Exploring the social science of tropical peatland restoration: Towards more effective community empowerment initiatives for the Aceh peatland ecosystem

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SUMMARY

Peat swamp forest in Aceh Province is one of the Indonesian peatland ecosystems that is undergoing systemic degradation due to land conversion. Strong corporate domination of land conversion activities has also degraded livelihood opportunities for local communities, driving them into poverty and conditions of under-development. Despite government interventions aiming to improve both ecosystem and social sustainability that have included initiatives in community empowerment, the peatland has continued to suffer degradation. This raises concerns about the effectiveness of social aspects of the interventions. Our study analysed correlations amongst indicators of community empowerment on the one hand, and environmental, economic and social sustainability on the other, with a view to devising an improved approach for future sustainable development initiatives. Quantitative interview methods were used to survey 112 local residents, then qualitative and Structural Equation Model (SEM) analyses based on Likert scoring were employed to interpret the data. The results show that the social factor is the main reason for low empowerment of the community. In order to build capacity for independent and sustainable utilisation of the peatland, a new social-based learning approach to community empowerment is proposed.

KEY WORDS: farming community, Likert score, SEM, social learning, sustainable development

INTRODUCTION

Indonesia has the second largest peatland area (22.5 million hectares) of any country in the world, after Brazil which has 31.1 million hectares (Gumbricht *et al.* 2017). In Indonesia, peatland covers about 7.8 % of the total land area and is essential for agriculture including the production of economically important crops and commodities such as rice (paddy cultivation), oil palm, timber and biomass for (paper) pulp (The World Bank and BPS 2019). Peatland also provides a wide range of ecological, climate and socio-economic benefits that are vital for the wellbeing of people (Finlayson *et al.* 2018, Hergoualc'h *et al.* 2018). Thus, the activities of human communities living on and utilising the peatland constitute one of the most important influences on environmental and ecosystem sustainability.

Aceh is one of the Indonesian provinces that has a significant area (338,164 hectares) of peat swamp forest, which represents 3.52 % of the country's total peatland area. The Aceh peat swamp forest lies along the coastline (Figure 1) and includes the well-known Tripa, Kluet and Singkil peatlands. Part (159,651 hectares) of it is designated as conservation area and the remainder (178,513 hectares) as cultivation area (KLHK 2017).

Since the devastating tsunami of 2004, this ecosystem has been undergoing significant degradation primarily due to changes in land use. The Tripa peatland in particular (Tata *et al.* 2014) has suffered from systemic ecosystem degradation. This can be linked to high market demand for palm oil which has promoted further increases in productivity requirements and production commitments, encouraging the involvement of corporate stakeholders (Pacheco *et al.* 2017). The majority of the degradation occurred due to land clearance by burning which caused uncontrolled fires. Some companies have been charged and convicted by the courts for illegal activities in the peatland area, especially within the Tripa peatland and with regard to the cultivation of oil palm (Linkie *et al.* 2016).

Such uncontrolled exploitation of natural resources that ignores ecological limits - even if allowed within the political, administrative and legal framework - renders local people vulnerable to disruption of the socio-economic systems that support their livelihoods (Barr *et al.* 2006, Rahayu *et*

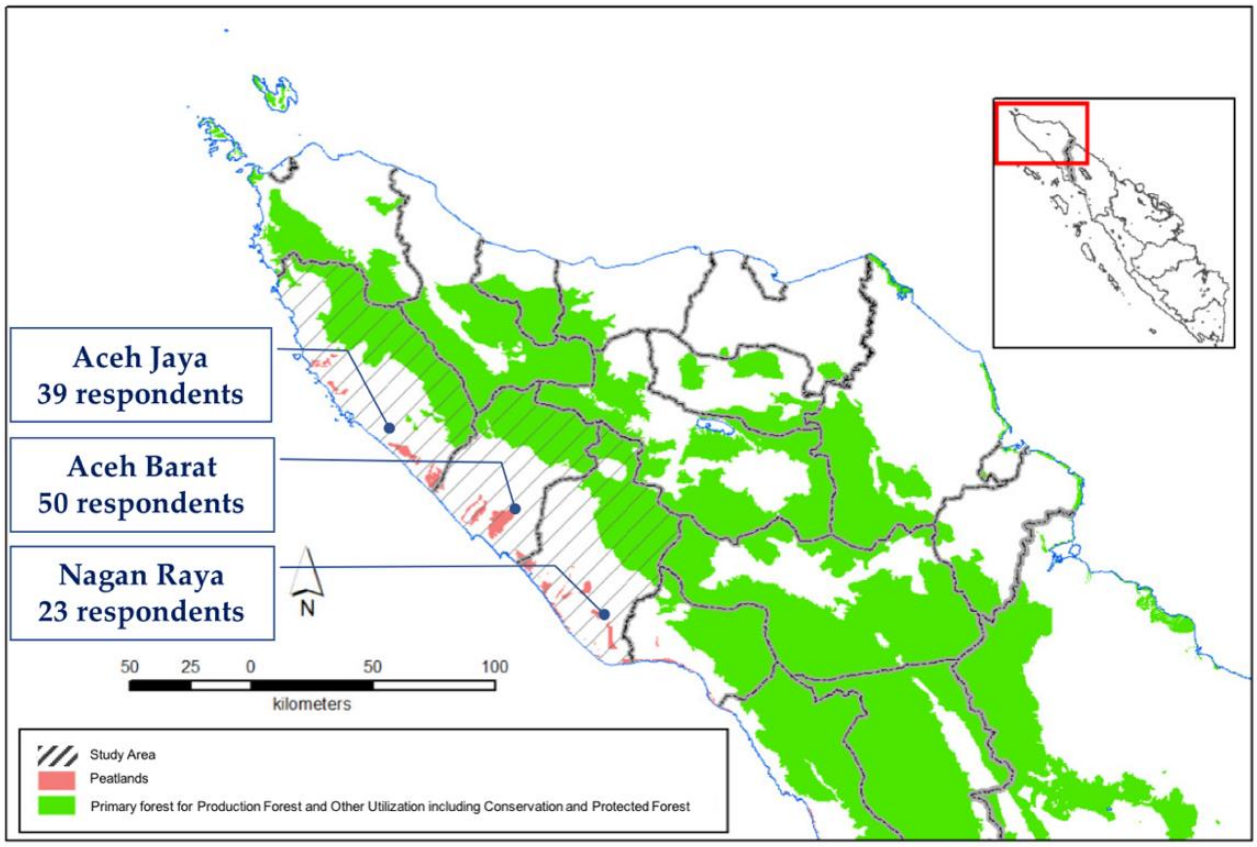

Figure 1. Map showing the location and extent of the study area, which covers three districts in Aceh Province, Indonesia.

al. 2010, Tata *et al.* 2014, Adriani *et al.* 2018). Indeed, because of their weak position in relation to land control and rights, it may drive them into conditions of poverty and under-development in which they are forced to cause further environmental damage in order to live (Rahayu *et al.* 2010).

To address these (amongst other well-known associated) problems, a restoration and sustainable development initiative focusing on the peat swamp ecosystem area was conducted by the government's Ministry of Environment and Forestry (KLHK) through the Community Self-reliance Program for the Restoration of Indonesia Peat Ecosystem (KLHK 2018). This initiative aimed to develop the institutional organisation of the community, with a view to increasing the participation of local people in preventing damage to the peat swamp forest ecosystem, especially by fire, as well as to increase their involvement in developing participatory peatland monitoring plans. The programme targeted both conservation and cultivation areas within the peat swamp forest ecosystem; and incorporated the establishment of legal frameworks for peatland protection and management, the rehabilitation of degraded ecosystems, and the development of alternative economic and livelihood support for local people.

Despite these efforts, the intended process of ecosystem rehabilitation and structural transformation did not progress as intended. Instead, the process of ecosystem degradation continues, with local people continuing to take land into cultivation within the area designated for peat conservation, and private companies still seeking to acquire peatland for industrial cultivation.

Previously published studies on development initiatives to support peatland restoration and the dependent human communities have focused on aspects such as the technical engineering of physical constructions and the economic development of forest (Lucchese *et al.* 2010, Parry *et al.* 2014, Schimelpfenig *et al.* 2014, Pullens *et al.* 2016, Kern *et al.* 2017, Wijedasa *et al.* 2017). Although such activities can lay a foundation for peatland restoration, the most urgent issue for local people is whether the intervention will disrupt their established sources of livelihood. Therefore, peatland restoration initiatives commonly include some attention to enabling those affected to adopt adjusted or alternative sources of livelihood support that are

compatible with the restoration (Irawati *et al.* 2021). This 'community empowerment' type of approach has potential to provide a foundation for equitably positive change but in practice often fails to effectively address the poverty problem because it is presented in a 'top-down' manner that tends to place participants in subordinate positions and thus to limit the level at which they may contribute (Ceruti 2016, Isager & Ivarsson 2002). For example, the assistance may be provided in the form of cash or consumables whose benefits do not long outlast the time-span of the intervention.

In this study we conducted a perceptual analysis to clarify the root cause for ineffectiveness of the restoration initiative targeted at the peat swamp forest ecosystem along the Aceh coastline. We qualitatively explored the perceptions of local people about peatland degradation and its causes, and employed a structural equation model (SEM) as a framework for assembling and quantitatively analysing their views about the sustainability of their environment and livelihoods, along with their opportunity and motivation (empowerment) to participate in peatland restoration. On this basis we aimed to identify ways in which the effectiveness of peatland restoration programmes could be improved through innovative approaches to encouraging local community involvement.

METHODS

Model and questionnaire

Structural Equation Modelling (SEM) is a powerful multivariate statistical technique that is used to test and evaluate direct and indirect effects on pre-assumed causal relationships (Fan *et al.* 2016). The core of our model was the concept of 'community empowerment' to participate in local peatland restoration. We hypothesised that the level of community empowerment within the study area depends upon the degree to which all members of the community understand and ascribe to the principles of 'three-pillar' (environmental, economic and social) sustainability (Purvis *et al.* 2019) in this context.

The model was built using Statistical Package for Social Science (SPSS) Version 16 developed by IBM (Byrne 2010, Fan *et al.* 2016). Community empowerment is closely related to environmental (Fraser *et al.* 2006), economic (Muljono *et al.* 2019) and social (Ansari *et al.* 2012) factors. Therefore, in this study, the SEM was designed to connect and analyse these variables. The survey questions (instruments based on the indicator variables) were composed to gauge the opinions of respondents in relation to four variables, namely Empowerment level (Y), the Environmental factor (X1), the Economic factor (X2) and the Social factor (X3) on the basis of five measurable indicators per variable (Table 1).

These survey questions were incorporated into a questionnaire comprising five sections covering (I) personal information, (II) socio-demographic characteristics, (III) community perceptions about peatland condition and the need for remediation, (IV) community empowerment and (V) the sustainability factors (see Appendix). Responses for all of the variables and indicators in Sections III–V were specified for scoring on a 5-point Likert scale (strongly disagree (1) to strongly agree (5) (Likert 1932), meaning that the data to be collected for input to the model were entirely quantitative.

Location, sampling and data collection

The study was conducted within the peat swamp area along the west coast of Aceh Province which is included in the peat ecosystem as stated in the Indonesian Government regulation (KLHK 2017). Respondents were selected from six villages in the

Table 1. Variables and indicators of the SEM. All variables and indicators were measured quantitatively on a 5-point Likert scale.

Variables	Indicators
Y. Empowerment level	Y1. Resource management Y2. Environmental condition Y3. Production system Y4. Community engagement Y5. Problem solving
X1. Environmental factor	X11. Restoration capacity X12. Land control X13. Land clearing X14. Biodiversity X15. Ecosystem
X2. Economic factor	X21. Livelihood capacity X22. Productivity X23. Land assets X24. Economic value X25. Income generation
X3. Social factor	X31. Local institution X32. Participation X33. Networking X34. Mutual work X35. Social norms

three districts Aceh Jaya, Aceh Barat and Nagan Raya. These locations were selected because in 2018–2020 they were subjects of the government's community self-reliance programme for the restoration of Indonesian peat ecosystems. The total population of the six targeted six villages is 4454 people (550 households).

A quota sampling technique was adopted amongst three categories of local residents, namely: inhabitants, community leaders, and other informal leaders who live and make a living within the peatland ecosystem area. This resulted in the selection of 39 respondents in Teunom (Aceh Jaya) district, 50 respondents in Kawai XVI (Aceh Barat) district and 23 respondents in Tadu Raya (Nagan Raya) district (total 112 respondents). The respondents came from six villages, two in each district, which have a part of their territory included in the peat ecosystem area. Demographic data for the respondents are summarised in Table 2. Most (106) of them described their regular job as 'farmer' and 18 had an additional part-time job.

Data were acquired by survey and interview of the 112 respondents, using the questionnaire. The survey was conducted during October and November 2019. Each respondent was interviewed individually by a trained interviewer. Before the interview, the respondent was briefed with a general introduction about peatland ecosystems, utilisation, and conservation.

Table 2. Demographic data of respondents.

Variable	Category	Frequency
Age	20–29	2
	30–39	21
	40–49	45
	50–59	26
	60–69	10
	70–79	8
Education	No school	8
	Primary school	38
	Secondary school	32
	High school	32
	College/University	2
Regular job	Farmer	106
	Non-farmer	6
Side job	Unskilled labour	3
	Freelance tutor	2
	Small home business	3
	Gardening	2
	Farm worker	2
	Village apparatus	4
	Local leader	2
	None	94
Land holding (hectares)	<1	17
	1–2	38
	2–3	57
Crop(s) cultivated	Rubber	20
	Oil palm	38
	Corn	22
	Palm and rubber	4
	Other	4
Average monthly income (USD)	< 100	22
	100–500	90

Data analysis

The quantitative responses were weighted and scaled (indexed) by expressing the Likert score (range 1–5) as a fraction of the maximum score (i.e. index value range 0.2 to 1.0).

To understand the construction and structure of community empowerment level, we used a descriptive analysis method to build an understanding of the community's perception of peatland degradation, the needs for its restoration and their willingness to participate. Previously, it has been found that cultural background and experience are factors that influence perception (Wu & Kurylo 2010). In this study, a process to measure the community perception was conducted using information from the knowledge, life experience, recognition, and response to the surrounding environmental conditions of the respondents (Section III of the questionnaire). The indexed Likert scores were subjected to a forced choice procedure for exploring community perceptions by plotting the response indices for pairs of perceptions in a coordinate plane divided into four quadrants (see Figure 2 later). In this plane, the vertical and horizontal variable axis values range from 0.2 to 1.0, indicating standardised (indexed) responses obtained by dividing the Likert score by the maximum score of 5. When the data have been inserted, a trendline is generated. A trendline with positive slope indicates a shift from lower to higher values of perception, and vice versa.

The remaining quantitative data were loaded into the SEM. The convergent validity test was carried out to test whether the indicator variables used were really significant in terms of reflecting the construct and/or latent variables. The validity level of the surveyed variables was determined by calculating Composite Reliability (*CR*) and Average Variance Extracted (*AVE*) using the following equations:

$$CR = \frac{(\sum_{i=1}^{n} \lambda_i)^2}{(\sum_{i=1}^{n} \lambda_i)^2 + (\sum_{i=1}^{n} \delta_i)} \quad [1]$$

$$AVE = \frac{\sum_{i}^{n} \lambda_i^2}{n} \quad [2]$$

where λ is the standardised factor loading, δ is the error variance term, and *i* is the number of items. The values of λ and δ were obtained from the output of the software, and the values of *CR* and *AVE* they generated were checked to conform reliability. Good reliability is indicated by *CR* > 0.7 and AVE > 0.4 (Fornell & Larker 1981). The SEM was then used to test the hierarchical relationship amongst the empowerment level, environmental, economic and social factor variables.

RESULTS

Local community perception of empowerment level

According to the respondents, there have been several government programmes focusing on peatland ecosystem rehabilitation and involving some attention to community empowerment. Most of these have referred to the management of peatland for the mutual benefit of human livelihoods and the natural surroundings. They have generally involved strengthening of legal instruments, peatland restoration, moratorium, and the development of regional spatial plans (Austin *et al*. 2014, BRG 2016, Linkie *et al*. 2016). The most recent approach attempted to alter social behaviour in the context of peatland conservation through rewetting, revegetation and revitalisation programmes (Giesen & Sari 2018).

However, there was still reluctance amongst the local community to participate in such programmes, reflected by the small uptake recorded in our survey. Of the 112 respondents, only 34 (30 %) had taken part in rewetting programmes, 56 % had not taken part, and 14 % did not respond to the question. Explanations given by respondents who did not participate were that they: a) did not see any direct benefit from the programmes; b) considered that the ownership of land used in the programmes was in conflict; c) lacked support from informal leaders; and d) lived too far from the locations of programmes.

An underlying circumstance that emerged was that some of the local people, who considered the degradation of peatland was caused by corporations taking the benefits from the converted land, had responded by undertaking land conversion themselves through illegal logging and clearing the land for plantation using pragmatic methods such as burning. This is illustrated by the perception analysis results shown in Figure 2a, in which the indexed responses to Instruments 15 and 20 from the questionnaire are compared. Here, the data label indicates the frequency of the responses. The trendline passes almost exactly through the centre of the coordinate plane and so is confined to Quadrants III and I, indicating that regardless of the perceived degree of illegal logging it is attributed quite evenly between corporate and community agents.

Nevertheless, there is still awareness within the community that the peatland ecosystem should be restored. Figure 2b compares responses to Instruments 21 and 22 of the survey. In this case the regression line is almost horizontal and confined to Quadrants II and I. Thus, the perception is that peatland restoration is necessary, whether or not members of the community would be able or willing to implement it voluntarily. Moreover, the plotted points are clustered towards Quadrant I with few in Quadrant III, providing evidence that the majority of people both recognise the need for re-conversion and are willing to participate. Even some respondents who do not consider the need to be pressing would contribute (Quadrant IV). This means that, despite the hesitation evidenced by low uptake to date, the people still express motivation and willingness to participate in peatland restoration activities.

Correlations amongst SEM variables and indicators

Table 3 shows that the *CR* values of all three variables are significantly high (> 0.8) while the *AVE* values are all ~ 0.5. This encapsulates the community's perception of the relationship between the Y variable 'empowerment level' (as measured using its five indicators) and the three X variables (environmental, economic and social factors). Each construct shows a good composite reliability (*CR*), achieving a value of 0.7 or above (Raykov 1997); and convergent validity is evident, with all average variance extracted (*AVE*) values > 0.4 (Fornell & Larcker 1981). Loading factors for all indicators are significant at $\rho < 0.001$ (Anderson & Gerbing 1988), and the measurement model (Figure 3) fits the data well with $\chi^2 = 506.035$, df = 164, root mean square error approximation (RMSEA) = 0.00, comparative match index (CFI) = 0.778, and non-normed match index (NNFI) = 0.707.

Table 4 shows the index values (based on Likert scores) relating the empowerment level to its five indicators. It shows that the index values relating empowerment level to its five indicators are high, at 0.86 (resource management), 0.91 (environmental

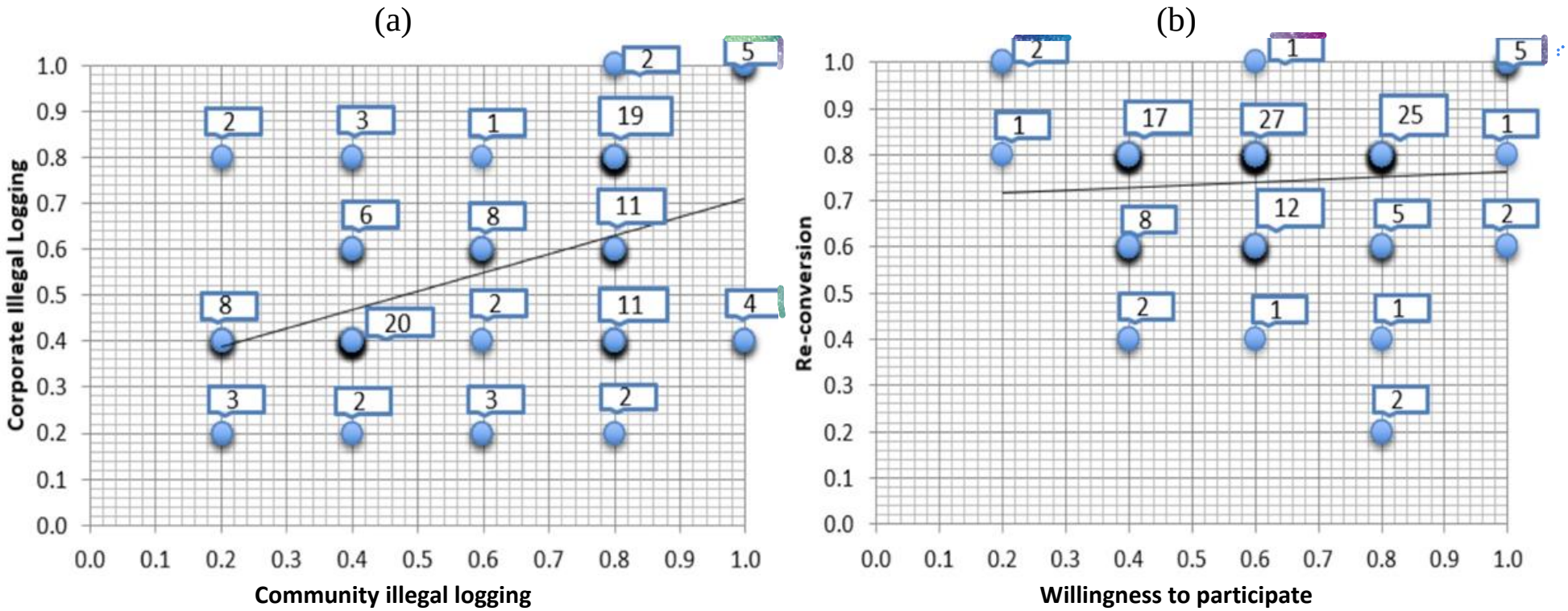

Figure 2. Example results of the perception analysis, exploring local community perceptions of (a) responsibility for illegal logging and (b) the need for peatland restoration and willingness of local people to participate. Data labels show the frequency of responses per data point. The vertical and horizontal axis values range from 0.2 to 1.0, indicating standardised (indexed) responses (= Likert score ÷ maximum score). For example, a value of 0.2 indicates the response of 1 (Likert score) divided by the maximum score of 5, i.e. 1/5 = 0.2, and so on. The inset (right) shows how the co-ordinate plane is divided for the forced choice procedure. Positive trendline (Fig 2.a and b) indicates a shift from lower value of perception to a higher value of perception.

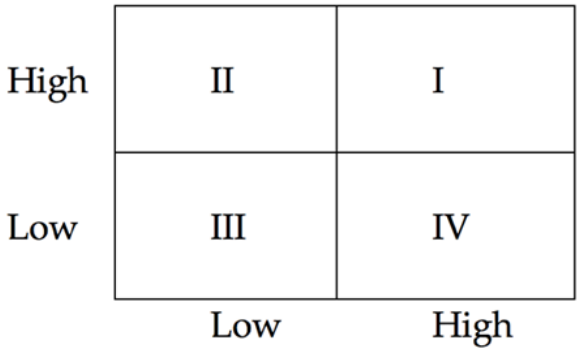

Table 3. Convergent validity of measured variables in terms of Composite Reliability (*CR*) and Average Variance Extracted (*AVE*).

Variables	*CR*	*AVE*
Environmental Factor (EL)	0.875	0.464
Economic Factor (EE)	0.864	0.463
Social Factor (ES)	0.908	0.547

management), 0.88 (production system), 1.00 (community engagement) and 0.85 (problem solving). The index values correlating environmental and economic factors with the five indicators of empowerment level are lower, ranging from 0.38 to 0.59. These results reflect the physical condition of the studied peatland ecosystem, which is heavily damaged due to flooding and fires caused by uncontrolled exploitation. The damaged land and ecosystem have a disruptive effect on both the

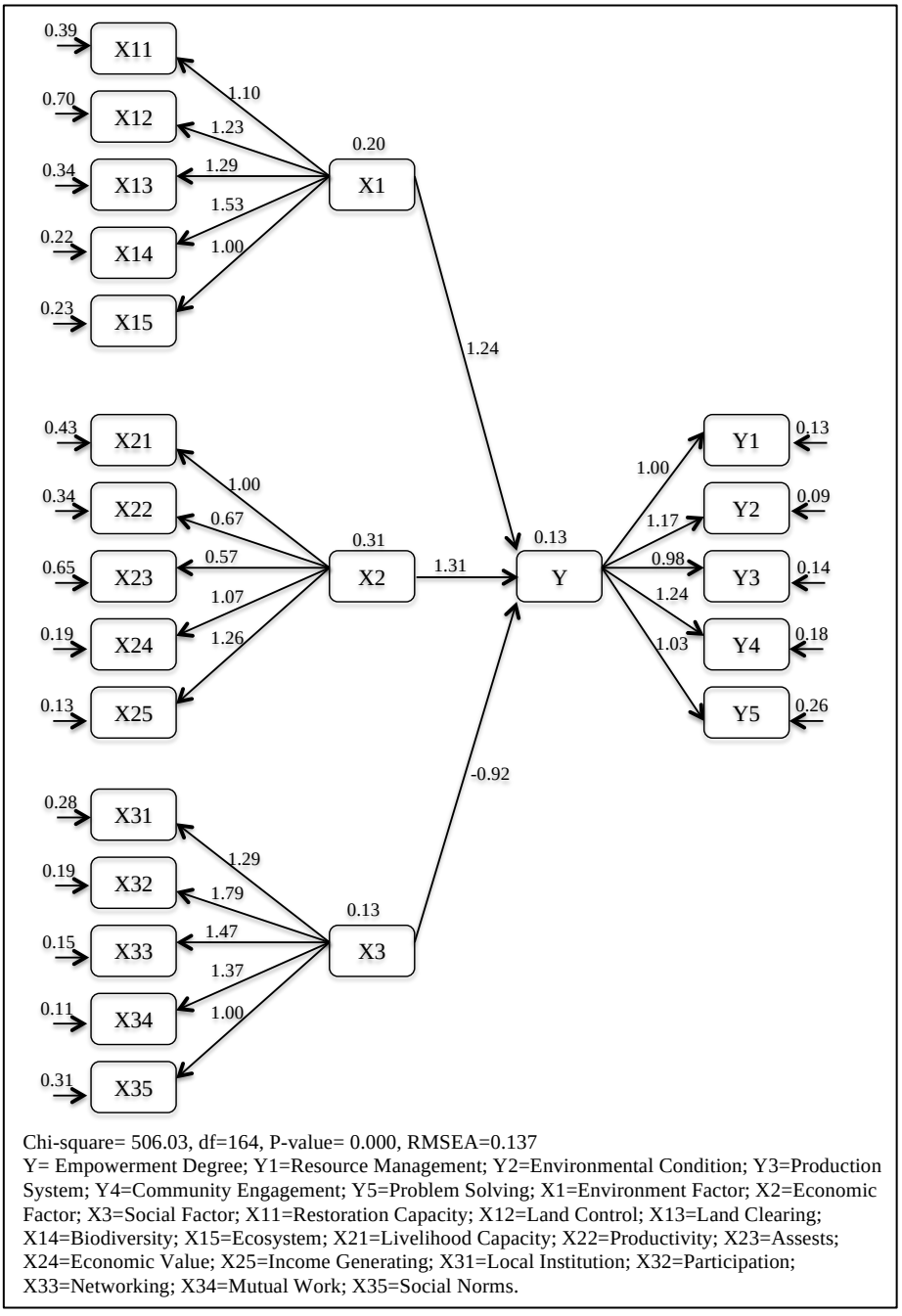

Figure 3. Structural equation model (SEM) constructed to quantify the relationships between the factors (X1–3) contributing to the empowerment level (Y) of the local community. Numbers alongside the arrows are the factor loadings, which indicate the correlation between factors (variables).

environment and the economic system, which affects the livelihoods of local people (apparent from the low economic capability of human communities in the studied peatland). The weakest relationships that emerged in this analysis were for the social factor, with index values of 0.33 (resource management), 0.39 (environmental management), 0.25 (production system), 0.28 (community engagement) and 0.21 (problem solving).

Factors contributing to the level of community empowerment

Figure 3 also shows the structure of the SEM and the result of the analysis. The contributions of the environmental (X1) and economic (X2) variables to the level of community empowerment (Y) are positive, with correlation values of 1.24 and 1.31, respectively. A positive correlation indicates that a variable has promoted empowerment of the community. Thus, we may surmise that local people believe the environment has provided resources to support their lives and livelihoods, and the programmes for community empowerment carried out by external agents have made some contribution to increasing their economic capacity (cf. Question 40 of the questionnaire).

The highest of the correlations between the environmental variable (X1) and its indicators is 1.53 (X14: biodiversity), indicating that biodiversity persists in the three peatland areas despite ecosystem damage due to the poorly controlled exploitation; whereas the lowest correlation of 1.00 (X15: ecosystem) reflects the damaged condition of the ecosystem.

With regard to the economic variable (X2), the highest indicator correlation is 1.26 (X25: income generation), whereas the lowest is 0.54 (X23: land assets). This suggests that the empowerment initiatives carried out by external agents have provided the community with assistance in the form of physical or cash-oriented benefits. At the same time, the community commonly remained the weaker party in land ownership conflicts with corporate stakeholders, and the productivity of community-owned land assets was relatively low. All of this adds up to land assets making a low contribution to the economic variable.

The social variable (X3) is negatively correlated with empowerment level (correlation value -0.92), and the correlation values for the five indicators are 1.29 (local institution), 1.79 (participation), 1.47 (networking), 1.37 (mutual work) and 1.00 (social norms). Because of the negative correlation with empowerment level, the contributions of the five indicators should be interpreted in a converse perspective. Thus, the high value for participation (X32) indicates very weak participation of the local community in previous empowerment programmes, which was confirmed by respondents' answers to Question 26 (Section III) of the questionnaire. The networking (X33) and mutual work (X34) indicators provide significant contributions to the social variable, reflecting weak networking capacity and thus weak cooperation amongst the local community.

DISCUSSION

In this research a descriptive analysis method was used to explore the construction and the structure of community empowerment level, and this was followed by a structural equation model (SEM) analysis to measure the structural relationships among the contributing factors. Similar combinations of descriptive and quantitative techniques have been used in several recent studies concerning community development capacity, empowerment and sustainable development in peatland management (Kencana & Manutami 2017, Mujiono 2017, Herawati *et al.* 2019, Zulkarnaini & Sadad 2019).

Table 4. Likert index values showing the relationships between the four variables (Y and X1–3) and the indicators of Empowerment Level (Y1–5). The values presented are indexed Likert scores (value 0–1, as in Figure 2 and Table 3); i.e., the minimum value is 0.2 and the maximum value is 1.

	Y1 Resource management	Y2 Environmental management	Y3 Production system	Y4 Community engagement	Y5 Problem solving
Y: Empowerment level	0.86	0.91	0.88	1.00	0.85
X1: Environmental factor	0.52	0.59	0.43	0.55	0.38
X2: Economic factor	0.54	0.53	0.42	0.52	0.43
X3: Social factor	0.33	0.39	0.25	0.28	0.21

In our analysis, the small contribution value (0.13) of the social factor (X3) in Figure 3 is incongruous with the rest of the SEM and indicates a disproportionately weak relationship between X3 and its five indicators. This observation can be linked to the massive structural changes towards centralisation of the administrative, social, and political framework of Indonesia that have occurred during the last three decades (Zikri 2017). These changes have weakened the traditional roles and functions of both the local institutions that were formerly responsible for management of natural resources (the local customaries) and the intercommunity organisations. The new political power relationship with the state has placed legal force behind the pursuit of economic growth that ignores the informal local customary law. Thus, when faced with external forces such as large farming corporations equipped with legal rights to move into the peatland area granted by central government, the local community has lacked power to refuse the excessive exploitation proposed. As a result, land ownership and access to livelihood assets by local people were eventually impaired, so that grassroots community engagement in matters such as decision making and agricultural production became neglected as the main foundation of development. In addition some social norms, such as a mutual sense of belonging within the local community, were abandoned. Thus, the traditional system of community cooperation in natural resource management has been substantially weakened as a result of strong interventions by wealthy outside institutions, e.g. industrial palm oil producers. Such circumstances can foster both passive and materialistic attitudes to development activities (Daly *et al*. 2012, Zikri 2017), the latter illustrated by the decision of some local people in the peatland areas to indulge in uncontrolled exploitation of the peatland themselves. Therefore, in the next wave of interventions, it is most important to provide a space for participation by local people in every effort to increase the level of community empowerment to manage and preserve the peatland (He *et al.* 2020). The second priority should be law enforcement.

From our results the social factor emerges as the focal entry point for the empowerment process. During the past several decades, community empowerment programmes conducted in the peatland area have adopted a top-down 'social engineering' approach (Giesen & Sari 2018, Ruysschaert & Hufty 2018). Such approaches are often included amongst the interventions of development programmes (Friedmann 1989) influenced by the positivism tradition. However, due to their strong domination by external actors or agents, previous interventions have created a dependence of local people on external assistance. It seems that little attention was paid to developing social capacity within the community, who consequently became passive in taking practical benefits from government and NGO (non-government organisation) empowerment programmes whilst feeling no need to actively participate.

We suggest that a shift of focus, towards changing attitudes and behaviours so as to foster a greater sense of inclusion and ownership amongst local people, could empower this community to participate more actively in the conservation and sustainable utilisation of the peatland. Thus, future empowerment initiatives for the peatland should focus on encouraging the restoration of social capacity and resilience as reflected by activities such as participation, networking, cooperation, local institutions, rules of action, social norms, and norms and values of life. The final goal is to restore the community's capacity to function independently in managing its natural resources in a sustainable way.

Based on our findings (Table 2), one of the most important community objectives for the future of the Aceh peatland ecosystem is to maintain its rich biodiversity by restoring the balance of the ecosystem. Effort in this direction needs to be supported by strong capacity and human capital amongst local people, because human capital is one of the most important factors in determining the sustainability of ecosystems (Kim & Go 2020). In other words, the community needs first to have capacity to explore the available variety of opportunities for restoration-compatible means of livelihood support.

To improve the economic situation, effort will be needed to create income-generating programmes and added-value enterprises based on local potential and resources (Curtis & Lehner 2019). One obvious opportunity is to develop added-value local forest products and farming of freshwater fishes with high economic value. However, to ensure that changes in such a direction through 'empowerment' would be lasting (i.e. sustainable), the initiative must be designed to provide enough room for optimal participation of the local community.

What is needed is a process of social learning in which the desire to participate comes from within the community itself and people learn from one another through observation, imitation and modelling (Bandura & Walters 1963, Bandura 1978, Blum 2020). It is, essentially, a 'bottom-up' process of empowerment centred on the idea of valuing local knowledge, values, beliefs, skills, processes and

resources within the community. For example, in the context of the three peatland areas in this study, the community might learn from sustainability-aware local innovators who farm high-value annual crops that are native to the area without felling trees or burning the land. Human behaviour in social learning is explained in terms of ongoing reciprocal interactions among cognitive, behavioural and environmental influences. The approach achieves an improved involvement of people, which increases creativity and local initiatives towards sustainable peatland management (Manaf *et al.* 2018).

A proposed social learning scheme for the peatland ecosystem area is outlined in Figure 4. In this scheme, the first step is to discover the existing social condition of the peatland area. The local community is the main actor, but the facilitating roles of change agents - government, private sector, NGOs or universities - are still required, especially in the initial stages. Two strategies are employed, involving (1) a learning process in peatland management and conservation through modelling, imitation, conditioning and learning outcomes, and (2) a cluster community model for management of the programme which should improve productivity and efficiency, increase scale and economic value, stimulate and promote adaptive technological innovation, and facilitate product commercialisation. The cluster community model is a cluster of learners consisting of local people and their social institution leaders, which can be chosen amongst the villages where the willingness of people to participate is highest.

The learning process starts with improving collective awareness (and thus capacity) amongst local people with regard to the utilisation of local resources (Bandura 1978). The internal process of learning by modelling, imitation, conditioning and learning outcomes should be approached by strengthening the local institutions *pawang uteun* (local forest leader) and *peutua seunebok* (elders who regulate the local forest utilisation) and the community groups, in order to follow established values and social norms of cooperation and participation. In the social learning process, it is necessary to involve the community leaders, partner institutions and facilitators as the models and main actors of empowerment. For an optimum result, a cluster approach is necessary. Using the cluster, it is easier to facilitate introduction of the learning model, preservation of local wisdom and regional

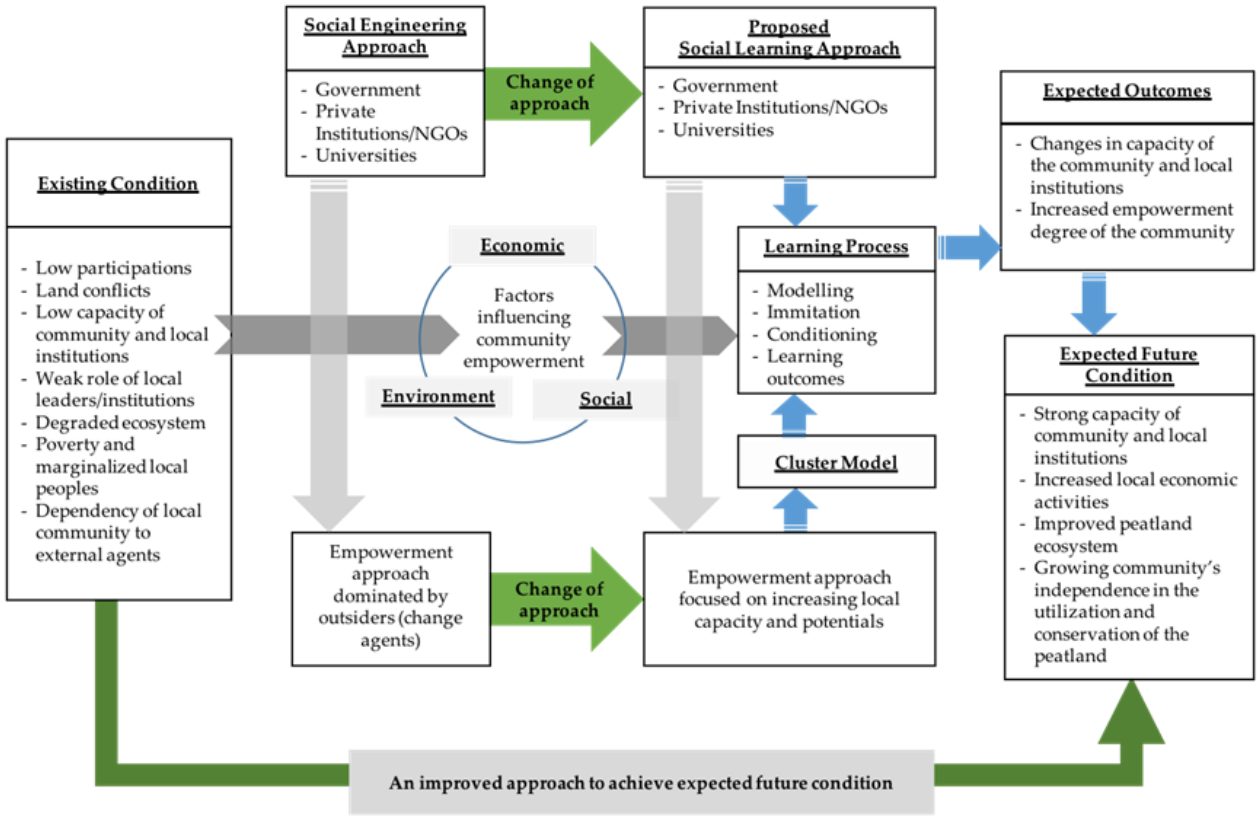

Figure 4. Proposed mechanism for more effective empowerment of the local community to carry out peatland restoration in the Aceh peat swamp ecosystem.

development. It is expected that this scenario will promote synergy between the economic, social, and environmental aspects of community empowerment and improve the capacities of both the community and local institutions.

The expected outcomes of the social learning process are strengthened community capacity and local institutions, increased local economic activities, improved condition of peatland areas, and growing community independence in the management and conservation of peatland areas and their biodiversity value. Through a social learning approach, the community should eventually become enabled to manage and conserve the peatlands in an economically profitable way while avoiding social conflicts and damage to the peatland environment.

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AUTHOR CONTRIBUTIONS

Funding acquisition was done by AA, who supervised the project and contributed to conceptualisation of the initial proposal. IZ and RR performed the analysis and wrote the first draft. AB performed data curation. AHH, IZ and MT conducted the final review and editing of the manuscript.

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Appendix

Questionnaire Survey: Community Empowerment and Sustainable Development of Peatland in Aceh

I. PERSONAL INFORMATION

1	Respondent ID:	……..	
2	Name (optional):	……..	
3	Gender:	1. Male 2. Female	☐
4	Age:	…….y.o.	
5	Village/Sub-District/District:	……. / …….. / ……..	
6	Role in community	1. Formal leader 2. Informal leader 3. Community member 4. Other: ……..	☐

II. SOCIO-DEMOGRAPHIC CHARACTERISTICS

6	Educational attainment:	1. No school 2. Primary school 3. Secondary school 4. High school 5. College/University	☐
7	Regular job:	……..	
8	Side job (if any):	……..	
9	Monthly family income (USD):	1. Less than 100 2. 100–500 3. More than 500	☐
10	Monthly family expenditure (USD)	1. Less than 100 2. 100–500 3. More than 500	☐
11	Land possession:	1. Less than 1 hectare 2. 1–2 hectares 3. 2–3 hectares 4. More than 3 hectares	☐
12	Method used for land opening and clearing:	1. Cut down 2. Burning 3. Cut down and burn 4. Other: …… Why?: …….	☐
13	Commodity cultivated:	……..	
14	Length of tenure of peatlands for production (years):	……..	

III. COMMUNITY PERCEPTIONS

The following statements contain the community's perception of the condition of the peat hydrological area, measured using a scale of 1–5: **(1) strongly disagree; (2) disagree; (3) Neither agree nor disagree; (4) Agree; (5) Strongly agree**

15	The exploitation and use of peatland by the community has been rampant through illegal logging of forest areas for livelihood activities.	1 2 3 4 5	☐
16	Recently, many people have been actively involved in exploiting peatlands for production following other community members.	1 2 3 4 5	☐
17	People have joined in using peatlands for production activities because many corporations have exploited the area.	1 2 3 4 5	☐
18	Corporations can exploit peatlands and cut forests for production activities.	1 2 3 4 5	☐
19	Recently, there has been the use of peatlands in this area for production activities by corporations.	1 2 3 4 5	☐
20	In carrying out exploration and production, the corporation has carried out illegal logging activities that have damaged the peat hydrological area.	1 2 3 4 5	☐
21	It is necessary to carry out conservation activities and re-conversion of peatlands to protect the area's ecosystem.	1 2 3 4 5	☐
22	The community is voluntarily willing to be directly involved in conservation activities and the conversion of peatlands.	1 2 3 4 5	☐

23. In your opinion, which party is most responsible for the destruction of the peat ecosystem in this area?

24. In your opinion, who is most responsible for improving the peatland ecosystem area?

25. In your opinion, what is the most important thing to do for the sustainability of the peatland ecosystem?

26. What efforts have you made so far for the sustainability of the peatland ecosystem?

IV. COMMUNITY EMPOWERMENT

The following statements contain the community empowerment indicators in managing hydrological peat area, measured using a scale of 1–5: **(1) strongly disagree; (2) disagree; (3) Neither agree nor disagree; (4) Agree; (5) Strongly agree**

27	Communities are capable in planning, employing, and managing environmental resources and peatlands for optimal production activities.	1 2 3 4 5	☐
28	The community can maintain and manage natural resources and the peat environment optimally.	1 2 3 4 5	☐
29	The community can carry out the input, process, and output functions required in the peat area for optimal production activities.	1 2 3 4 5	☐
30	Communities can work collaboratively and participate with and through groups in mobilising and developing peatland resources for their capacity and livelihood sustainability.	1 2 3 4 5	☐
31	Communities can identify, analyse and solve problems; and collectively find alternative solutions in managing peat areas.	1 2 3 4 5	☐

V. SUSTAINABILITY FACTORS

A. Environmental Factors (X1)

32	The ecological capacity of the peat area is still capable of repair and restoration to protect the ecosystem and its sustainability.	1 2 3 4 5	☐
33	The condition of the peatlands in this area is preserved and can be controlled for land fertility and viable production.	1 2 3 4 5	☐
34	Peatland operation and exploitation activities can be carried out by clearing land wisely without uncontrolled cutting and burning.	1 2 3 4 5	☐
35	The biodiversity condition of the peatlands in this area is still maintained in a balance between community livelihoods and the ecosystem.	1 2 3 4 5	☐
36	Peatlands can be managed and exploited while maintaining the balance of the cycle of the life chain and the ecosystem therein.	1 2 3 4 5	☐

B. Economic Factors

37	Peatlands provide economic benefits for sustainable livelihoods and community production activities.	1 2 3 4 5	☐
38	Peatlands can increase the productivity of production businesses and the local economy.	1 2 3 4 5	☐
39	Peatlands are an important asset for the livelihoods of local communities and need to be managed wisely to sustain community economic activities.	1 2 3 4 5	☐
40	There is an added value to the local economy that is felt as a result of optimising environmental preservation.	1 2 3 4 5	☐
41	Peat areas and their natural resources are assets and production factors that support the sustainable livelihoods and income of local communities.	1 2 3 4 5	☐

C. Social Factors

42	The role of customary and local institutions to encourage sustainable management of peatland areas.	1 2 3 4 5	☐
43	Community participation that encourages sustainable management of peat areas independently and sustainably.	1 2 3 4 5	☐
44	Institutional performance and capacity of social networks in optimising integrated peat areas.	1 2 3 4 5	☐
45	Preserving the values of cooperation and collectivity in an integrated effort to maintain and improve environmental conditions.	1 2 3 4 5	☐
46	Strengthening local values and wisdom in designing and governing the community and managing peatland areas.	1 2 3 4 5	☐

47. How has the performance of peatland conservation been carried out by the community or other institutions so far?

48. How is the capacity of local community development in increasing efforts to conserve peat areas?

49. What strategies and steps should be taken to improve community empowerment in the sustainable management of peatland areas?

50. What are your suggestions for conservation and community empowerment in peat areas?