village and Tambak Sari Panji village, located in the Hulu Sungai Selatan Regency of Indonesia. The study focused on peatland plant species, community knowledge, expert opinions, and community attitudes. Data collection involved field surveys using nested plot sampling, with plots measuring 20 m x 20 m. A total of 10 plots were used to document plant species at different levels, including trees, poles, saplings, and seedlings. Community knowledge, expert opinions, and community attitudes were gathered through interviews. Descriptive analysis and scoring were used to analyze the data on species selection. Public willingness was assessed descriptively using specific indicators. The study identified seven plant species at various vegetation levels in the peat forest. The limited number of species indicates a high degree of disturbance in the peat forest. Combretocarpus rotundatus, Shorea balangeran, and Alstonia pneumatophora were the main species selected for revegetation. Other species included Melicope sp. and Pternandra azuera. The preferred seed size was approximately 80 cm in diameter. The high willingness of the community to participate in peat ecosystem restoration activities can be attributed to the presence of social capital within the community. The willingness of the Pulantani village community to engage in peat ecosystem restoration was higher than the Tambak Sari Panji village community. A comprehensive approach that considers the community's ecological and socio-economic aspects is necessary for restoring degraded peat ecosystems. The study is unique in bringing real-life issues to peat ecosystems, and problems identified, like species disturbances, will help advance the literature in the field.

INTRODUCTION

Indonesia's peat ecosystems are renowned for their significant carbon storage capacity, potentially storing up to 44.5 gigatonnes. This carbon reservoir has the potential to grow even further by increasing peat thickness, which is estimated to accumulate at a rate of 3 mm per year. However, any disturbances to these natural conditions can accelerate the decomposition process, releasing greenhouse gases, mainly CO^2 (Parish et al., 2008).

Government policies establishing the Unity of Peatland Hydrology (UPH) as a management unit govern the management of peat ecosystems in Indonesia. The country currently has 865 UPHs, covering a total area of 24,667,804 hectares. UPHs are peat ecosystems located between two rivers, between rivers and the sea, and/or in swamps (Ministry of Environment and Forestry, 2017).

In the region of South Kalimantan, the UPH spans an area of 235,561 hectares (Sudrajat and Subekti, 2019). However, various disturbances have caused degradation within the South Kalimantan UPH. Approximately 227,857 hectares, or 96.7% of the UPH, have been degraded (Ministry of Environment and Forestry, 2021). Addressing this damage is crucial, and efforts must be made to restore the peat ecosystem.

Peat ecosystem restoration involves activities aimed at reinstating the original characteristics and functions of peat ecosystems or closely resembling them. One approach to restoration is through revegetation, which entails planting trees on peatlands to mitigate the area reduction rate and restore the ecological function of peat forests (Ministry of Environment and Forestry, 2021; Brieta et al., 2018).

The selection of suitable seedlings in revegetation plays a crucial role and requires careful consideration. The type test mechanism is one method for choosing plant species that possess specific characteristics suitable for peatlands. It is important to select the appropriate type and size of seeds that can adapt to the unique biophysical conditions of the peatland habitat. Factors such as water level, inundation, depth, and peat type are considered when determining suitable seeds (Tata, 2019). Gathering information on seedling types and sizes for revegetation activities based on ecological characteristics can be done through field surveys, reviewing references on plant suitability in peatlands, species testing, and expert opinions.

The choice of seedling types and sizes in peat revegetation should take ecological considerations into account as well (Tata, 2019). The success of revegetation efforts relies on taking into account the social aspects of the community, as they are actively involved in implementing these activities. Medrilzam et al. (2014) suggest that the relationship between human activities (the social system) and nature (the ecological system) is a key factor influencing changes in forest cover in tropical peat ecosystems.

Typically, communities prioritize the socio-economic benefits derived from revegetation activities. The community's willingness to participate in the revegetation program can indicate the extent of socio-economic benefits. The community hopes that the planted seeds will contribute to their future economic benefits. Considering ecological and socio-economic benefits for the community highlights the need for peat ecosystem restoration efforts to focus on ecology and the community's social economy (Tata, 2019).

The social characteristics of the community involved also play a role in the success of revegetation efforts in addition to the seed selection process. Utilizing a community social empowerment approach in revegetation activities for peat ecosystems is suggested to yield positive outcomes (Syahza et al., 2021). This study aimed to formulate the selection of seed types and sizes based on three data sources that represent the ecological and socio-economic aspects of the community. By incorporating these three aspects, the implementation of peat ecosystem restoration through revegetation is expected to be facilitated.

LITERATURE REVIEW

The selection of appropriate plant species for peat ecosystem restoration in South Kalimantan, Indonesia, is a critical aspect of the restoration process. Previous studies have emphasized the importance of ecological considerations and community participation in achieving successful restoration outcomes. This literature review aims to explore the existing knowledge on plant species selection and community involvement in peat ecosystem restoration while proposing a new approach for enhancing the restoration process.

When considering the ecological aspects of plant species selection, it is crucial to acknowledge the unique hydrological and soil conditions of peatlands in South Kalimantan. Murdiyarso et al. (2010) emphasized the presence of high water tables, acidic pH levels, and nutrient limitations in these ecosystems. Therefore, it becomes essential to identify plant species that can adapt to waterlogged conditions and nutrient-poor environments and effectively sequester carbon. Hooijer et al. (2010) stressed the suitability of native plant species, which naturally occur in peatland ecosystems, as they possess adaptive traits that make them well-suited for restoration efforts.

In addition to ecological considerations, the restoration process should address the significance of plant species diversity. Jauhiainen et al. (2012) and Page et al. (2009) emphasized that establishing a diverse plant community enhances ecosystem resilience, provides suitable habitats for fauna, and contributes to essential ecological functions such as nutrient cycling and carbon storage. Understanding the successional dynamics and interactions between different plant species is critical to selecting suitable species that can promote the recovery of peat ecosystems. By replicating the natural community composition and successional patterns of peatlands, restoration efforts can facilitate the establishment of a diverse and self-sustaining vegetation mosaic (Tata, 2019; Yutitum and Khantachawana, 2020).

Community participation is another integral aspect of peat ecosystem restoration. Gómez-Baggethun et al. (2010) highlighted the importance of engaging local communities in the restoration process, as it fosters a sense of ownership and increases the effectiveness of restoration actions. Assessing the knowledge, attitudes, and willingness of the local community to participate in restoration activities is crucial for the success of restoration initiatives. McCarthy et al. (2012) emphasized that social capital, including trust, shared values, and social networks, positively influences community engagement in restoration efforts. Furthermore, addressing socio-economic considerations such as livelihood opportunities and providing incentives is vital for ensuring restoration initiatives' long-term sustainability and acceptance.

A new approach is proposed to improve the process of selecting appropriate plant species for peat ecosystem restoration in South Kalimantan. This approach advocates integrating ecological knowledge, species diversity, successional dynamics, and community participation. Di Maddaloni and Sabini (2022) emphasized the significance of participatory approaches involving collaboration between scientists, local communities, and stakeholders in decision-making. By incorporating local knowledge, preferences, and traditional practices, this approach ensures that restoration efforts align with community needs and aspirations. Additionally, decision-support tools and models can assist in selecting suitable plant species based on ecological criteria, community preferences, and restoration goals. These tools provide valuable guidance in navigating plant species selection's complex trade-offs and uncertainties.

In conclusion, selecting appropriate plant species for peat ecosystem restoration in South Kalimantan, Indonesia, requires a comprehensive approach considering ecological factors, species diversity, and community participation. By integrating ecological knowledge, successional dynamics, and community preferences, restoration practitioners can enhance the effectiveness and sustainability of restoration initiatives. Incorporating decision-support tools and models further aids in navigating the complexities associated with plant species selection, thus promoting successful restoration outcomes. Future research should continue to explore and refine these approaches to continually improve peat ecosystem restoration efforts.

METHODS

Location and research object

The study was conducted in two villages, namely Pulantani Village and Tambak Sari Panji Village, located in Haur Gading District, Hulu Sungai Utara Regency, South Kalimantan Province. The selection of these locations was based on specific criteria, including: 1) the presence of peatland; and 2) the implementation of a peat ecosystem restoration program through revegetation. The research spanned seven months, starting in March and concluding in October 2022. The research focused on several aspects, including a) identifying plant species in peatlands, b) assessing the knowledge and opinions of the local community and peatland experts, and c) evaluating society's attitudes. The tools employed for this study included stationary materials, a computer setup, a questionnaire, and a survey kit.

Data collections

The sources of data for determining the recommended type and size of seeds for revegetation activities on peatlands include the following:

- Community informants: These are individuals from the local community who have participated in peat revegetation activities. They include farmer group administrators, religious leaders, community leaders, village officials, and other community members.
- Expert informants on peat ecosystems: These are knowledgeable individuals with expertise in peatlands and can provide insights into the appropriate type and size of seeds for peatland revegetation. They consist of the Provincial Environmental Service (DLH), the DLH of North Hulu Sungai Regency, academics, the South Kalimantan Regional Peat Restoration Team, and the Forestry Service.
- Data on plant species from inventory: Information on plant species suitable for peat ecosystems is obtained from inventory data collected at the research location.

The selection of informants is made using the purposive sampling method. Community informants are chosen based on their involvement in peat revegetation activities, while expert informants are selected based on their knowledge and experience in peatlands.

Field surveys are conducted to collect data on tree species and regeneration in peat ecosystems. Ten observation plots measuring 20m by 20m are strategically placed to represent the distribution of forest cover. Different plot sizes are used for data collection at various levels: 20 m x 20 m for tree level, 10 m x 10 m for pole level, 5 m x 5 m for sapling level, and 1 m x 1 m for seedling level.

The method used to gather data on the willingness of the community to participate in and receive incentives from the peat ecosystem restoration program through revegetation involves interviewing the community. The number of respondents is determined using the Slovin formula (Umar, 2000).

$$n = \frac{N}{1 + N \cdot e^2}$$

Where:

n = sample size

N = population size

e = estimation error (percentage of tolerable inaccuracy)

Pulantani village has 183 family heads, while TSP village has 227 families. The chosen error margin (e) is 8%. According to the Slovin formula, the required number of respondents is 85 family heads in Tambak Sari Panji village and 93 individuals in Pulantani village. Each respondent represents a family.

The willingness to participate in the activity is assessed through interviews. The information regarding the incentive value is determined using a cost-based analysis to establish the initial price base. Additionally, the bidding game technique (bargaining) will be employed to ascertain the value desired by the community (Onwujekwe, 2001; Frew et al., 2004) for peat ecosystem restoration activities. This method involves proposing a certain amount of money to the respondents as a starting point and asking them if they are willing to accept it. The minimum value accepted by the respondent becomes the expected incentive for their involvement in peatland revegetation activities.

DATA ANALYSIS

Selection of type and size of seeds

The individuals who acted as informants provided details regarding the categories and specifics of the seeds chosen for reforestation endeavors in peatlands. The gathered information will be organized sequentially, starting with the most suitable type and size for planting activities in peatlands.

The selection process for seedling types and sizes was evaluated based on three data sources: community knowledge, expert opinions on peatlands, and species data from the study site. These three data sources were assessed and assigned scores to determine the recommended order for selecting seed types and sizes. The maximum number of species to be recommended is five, and the range of seed sizes should be at most three variations.

Table 1: Type suitability parameters

Variables/Parameters	Size/indicator	Evaluation
1. Knowledge of local people	Community knowledge about:	Generated data:
	1. Types of seeds suitable for planting in peatlands	· Five types of seeds were selected by community informants.
	2. The size of the seeds that are usually planted	· The three sizes of seeds were most chosen by community informants.
	3. The benefits of these plants for society	· Description of the underlying benefits of planting seedlings
2. Opinion of peatland experts.	Opinion based on science about:	Generated data:
	1. Recommended seed types for planting on peatlands.	· The five types of seeds most commonly recommended on peatlands.
	2. Recommended seed size for planting on peat land.	· The three most widely recommended seed sizes.
	3. The advantages of these types are that they are recommended for planting on peatlands.	· Description of the basic reasons for recommending the seed.
3. Types of plants in the research location.	The number of plant species found in the research location is based on the vegetation level.	Generated data:
		· Number of types of tree levels · Number of types of pile levels. · The number of types of stake levels · The number of seedlings of each type of plant.

Level of willingness to be involved in peat ecosystem restoration activities

A descriptive analysis examined individuals' inclination to partake in peat ecosystem restoration endeavors (Nazir, 1988). Their willingness to engage was evaluated based on their readiness to participate in revegetation activities, preferred modes of cooperation, and the economic benefits they deemed valuable in exchange for incentives. The analysis employed the Willingness to Accept (WTA) method to identify respondents' acceptance or rejection of incentives offered concerning the revegetation activities.

Table 2: Willingness to engage in peat ecosystem restoration activities

Operational Definition/ Variable	Indicators	Valuation
Willingness to participate and accept in peatland revegetation activities	1. Statement of willingness to participate in the activity. The resulting data:	• Willingness to participate in revegetation activities
	2. Forms of Cooperation in Activities	• Desired forms of cooperation
Data obtained using interviews	3. The initial value of the desired incentive	• Desired initial nominal value of the incentive

RESULTS AND DISCUSSION

Type and size of selected seeds

The information gathered through the field survey activities revealed the presence of seven distinct tree species, along with their respective levels of rejuvenation, as documented in Table 3. This data provides insights into the variety of trees observed and the extent to which they have undergone rejuvenation, serving as a valuable reference for further analysis and understanding of the surveyed area's ecological composition and health.

Table 3: Tree species and rejuvenation rates found in the study locations

Nu	Type of Species	Vegetation Level			
		Tree	Poles	Sapling	Seedling
1	Combretocarpus rotundatus	√	√	√	√
2	Shorea balangeran	√		√	√
3	Alstonia pneumatophora	√	√		
4	Adina minutiflora			√	√
5	Melicope sp.			√	
6	Pternandra azurea				√
7	Syzygium sp.				√

The information presented in Table 3 indicates that the peat forest within the study area is degraded and experiencing significant levels of disruption. Field observations suggest that this peat forest frequently suffers from recurring fires and illegal logging activities. Three species, namely C. rotundatus, S. balangeran, and A. pneumatophora are identified at the tree vegetation level. According to several references (Putra et al., 2011), these three species are considered significant components of the peat ecosystem. While C. rotundatus is present at various vegetation levels, the other four species are only found at the sapling and seedling stages.

Regarding the selection of plant seeds, the community's knowledge led to the choice of five different types of plants. Furthermore, the community considered two criteria for seed size when making their selections. On the other hand, experts identified eight types of seeds and one specific seed size. The outcomes of both community and expert opinions on the selection of seed types and sizes are presented in Table 4.

Table 4. Types and sizes of seedlings based on community knowledge and experts

Table 4: Descriptive summary of studies included in the systematic review

Data Sources	Selected Species	Selected Size
Local Community Knowledge	Shorea balangeran, Combretocarpus rotundatus,	≥80 cm and ±40 cm
	Melicope sp.	≥80 cm and ±40 cm
	Alstonia pneumatophora	≥80 cm and ±40 cm
	Pternandra azurea	≥80 cm and ±40 cm
		≥80 cm and ±40 cm
Opinion from peatland expert	Combretocarpus rotundatus	80cm-100cm
	Shorea balangeran.	80cm-100cm
	Alstonia pneumatophora Melaleuca cajuputi	80cm-100cm
	Dyera costulata	80cm-100cm
	Tetrameristra glabra	80cm-100cm
	Callophyllum inophyllum	80cm-100cm
	Gluta renghas	80cm-100cm

The community selected S. balangeran as their primary choice due to their experience in revegetation activities. The S. balangeran species are highly effective in planting activities and produce valuable carpentry wood. The community also chose C. rotundatus as the next preferred option due to its growth and seed multiplication ease. Other types of plants were chosen as alternatives to enhance the diversity of revegetation plants.

The community highly recommends seedlings with a size of 80 cm (82%), as they are considered capable of surviving in waterlogged conditions on peatlands for an extended period. A few individuals mentioned using seeds of approximately 40 cm, which is considered ideal for optimal growth and adaptation of young roots to peatlands.

The experts strongly recommended S. balangeran, C. rotundatus, A. pneumatophora, and M. cajuputi out of the eight seed types in total. The experts based their selection on factors such as the prevalence of these species in peat forests, their adaptability to specific peat environments, the ease of seed propagation, and the availability of sufficient captive seeds. The recommended seed size by the experts is 80 cm to 100 cm, which aligns closely with the size suggested by the community at approximately 80 cm.

One notable difference between the expert and community choices is the selection of M. cajuputi. The community believes M. cajuputi leaves contain essential oils that can easily trigger fires. Additionally, the bark's crumbly nature, similar to that of paper, is considered a potential source of flammable materials that can initiate fires.

A score was calculated for each type to assess the selected seed types based on data from the community's local knowledge, expert opinions, and field observations (Table 5).

Table 5: Recommended seed types and sizes from three data sources

	Scoring values											
Data sources	S. balangeran	C. rotun-datus	Melicope sp.	A. pneu-matophora	P. azurea	M. caju-puti	A. minuti-flora	D. costu-lata.	Syzygium sp.	T. glabra	C.inophy-llum	G. reng-has
Community knowledge	5	4	3	2	1	-	-	-	-	-	-	-
Expert opinion	4	5	-	3	-	2	-	1	-	1	1	1
Plant species found in the peatland	4	5	1	3	2	-	1	-	1	-	-	-
sum	13	14	4	8	3	2	1	1	1	1	1	1
Recommendation class	2	1	4	3	5	6	7	7	7	7	7	7

Based on the scoring calculations derived from the three utilized data sources, five species were chosen based on their respective scores: i) C. rotundatus; ii) S. balangeran; iii) A. pneumatophora; iv) Melicope sp.; v) P. azuera. C. rotundatus is a prominent tree species found in primary, secondary, and degraded peat forests (Yenihayati, 2018; Kalima and Denny, 2019). S. balangeran exhibits the highest growth percentage in peatland revegetation. The main challenge faced during revegetation activities is the high water level, which causes the seedlings to be submerged in the field for 2-3 months (Kissinger et al., 2022).

For effective revegetation activities, it is recommended to use seedlings with a minimum height of 80 cm. Wibisono and Dohong (2017) noted that suitable seedlings for planting in peatlands should have a height ranging from 50 cm to 120 cm and be at least 6 months old after being weaned.

The analysis of community willingness to participate in peat ecosystem restoration activities involved 85 respondents from Pulantani village and 93 respondents from Tambak Sari Panji village. Four indicators were used to assess the community's willingness, including 1) willingness to participate in activities; 2) forms of cooperation; 3) the initial value of incentives; and 4) the system for carrying out activities. A detailed summary of the obtained results can be found in Table 6.

Table 6: Willingness of the community to be involved in peat ecosystem restoration activities

Indicators	Community of Pulantani Village	Community of Tambak Sari Panji Village
willingness to participate in activities	All respondents (100%) are willing to take part in the activities	79% of respondents are willing to take part in the activity, but there are 21% of respondents who are not willing.
Form of cooperation	The form of cooperation is a partnership with the village institution	the form of cooperation is directly with individual executors or small groups
Starting point for the incentive value of willingness to participate in activities	IDR 50.000,-/day	IDR 80.000,-/day
Activity processing system	The system of activity implementation is adjusted based on the agreement between the Partner and the village institution.	The system of activity implementation is through a contract based on either a per-unit or a per-activity basis

The residents of Pulantani village are eager to participate directly or indirectly in the restoration activities of the peat ecosystem, such as revegetation, rewetting, and economic revitalization. In the TSP village, a majority of the community in Tambak Sari Panji Village (79%) expressed their willingness to engage in peatland ecosystem restoration activities. In comparison, 21% of the respondents cited their lack of experience and limited ability to collaborate with external or internal village parties as reasons for not participating.

The respondents from Pulantani Village expressed their desire for cooperation through partnerships with village institutions under the guidance of the village head or competent village officials. The high level of trust that the Pulantani village community has in their village officials motivates them to seek shelter and support from village institutions in all forms of cooperation. The respondents do not prioritize competing for jobs but prefer to work together, adjusting to their respective areas of expertise. They are not overly ambitious in controlling or mastering all the peat ecosystem restoration "projects." Instead, they find greater satisfaction in collaborative efforts.

In Tambak Sari Panji village, all respondents preferred direct cooperation with the implementers of the activities, either individually or in small groups. This form of cooperation was chosen because it is more straightforward, without involving intermediaries from other parties, and allows for flexibility in self-regulating the activities.

Regarding incentives, 87% of the Pulantani village respondents indicated IDR 50,000 per day as the starting point for the incentive value of participating in peat ecosystem restoration activities. Some respondents (13%) did not specify an initial nominal value, believing it should be determined through group deliberations. The community believes that incentives can be adjusted if they provide tangible benefits from these activities. The observations reveal that Pulantani villagers find pleasure and pride in working together and enjoying the benefits of these activities. This sense of togetherness and empathy for others is vital for Pulantani village.

In Pulantani village, the social aspect of activities, particularly the sense of togetherness, takes precedence over individual monetary gains. This aligns with their experience in carrying out revegetation activities, where technical cooperation is discussed collectively among partners, village institutions, and the community. Decisions regarding participation and task assignments are made through deliberations. Planting activities are carried out with enthusiasm in groups, ensuring timely completion. There is no competition for work, as tasks are assigned based on capabilities and decisions made through deliberations. Despite alternative activities in Pulantani village, residents remain committed to completing their planned activities. One of the reasons for this commitment is the close relationship between partner representatives (revegetation assistance officers) and local residents. Residents view the partner representatives as part of their family or relatives, strengthening cooperation between partners and the village. This family-oriented approach, treating residents as partners rather than workers, fosters a greater acceptance of activities and enhances collaboration.

In Tambak Sari Panji village, the initial value of incentives for participating in peat ecosystem restoration activities is IDR 80,000 per day. The residents hope the incentives align with market rates or exceed them. This incentive value differs significantly from that of Pulantani village.

Regarding the workmanship system, most respondents from Pulantani village (92%) did not specify their preferred system. The community leaves such decisions to group meetings and village institutions. In contrast, all respondents from Tambak Sari Panji village chose a working system where incentives are provided based on a contract system per unit volume or per unit area of activity rather than a daily wage system.

Trust in village institutions, trust in the neighborhood, outsiders, concern for others, and a desire to share the benefits of activities all impact the community's decisions regarding incentive amounts. In peat ecosystem restoration activities, Pulantani Village prioritizes the social benefits derived from collaboration. According to existing research, social capital serves as the underlying force in society. Shared values, personal relationships, trust, and a common sense of shared responsibility are crucial to foster social capital. The Tambak Sari Panji village community perceives revegetation activities as an opportunity to increase income, aligning with their chosen form of cooperation and the initial incentive value.

The trust residents have in village officials in Pulantani village leads them to defer to the results of deliberations and the directions provided by village officials and institutions. In contrast, Tambak

Sari Panji village residents prefer to manage their activities independently. The effect of social capital on reducing activity costs is evident in the lower initial incentive value of Pulantani Village (IDR 50,000 per day) compared to Tambak Sari Panji Village (IDR 80,000 per day). According to research the costs of revegetation activities are linked to cooperation, coordination, and trust within community groups, which are elements of social capital. Pulantani village community demonstrates a higher social capital level than Tambak Sari Panji village.

The elements of social capital play a supportive role in peat ecosystem restoration efforts. Evaluations of revegetation activities show that the Pulantani village community has achieved better results than the Tambak Sari Panji village community. The success rate of revegetation is closely related to the community's social capital (Muhayah Noor Pitri, 2023). References indicate that development activities are easier to accomplish and more cost-effective when there is a high level of social capital (Grootaert and Van Bastelaer, 2001).

Understanding the social characteristics of the community in peat ecosystem restoration is crucial as it relates to the economic values that are formed within the community. High social capital within an area contributes positively to peat ecosystem restoration activities. Adopting an approach that considers ecological requirements, technical expertise, and the socio-economic value of local community knowledge when selecting plant species is expected to enhance the success of peatland ecosystem revegetation activities.

The theoretical implications of the study

The theoretical implications of the study on revamping the process of selecting appropriate plant species for restoring peat ecosystems in South Kalimantan, Indonesia, through the implementation of a new approach can be summarised as follows:

Ecological considerations: The study emphasizes the importance of considering ecological factors when selecting plant species for peat ecosystem restoration. The study highlights the high degree of disturbance in the current peat forest by examining the existing plant species and their distribution at different vegetation levels. This finding suggests that restoration efforts should focus on selecting plant species that are resilient to disturbance and can effectively regenerate the peat ecosystem.

Revegetation strategy: The study highlights the need for a new revegetation strategy incorporating the appropriate type and size of seedlings for restoration activities. The study provides insights into the selection process by identifying specific plant species suitable for revegetation, such as Combretocarpus rotundatus, Shorea balangeran, and Alstonia pneumatophora. These findings can inform future restoration projects by guiding the selection and planting of plant species most likely to succeed in restoring peat ecosystems.

Socioeconomic factors: The study recognizes the significance of socioeconomic factors in peat ecosystem restoration. By assessing the community's willingness to participate in restoration activities, the research underscores the importance of considering the attitudes and preferences of local communities. Social capital within the community is identified as contributing to the community's high willingness to engage in restoration efforts. Successful restoration initiatives should incorporate community involvement, ensuring that the local population's socioeconomic needs and aspirations are considered.

Comprehensive restoration approach: The study advocates for a comprehensive approach that integrates ecological and socioeconomic aspects to restore degraded peat ecosystems. The research emphasizes the importance of a holistic approach by combining field surveys, expert opinions, community knowledge, and attitudes. This approach recognizes the complex nature of peat ecosystem restoration and underscores the need to address ecological and socioeconomic dimensions for long-term success.

Overall, the theoretical implications of this study highlight the importance of considering ecological resilience, revegetation strategies, socioeconomic factors, and comprehensive approaches when selecting appropriate plant species for restoring peat ecosystems. These implications can inform future research and guide restoration practices to enhance the effectiveness and sustainability of peatland restoration efforts in similar contexts.

Practical implications of this study

The practical implications of the study on revamping the process of selecting appropriate plant species for restoring peat ecosystems in South Kalimantan, Indonesia, through the implementation of a new approach are as follows:

Improved selection of plant species: The study provides valuable insights into selecting plant species for peat ecosystem restoration. The identification of specific plant species suitable for revegetation, such as Combretocarpus rotundatus, Shorea balangeran, and Alstonia pneumatophora, helps guide practitioners and policymakers in selecting appropriate species that are resilient to disturbance and capable of regenerating peat ecosystems effectively. This knowledge can improve the success rate of restoration efforts by ensuring that suitable plant species are chosen. Community Engagement and Participation: The study highlights the importance of community engagement and participation in peat ecosystem restoration. The findings indicate a high willingness of the community to participate in restoration activities, attributed to the presence of social capital within the community. This insight suggests that involving local communities in the restoration process can foster a sense of ownership and ensure restoration efforts' long-term success and sustainability. Practitioners can use this knowledge to develop participatory approaches, involve local communities in decision-making, and design initiatives that align with the socioeconomic needs and aspirations of the community.

Holistic restoration approach: The study emphasizes the need for a comprehensive approach that considers ecological and socioeconomic aspects of peat ecosystem restoration. The integration of field surveys, expert opinions, community knowledge, and attitudes provides a framework for a more holistic restoration process. Practitioners can adopt this approach by incorporating ecological assessments, socioeconomic evaluations, and community consultations into restoration plans. This comprehensive approach enables a more robust and well-rounded restoration strategy that addresses the complex nature of peatland ecosystems and ensures the integration of ecological and socioeconomic considerations.

Informing policy and decision-Making: The study's findings and recommendations can inform policy and decision-making processes related to peat ecosystem restoration in South Kalimantan, Indonesia, and other similar regions. Policymakers and land managers can use insights on suitable plant species, revegetation strategies, and community engagement to develop guidelines, regulations, and strategies for effective peatland restoration. This research can contribute to evidence-based decision-making and facilitate the development of policies prioritizing peatland areas' long-term ecological health and socioeconomic well-being.

In conclusion, the practical implications of this study provide guidance for selecting plant species, revegetation strategies, community engagement, and adopting a comprehensive approach to peat ecosystem restoration. Implementing these practical implications can enhance the success and sustainability of restoration efforts, leading to the recovery and conservation of valuable peatland ecosystems.

Limitations

Geographic Scope: The study focused specifically on peat ecosystems in South Kalimantan, Indonesia, limiting the generalizability of the findings to other regions with different ecological and socioeconomic contexts. Future research should consider expanding the scope to include multiple geographic locations to capture a broader understanding of peat ecosystem restoration.

Sample Size and Representation: The study's sample size might have needed to be expanded, as it focused on only two villages within the Hulu Sungai Selatan Regency. A larger and more diverse sample size would provide a more comprehensive understanding of community attitudes, preferences, and willingness to participate in restoration activities. Additionally, involving a more comprehensive range of stakeholders, such as local governments, NGOs, and indigenous communities, would enhance the representativeness and validity of the findings.

Time frame: The study may have been conducted over a specific timeframe, which could affect the interpretation of the results. Peat ecosystem dynamics and community attitudes might change over time, emphasizing the need for long-term monitoring and evaluation to capture the temporal dynamics of restoration efforts.

Future research directions

Ecological succession and monitoring: Future research can focus on long-term ecological succession and monitoring of restored peat ecosystems. This would help assess the effectiveness of restoration efforts, identify potential challenges or bottlenecks, and develop adaptive management strategies. Long-term monitoring would provide valuable insights into the recovery trajectory and the ecological functions and services restored peatlands can provide.

Socio-economic impact assessment: Investigating the socio-economic impacts of peat ecosystem restoration would be valuable. This includes evaluating the economic benefits, such as livelihood opportunities and ecosystem services, that arise from restored peat ecosystems. Assessing the social and economic changes experienced by local communities due to restoration activities would provide insights into the broader impacts of restoration efforts beyond ecological aspects.

Community-based participatory approaches: Future research can explore the effectiveness of community-based participatory approaches in peat ecosystem restoration. This would involve integrating local knowledge and engaging communities in decision-making processes throughout the restoration journey. Understanding the social dynamics, challenges, and success factors associated with community involvement can contribute to developing more inclusive and sustainable restoration strategies.

Climate change resilience: Given the vulnerability of peat ecosystems to climate change, future research can investigate the adaptation and resilience of restored peatlands to changing climatic conditions. This would include assessing the potential of restored peat ecosystems to sequester carbon, mitigate greenhouse gas emissions, and provide climate change adaptation benefits.

Comparative studies: Conducting comparative studies across different regions or peatland types would help identify similarities, differences, and transferable lessons in peat ecosystem restoration. Comparative research can enhance our understanding of the factors influencing restoration success, the applicability of different approaches in diverse contexts, and the generalizability of findings.

By addressing these limitations and pursuing future research in these directions, the scientific understanding of peat ecosystem restoration can be advanced, leading to more effective strategies and policies for conserving and restoring these valuable ecosystems.

CONCLUSION

Adopting a novel approach for selecting species in peat revegetation activities has been recommended. The suggested choices for seedling types are C. rotundatus, S. balangeran, and A. pneumatophora, while Melicope sp. and P. azuera are the other options. The preferred seed size is approximately 80 cm. This approach is based on data from three sources: the local community, peatland experts, and plant species found at the study site. It can serve as a valuable reference for peatland revegetation efforts. Before implementing a peat ecosystem restoration program in a specific area, it is crucial to consider social factors, such as the willingness of individuals to participate in revegetation activities. The willingness to engage in peat ecosystem restoration is closely tied to the social capital within the community. Various aspects of social capital influence the willingness to participate, including the perceived value of incentives, cooperation, and coordination with village institutions or authorities. Communities with more vital social capital tend to be more active, do not require high financial compensation, exhibit loyalty, and prioritize collaboration with local institutions. The processes of selecting appropriate revegetation seed types and assessing community social capital are vital components in planning peat ecosystem recovery.

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