



Perceived Forest-based Ecosystem Services and Attitudes Toward Forest Rehabilitation: A Case Study in the Upstream of Central Java, Indonesia

Jasa Ekosistem Berbasis Hutan yang Diterima dan Sikap terhadap Rehabilitasi Hutan: Studi Kasus di Hulu Daerah Aliran Sungai di Jawa Tengah, Indonesia

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ABSTRACT

Forest rehabilitation is essential in restoring forest-based ecosystem services (ES) provided by forest area. However, the critical issue on how locals perceived importance of forest rehabilitation, and how forest rehabilitation generates, both direct and indirect, benefits for the adjacent communities has remained contentious. A questionnaire survey was employed to examine locals' perceived importance, perceived ES, and attitudes toward forest rehabilitation in a village adjacent to Perhutani's forest area in the upstream of a catchment in Central Java, Indonesia. In total, 90 usable questionnaires were collected. The findings indicate that their perceived pine-sap production, conserving forest area, and water availability are the importance of forest rehabilitation programs. Locals recognized various ES benefits, including provisioning, regulating, supporting, and cultural services, though the adverse impacts emerged. Spearman rank correlation analysis revealed that local's satisfaction with forest rehabilitation positively and significantly correlated with their positive perceptions and subsequently increase their willingness to be actively involved in forest conservation efforts. The findings also imply that forest managers should not only focus on delivering benefits but also be aware of the adverse impacts of forest rehabilitation and management practices, which are crucial for ensuring forest sustainability.

INTISARI

Rehabilitasi hutan penting untuk memulihkan jasa ekosistem berbasis hutan yang disediakan oleh kawasan hutan. Sementara rehabilitasi hutan sangat penting dalam memulihkan jasa lingkungan, pertanyaan mengenai bagaimana penduduk setempat memandang pentingnya rehabilitasi hutan, dan bagaimana rehabilitasi hutan menghasilkan manfaat, baik langsung maupun tidak langsung, bagi masyarakat sekitar masih diperdebatkan. Kuesioner survey dilaksanakan untuk menggali persepsi masyarakat tentang tingkat kepentingan, persepsi terhadap jasa

lingkungan, dan sikap mereka terhadap rehabilitasi hutan di desa berdekatan kawasan hutan Perhutani, di hulu daerah alisan sungai, Jawa Tengah, Indonesia. Secara total, 90 kuesioner yang lengkap berhasil dikumpulkan. Temuan menunjukkan bahwa persepsi masyarakat terhadap pentingnya rehabilitasi hutan yaitu untuk produksi getah pinus, melestarikan kawasan hutan, dan ketersediaan air. Masyarakat desa merasakan berbagai jasa lingkungan yang diperoleh dari kawasan hutan meliputi manfaat penyediaan, pengaturan, dukungan, budaya, meskipun dampak negatif juga teramati. Analisis korelasi Spearman menunjukkan bahwa kepuasan masyarakat terhadap rehabilitasi hutan berkorelasi positif dan signifikan terhadap persepsi positif mereka, dan selanjutnya akan meningkatkan kesediaan mereka untuk terlibat aktif dalam upaya konservasi kawasan hutan. Temuan ini juga menyiratkan bahwa pengelola hutan tidak hanya fokus memberikan manfaat, tetapi harus juga menyadari dampak buruk dari praktik rehabilitasi dan pengelolaan hutan yang muncul untuk memastikan kelestarian hutan.

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Introduction

Forests are not only playing a pivotal role in biodiversity conservation (Lelli et al. 2019) but also necessary for the livelihood of adjacent local communities especially on forests-based ecosystem services (ES) (Cruz-Garcia et al. 2017; Harbi et al. 2018; Muhamad et al. 2014). Significant ES provided by forest includes provisioning services (e.g., timber, fuelwood, and fodder), regulating services (e.g., water regulation), supporting services (e.g., erosion control, landslide prevention), and cultural services (e.g., tourism, social activities-related to the forest). However, changes in the ecological system of forest areas may change the inherent properties of ES (Nugroho et al. 2013; Sharma et al. 2019; Suryatmojo 2015). Unfortunately, a substantial part of the remaining forest in Indonesia, the upstream areas, are experiencing various forms of degradation (Higginbottom et al. 2019; Lukas 2014; Prasetyo et al. 2011; Tsujino et al. 2016). Nawir et al. (2008) pointed out that illegal logging, encroachment, and forest fire had been a trigger for land degradation since the 1990s. More importantly, scholars have warned that the remaining upstream areas in Java are threatened

(Higginbottom et al. 2019; Lukas 2014; Miettinen et al. 2011). These circumstances were undermining the capacity of forests area to supply valuable multiple ES.

To overcome forest degradation and restore ES, forest rehabilitation is becoming a prominent program throughout Indonesia (Nawir et al. 2008). Indeed, the watershed approaches have often been the unit of the program implementation. At this point, the upstream is the key target whereby most of the protected forest or limited production forest area is located. More importantly, the upstream areas are serving pivotal services for not only locals but also the downstream ecosystem (Liu et al. 2019; Nepal et al. 2014; Nugroho et al. 2013). Nevertheless, the upstream of Java represents the place where locals' livelihood is contingent upon forest areas and farming-related activities (Cahyono & Wisnu Wijaya 2014; Jariyah & Pramono 2018; Muhamad et al. 2014; Nijman & Nekaris 2014). These may lead to latent conflicts and land degradation (Lukas 2014). Furthermore, beyond the substantial emphasis on the technical aspect of the forest rehabilitation program, Nawir et al. (2008) argue that a lack of social approaches to support the sustainability of the forest rehabilitation program in

Indonesia has remained unsolved. Given these scenarios, linking forest rehabilitation and its inherent ES with locals' livelihood is strongly advocated (Adams et al. 2016).

Numerous studies have indeed been dedicated to explaining the importance of forest rehabilitation program in upstream of Java, but most of them focus on forest rehabilitation policy in national level (Nawir et al. 2008), assessment of forest rehabilitation implementation (Marliana & Rhe 2014), biophysical impacts (i.e., water regulation and natural hazard prevention) (Nugroho et al. 2013; Sudarsono et al. 2018; Suryatmojo 2015), and community empowerment (Indrawati et al. 2016; Wibawa 2014). In spite of the fact that all of those studies provide remarkable insights to explain the importance of forest rehabilitation, the literature gives inadequate answers on the impact of forest rehabilitation on communities adjacent to forest areas at a micro-level. More importantly, the critical issue on how locals perceived importance of forest rehabilitation, and how forest rehabilitation generates, both direct and indirect, benefits for the adjacent communities has remained contentious (Adams et al. 2016; Fedele et al. 2017; Ninan & Kontoleon 2016).

While quantifying biophysical and economic of ES are ubiquitous, there are growing recognitions for incorporating social dimensions in assessing perceived ES (e.g., Bryan et al. 2010; Kari & Korhonen-Kurki 2013; Kumar & Kumar 2008; Muhamad et al. 2014). Locals' perceived importance of forest management may influence their perceptions of and the way in which benefits from the forest (Parrotta et al. 2016). Their willingness to be actively involved in forest conservation efforts are strongly associated with their positive perceptions of forest management (Sirivongs & Tsuchiya 2012). Since ES should be benefiting human well-being (Cruz-Garcia et al. 2017),

understanding how community perceive, appreciate, and benefit from various ES in a particular landscape system is notable (Anton et al. 2010; Menzel & Teng 2009). Martn-Lpez et al. (2012) concurred that identifying which ES is highly appreciated and preferable might uncover the socio-cultural dimension of ES. In addition to perceived benefits, living proximity to forest area poses costs such as damage or loss of crops, landslide, the other potential natural hazard occurrence (Aditian et al. 2018; Gross et al. 2019). Likewise, people living closer to the forest area may have positive and negative attitudes (Muhamad et al. 2014). Therefore, understanding locals' perceptions and attitudes toward various potential ES generated by forest rehabilitation program are warranted.

Given the aforementioned background, the current study rests on the question of how forest rehabilitation affects local's livelihood, how they perceive the importance of, and react to forest rehabilitation in providing ES. We conceptualize that forest rehabilitation simultaneously offers provisioning, regulating, supporting, and cultural ES. Using the case of the forest rehabilitation of Perhutani, state-owned national forestry enterprises, this study attempts to assess locals' perceptions of ES in an adjacent village of Perhutani's forest area in the upstream of a catchment. It specifically examines to what extent forest rehabilitation associated with their perceived importance of forest rehabilitation to their livelihoods, perceived benefits and costs, and their attitudes toward forest management practices. This study will provide a basis for designing future strategies for improving forest management and policy decisions.

Material and methods

Study area

Our study was conducted in Ngambarsari village, Wonogiri regency, Central Java, Indonesia (see Figure 1). Ngambarsari is directly adjacent to the forestland of Perhutani in Sub District (Bagian Kesatuan Pemangkuan Hutan/BPKH) Baturetno, KPH Surakarta, Central Java. It specifically located at the upstream of one of the most degraded watersheds in Indonesia, Bengawan Solo Watershed (Sudarsono et al., 2018). Figure 1 shows land cover changes in the forest area adjacent to Ngambarsari village. The total population in 2017 was 4.254, and it comprised 389 households (BPS Kabupaten Wonogiri, 2018). Most of the locals' work predominantly in farming-related activities, while a small fraction of them are employed as entrepreneurs, government officers, and laborers. Ngambarsari was chosen as the study area due to its long history of locals' interaction with the forestland of Perhutani. A community forestry program (officially called as Pengelolaan Hutan Bersama Masyarakat/ PHBM) has been attracting them to be actively involved in forest management. In addition to work as a pine-tapper, those who were living adjacent to forests cultivate their land to produce herbal medicine, coffee, fruits, paddy field, fuelwood, and fodder.

Before felling in 1999, the area was fairly abandoned. It dominated by *Swietenia macrophylla* and shrubs, and locals' were cultivated open spaces for crops, collecting fuelwood, and fodder. In total, the area covers 53 ha (Suryatmojo, 2015). Moreover, natural springs water scattered inside, as well as at the edge of the forest area, have been being used as a source of freshwater. As a production forest, a clear-cutting in 1999 followed by a rehabilitation program. Mixed forest with agroforestry system, consisted of *Pinus merkusii*, *Schima walichii*, *Coffea robusta*, *Piper nigrum*, were established. During the forest

rehabilitation program, neighboring communities were involved under collaborative forest management program. In general, Perhutani provided locals limited access to grow food crops in between the tree's species. Conservation technique by using individual terrace was also implemented. Currently, the forest area has developed into the region with a reasonably dense vegetation cover dominated by *Pinus merkusii* (see Figure 1.). Due to its located at the upstream of the watershed, the main objectives of forest rehabilitation in this area are producing pine-sap (non-timber forest products), nature-driven hazard prevention, and water regulation services.

Data collection

Data were collected by a questionnaire survey in January 2018. The questionnaire included a set of sociodemographic profiles of the respondent. It was followed by sets of questions to assess the perceived importance of forest rehabilitation, perceived ES from a forest rehabilitation program, local's attitude toward forest rehabilitation practices. An open ended-ended question: "what is your perceived importance of forest rehabilitation program?" was used to elucidate their perceived importance of forest rehabilitation. To assess resident perceived benefits and costs, open-ended question: "Does the forest rehabilitation brings you benefits?" and "What are benefits and costs that perceived from the forest?" were asked. The final part of the questionnaire was about locals' attitudes of forest rehabilitation. The responses of locals' attitudes variables were coded on a five-point Likert scale, with 1 meaning 'strongly disagree' and 5 'strongly agree.'. The questionnaire implemented in both local and national languages: Javanese and Bahasa.

Looking at the time and financial resources limitation, non-probability with purposive sampling (Etikan et al., 2016; Guo & Hussey, 2004) was used to determine the targeted sub-villages. A series of

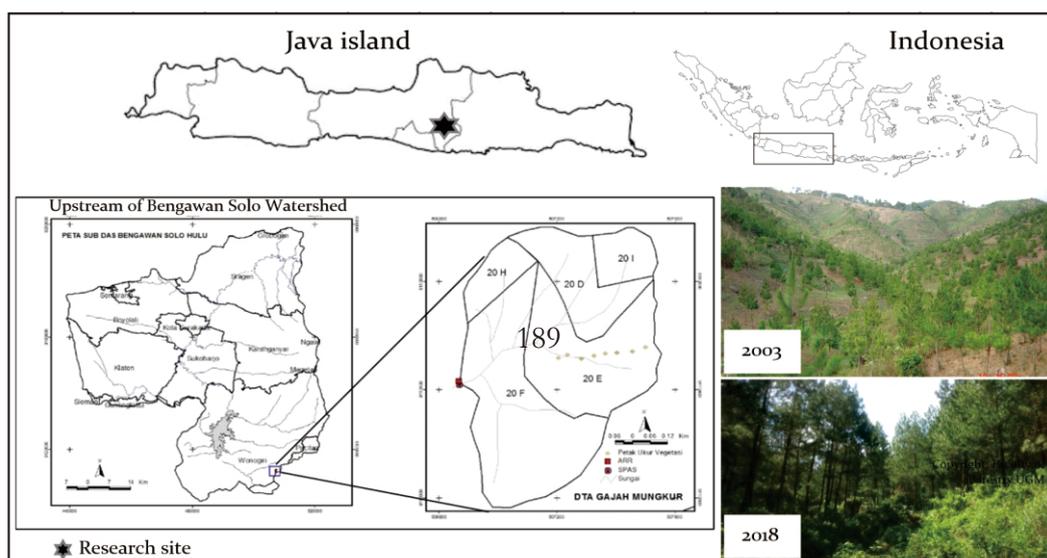


Figure 1. Land cover changes in forest area adjacent to Ngambarsari village
Gambar 1. Perubahan penutupan lahan hutan di kawasan hutan di Desa Ngambarsari

discussion with key person in the villages were conducted to determine targeted sub-villages. To suffice the study objectives and capture the phenomena of broader population, those sub-villages directly and non-directly adjacent to forest areas were selected. In total, 9 of 10 sub villages on Ngambarsari villages were determined. A convenience sampling method (Etikan et al. 2016; Rivera 2019) was employed to determine the targeted respondents based on their residence in the selected sub-village, involvement in pine-tapping activities, availability at certain times, accessibility, and willingness to participate. The questionnaires were administered in a direct face-to-face manner. On-site interviews were conducted at the field and door-to-door in settlement areas nearby forest. During the door-to-door surveys, individual respondents from the same household were avoided. Among 389 households in the villages, 90 households were obtained as respondents.

Data analysis

Descriptive statistics were performed to outline respondents' sociodemographic profiles, their perceived importance of forest rehabilitation, perceived ES, and their attitudes toward forest management practices. Correlations between locals'

attitude variables were analyzed by Spearman rank correlation analysis. We considered the sociodemographic profiles of locals in the correlation analysis. The sociodemographic profiles were coding into categorical data. The correlation analysis included age (AGE) coded 1 = < 25 years old, 2 = ≥ 25 - < 50 years old, 3 = ≥ 50 years old; gender (GENDER) coded 1 = 'female' or 2 = 'male'; formal educational attainment (EDU) coded 1 = 'no formal education,' 2 = 'elementary and secondary,' 3 = 'tertiary or university,' monthly income (INCOME) coded IDR in millions unit, length of residency (RESIDE) coded 1 = < 15 years, 2 = ≥ 15 - < 25 years, 3 = ≥ 25 years, and involvement as pine tapper (TAPPER) coded 1 = 'not pine-tapper' or 2 = 'pine-tapper.' Statistical analysis was performed using the R studio ver. 1.2.5033, and psych ver. 1.8.12 (Revelle 2018).

Results and discussion

General results

In total, 90 completed questionnaires were collected. This represents 23.14% of total household in Ngambarsari village. Table 1 lists the sociodemographic profiles of the respondents. Of them, 74.44% were male, 66.67% were 25 – 50 years old, 73.33% had formal primary education attainment, and 47.78% were pine-tapper.

Table 1. Sociodemographic profiles of the respondents.

Tabel 1. Profil sosiodemografi responden

Characteristics	Attributes	Frequency	Percentage (%)
Gender	Male	67	74.44%
	Female	23	25.56%
Age (years)	< 25	4	4.44%
	>= 25 - <50	60	66.67%
	≥ 50	26	28.89%
Formal educational attainment	no formal education	12	13.33%
	primary education	66	73.33%
	secondary education	12	13.33%
Length of residence (years)	< 15	10	11.11%
	≥ 15 - <25	12	13.33%
	≥ 50	68	75.56%
Income (IDR in million)	< 2	38	42.22%
	≥ 2 - <4	33	36.67%
	≥ 4	19	21.11%
Engagement Status with Perhutani	pine-tapper	43	47.78%
	non-pine tapper	47	52.22%

Perceived importance of forest rehabilitation

We found four perceived importance of forest rehabilitation that were acknowledged the most by locals, which were producing pine-sap (63.25%), conserving forested area (17.09%), preventing disaster (17.09%), and maintaining water availability (2.56%). The findings suggest that amongst various objectives of forest rehabilitation, producing pine-sap as non-timber forest products, was the most acknowledged by respondents. Although the agroforestry system has been adopted in the initial stage of forest rehabilitation, in fact, the *Pinus merkusii* was more dominant compared to other species. The findings were unsurprising since Perhutani has been expanding *Pinus merkusii* plantation in the mountainous land to increase their resin production. We also observed that regular activities of pine forest management, i.e. pine harvesting, collecting, transporting of pine sap, are common in the village. Accordingly, pine sap production activities are the easiest benefits that easy to be encountered by

community members. Interestingly, in addition to pine-sap, respondents acknowledged conserving forested areas and preventing disaster as the other prominent expected outcomes of forest management practices.

Locals' perceptions of benefits and costs from the forest area

Locals' perceptions of perceived benefits including pine-sap (47.74%), maintain water availability (24.52%), reducing soil erosion and landslide (16.13%), greener environment (6.45%), increase social bonding among locals (2.58%), and crops production (2.58%). Of 72.73% of them considered forest rehabilitation brought adverse impacts on their livelihoods. They claimed forest rehabilitation had increased wildlife-human conflicts (68.29%), reducing water availability (15.85%), and rising landslide occurrence (15.85%). Table 2 shows respondents' perceptions of the forest rehabilitation program.

Table 2. Respondent's perceived benefits and costs from the forest area
Tabel 2. Manfaat dan dampak negatif yang diterima dari hutan

Categories	Responses	Categories	Frequency	Percentage (%)
Does the forest rehabilitation bring you benefits	Yes		90	100.00%
	No		0	0.00%
	Don't know		0	0.00%
List any benefits that perceived from the forest*	Pine sap	Provisioning services	74	47.74%
	Water	Regulating services	38	24.52%
	Crops	Provisioning services	4	2.58%
	Reducing disaster (erosion & landslide)	Supporting services	25	16.13%
	Green environment	Cultural services	10	6.45%
	Increase social bonding	Cultural services	4	2.58%
Does the forest rehabilitation bring you losses	Yes		64	71.11%
	No		26	28.89%
	Don't know		0	0.00%
List any costs that perceived from the forest*	Increasing wildlife-human conflicts		56	68.29%
	Reducing water		13	15.85%
	Increasing disaster (e.g., landslide)		13	15.85%

Remark: *open-ended question: the answer can be more than one ES and ES category
 Keterangan: * pertanyaan terbuka: jawaban dapat lebih dari satu ES dan kategori ES

Our findings indicated that forest rehabilitation generates various ES to adjacent communities, including provisioning, regulating, supporting, and cultural services. Figure 2. illustrates the multiple ES provided by forest area. As the main objective of forest rehabilitation, locals acknowledged provisioning services such as pine-sap and freshwater availability as the dominant ES produced by forest area. Wijayanto and Wardhana (2019) argued that *Pinus merkusii* is relatively productive in producing resin. Accordingly, a pine-tapper in Ngambarsari could harvest the pine-sap twice in a month. Moreover, locals perceived water availability services from the forest rehabilitation program was corroborated by Suryatmojo (2015). He argued that forest rehabilitation in forest areas adjacent to Ngambarsari increases water retention in the area, thus this will maintain water availability throughout the year.

Interestingly, locals claimed that forest rehabilitation generated a greener environment. They concurred that forest rehabilitation had changed the area, which predominantly relatively abandoned, becoming greener and more productive. We observed that since its first rehabilitation in 1999, the forest areas had been transformed into densely forest areas (see Figure 1). Furthermore, forest rehabilitation may increase social cohesion in communities. Social cohesion escalates civic engagement and willingness to participate in social activities and eventually enhances resilient communities (Aker 2020; Fonseca et al. 2018). The existence of pine-tapping activities increased interaction opportunities among locals, as well as with Perhutani officers through voluntary works and regular meeting.

However, while locals perceived benefits from forest rehabilitation, adverse impacts have emerged. A

small fraction of respondents indeed believed that forest rehabilitation may trigger landslide occurrences and reducing water availability. They observed that landslide occurrences are often at the hilly of the forest area. They argue that during the heavy rain, the dense population of trees at the hilly forested landscape may trigger a landslide occurrence. This contradicts the evidence provided by Schmaltz et al. (2017), they argue that at the particular topographic area, forested areas are less susceptible to shallow landslides than their non-forested counterparts. Indeed, a very high intensity of rainfall within a short period of time may exceed capability of trees to maintain soil aggregate which eventually triggers a rainfall-induced landslide (Aditian et al. 2018; Marjanović et al. 2017). Locals' also claimed that forest decreases water availability. We observed that their assumption is based on the rumors that pine forests consume a lot of water. In fact, this contradicts with scientific research findings. Earlier hydrological research on hydrological stations in Ngambarsari revealed that forest rehabilitation reduces surface runoff and enhances flow persistence (Suryatmojo 2015). Moreover, they also affirmed that the better condition of the forest area was suitable as a wildlife habitat, and this triggered the uncontrolled wildlife population. Locals asserted that the long-tailed macaque (*Macaca fascicularis*) and wild boar (*Sus scrofa*) frequently attack their crops and fruits in their home gardens. They indicated that the relative

monoculture forest, which dominated by *Pinus merkusii*, may limit food availability for those species. The increasing number of wildlife is beyond the ability of the forest area to provide sufficient feed for wildlife. These corroborated by scholars who suggested that plantation forests generally are structurally simplified habitat with low species diversity (Barsoum et al. 2016), which affects insufficient feed supply for wildlife, thus subsequently increase wildlife attacking occurrences.

Locals' attitudes toward forest rehabilitation program

Of 53.33% and 18.89%, respondents were satisfied and very satisfied with the forest rehabilitation programs in their village, while 22.22% of them were not satisfied. Table 3 shows locals' attitudes toward forest rehabilitation program. Most of the respondents agreed (64.44%) and strongly agreed (17.78%) that they would say positive things about the impacts of forest rehabilitation, and 12.22% remaining respondents disagreed. Finally, 77.78% and 11.11% of the respondents were agreed and strongly agreed that they would play an active role in conserving the forest.

Table 4 shows Spearman rank correlations (ρ) between study variables. Satisfaction with forest rehabilitation (S-1) was positively and significantly correlated with willingness to say positive things about forest rehabilitation impacts (S-2) and



Figure 1. Perceived ecosystem services by locals (a. crops; b. pine-sap; c. fodder; d. source of water)

Gambar 1. Jasa ekosistem yang diterima oleh masyarakat (a. tanaman pertanian, b. getah pinus, c. pakan ternak, d. sumber air)

willingness to be actively involved in forest conservation efforts (S-3) ($p < 0.001$), pine-tapper ($p < 0.05$). Satisfaction with forest rehabilitation (S-1) was negatively and significantly with formal education attainment ($p < 0.01$). Willingness to say positive things about forest rehabilitation impacts (S-2) was positively and significantly correlated with willingness to be actively involved in forest conservation efforts ($p < 0.001$), pine-tapper ($p < 0.01$), and gender ($p < 0.05$). Willingness to be actively involved in forest conservation efforts (S-3) was positively and significantly correlated with pine-tapper ($p < 0.001$), gender ($p < 0.01$), and monthly income ($p < 0.05$).

Male was differed significantly ($p < 0.05$) in their satisfaction with forest rehabilitation (S-1) and willingness to be actively involved in forest conservation efforts (S-3). Table 5 shows the results of the t-test analysis of gender and locals' attitudes.

Table 6 describes the results of the t-test analysis of locals' involvement in pine-tapping activities and locals' attitudes. Those who pine-tapper differ significantly in their satisfaction with forest rehabilitation (S-1) ($p < 0.05$), willingness to say positive things about forest rehabilitation impacts (S-2) ($p < 0.01$) and willingness to be actively involved in forest conservation efforts (S-3) ($p < 0.001$).

Table 3. Respondent's attitude toward forest rehabilitation
Tabel 3. Sikap responden terhadap rehabilitasi hutan

Statement	Strongly Disagree	Disagree	Indifferent	Agree	Strongly Agree
S-1. I satisfied with the forest rehabilitation	0 0.00%	20 22.22%	5 5.56%	48 53.33%	17 18.89%
S-2. I am willing to say positive things about the impact of rehabilitation in supporting local livelihoods	0 0.00%	11 12.22%	5 5.56%	58 64.44%	16 17.78%
S-3. I am willing to be actively involved in forest conservation efforts	0 0.00%	6 6.67%	4 4.44%	70 77.78%	10 11.11%

Table 4. Spearman rank correlations (ρ) between study variables
Tabel 4. Uji Rank Spearman antar variable

	S-1	S-2	S-3	AGE	EDU	RESIDE	INCOME
S-1	1.00						
S-2	0.33 ^{***}	1.00					
S-3	0.53 ^{***}	0.59 ^{**}	1.00				
AGE	0.11	0.02	-0.09	1.00			
EDU	-0.22 [*]	-0.19	-0.14	-0.26 ^{**}	1.00		
RESIDE	0.08	-0.07	0.00	0.30 ^{**}	-0.169	1.00	
INCOME	0.08	0.25 [*]	0.24 [*]	0.045	0.17	-0.11	1.00

Remarks: S-1= satisfaction with the forest rehabilitation, s-2= willingness to say positive things about the impact of rehabilitation in supporting local livelihoods, S-3= willingness to be actively involved in forest conservation efforts, *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Keterangan: S-1= kepuasan terhadap rehabilitasi hutan, S-2=kesediaan untuk menyampaikan hal positif tentang dampak rehabilitasi dalam mendukung penghidupan masyarakat, S-3= kesediaan untuk berpartisipasi aktif dalam upaya konservasi hutan, *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$

Table 5. Results of the t-test analysis of gender and locals' attitudes
Tabel 5. Hasil analisis t-test antara gender dan sikap masyarakat

Locals' attitudes	Mean		t-value	sig
	Female	Male		
Satisfaction with the forest rehabilitation	3.26	3.84	-2.52	0.016*
Willingness to say positive things about forest rehabilitation impacts	3.61	3.97	-1.87	0.069
Willingness to be actively involved in forest conservation efforts	3.65	4.03	-2.27	0.030*

Remark: * p<0.05
 Keterangan: * p<0.05

Table 6. Results of the t-test analysis of locals' involvement in pine-tapping activities and locals' attitudes
Tabel 6. Hasil analisis t-test antara keterlibatan dalam penyadapan getah pinus dan sikap masyarakat

Locals' attitudes	Mean		t-value	sig
	non pine-tapper	pine tapper		
Satisfaction with the forest rehabilitation	3.47	3.93	-2.18	0.032*
Willingness to say positive things about forest rehabilitation impacts	3.66	4.12	-2.66	0.009**
Willingness to be actively involved in forest conservation efforts	3.72	4.16	-3.46	0.001***

Remarks: ***p<0.001, ** p<0.01, * p<0.05
 Keterangan: ***p<0.001, ** p<0.01, * p<0.05

Our findings implied that the locals' attitudes toward forest rehabilitation for their livelihoods and surrounding environment were generally positive. Even though locals encounter the adverse impacts of forest rehabilitation, those negative impacts may not outweigh their perceived benefits. Locals remain view forest rehabilitation as an essential ES producer for their community. Their satisfaction with forest rehabilitation will increase their positive perceptions and subsequently increase their willingness to be actively involved in forest conservation efforts. Nevertheless, locals' positive perceptions had a greater association on their willingness to be actively engaged in forest conservation efforts, and this finding is consistent with the conclusion of Sirivongs & Tsuchiya (2012). They argued that for locals to be actively involved in managing forest areas, their participation needs to be fostered and encouraged through developing sustainable benefits obtained from forest areas. Therefore, maintaining locals' positive perceptions to ensure forest sustainability is essential. However, a small portion of locals' yet to be

satisfied with forest rehabilitation. Their perceived negative impacts of wildlife attacks were the most locals' complained about the adverse effects of the forest rehabilitation program.

In the present study, gender has positive and significantly correlated with their attitudes toward forest rehabilitation. Males tend to hold more positive attitudes rather than females. This finding suggests that differences in attitudes between males and females might be explained by their level of involvement in forest-related activities, including pine-resin tapping. Males strongly associated with engagement as pine tapper than females by which they subsequently perceived more benefits that may lead to positive attitudes toward forest rehabilitation program. We also speculate that the positive attitudes by males might be due to in part to culture-specific norms. Looking at Javanese culture, males are generally responsible for taking care of the financial need of their families (e.g., Colfer et al. 2015; Herawati et al. 2019). Accordingly, males see forest rehabilitation program provides job opportunities from

which they earn income and other potential benefits. Indeed, males who acquired greater benefits from pine tapping activities had more positive attitudes concerning forest rehabilitation programs.

The study also found that the involvement in forest management activities, including pine tapper, positively and significantly correlated with positive attitudes toward forest rehabilitation and conservation efforts. These findings corroborated by scholars who concurred that encouraging community involvement in forest governance is imperative for sustainable natural resources management and conservation (Campbell et al. 2013; Harbi et al. 2018; Nugroho & Numata, 2020; Nurrochmat et al. 2017; Pudyatmoko et al. 2018; Sirivongs & Tsuchiya, 2012). Likewise, locals' involvement may empower them, enhance their awareness of potential impacts of the forest, and boost their respect for forest conservation efforts. As a result, these rationales conclude that locals' involvement in forest management practices could play a significant role in forest sustainability.

Conclusion

The current study concludes that forest rehabilitation by a relative monoculture system may not only offer opportunities for locals to benefits but also its inherent adverse impacts may emerge. Provisioning ecosystem services were the most acknowledged by locals. Our findings indicate that locals perceived importance, perceived ES benefits, and attitudes of forest rehabilitation were varied among locals. Their willingness to be actively involved in forest conservation efforts was strongly associated with their positive perceptions of forest rehabilitation positive perceptions, involvement, and satisfaction of forest rehabilitation, respectively. Therefore, providing policies to increase opportunities for locals' to benefits from forest rehabilitation initiative through locals' involvement are matters.

Following the notion that obtaining locals' positive attitudes to forest areas is significant in ensuring its sustainability, managers should not only focus on delivering benefits but also mitigating negative impacts of forest areas. Our findings demonstrate that wildlife attack is one of the major negative impacts of a forest rehabilitation by using relatively monoculture system. Hence, we recommend that Perhutani managers should manage and control wildlife populations in the forest area. Planting feed trees for wildlife would be promising options to tackle wildlife attack occurrences in neighboring communities.

Ultimately, the current study has captured the general trend on how locals perceive forest rehabilitation impacts in generating ES, but the quantification of economic, social, and environmental aspects as the consequences of their perception and attitudes of forest rehabilitation are beyond our study scope. Hence, quantitative research to gain a deeper understanding of those aspects is needed. Likewise, this research is limited to a village in the upstream of the catchment in Central Java. Locals in different villages and different forest management systems may hold distinct perceptions and attitudes toward forest rehabilitation programs. Therefore, the survey over a broader spectrum of forest management systems from different villages across Java is promising for future studies.

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References

- Adams C, Rodrigues ST, Calmon M, Kumar C. 2016. Impacts of large-scale forest restoration on socioeconomic status and local livelihoods: what we know and do not know. *Biotropica* **48**(6): 731-44.
- Adition A, Kubota T, Shiohara Y. 2018. Comparison of GIS-based landslide susceptibility models using frequency ratio, logistic regression, and artificial neural network in a tertiary region of Ambon, Indonesia. *Geomorphology* **318**: 101-11.
- Akter S. 2020. Social cohesion and willingness to pay for cyclone risk reduction: the case for the coastal embankment improvement project in Bangladesh. *International Journal of Disaster Risk Reduction* **48**: 2212-4209.
- Anton C, Young J, Harrison PA, Musche M, Bela G, Feld CK, Harrington R, Haslett JR, Pataki G., Rounsevell MDA, Skourtos M, Sousa JP, Sykes MT, Tinch R, Vandewalle M, Watt A, Settele J. 2010. Research needs for incorporating the ecosystem service approach into eu biodiversity conservation policy. *Biodiversity and Conservation* **19**(10): 2979-94.
- Barsoum N, Coote L, Eycott AE, Fuller L, Kiewitt A, Davies RG. 2016. Diversity, functional structure and functional redundancy of woodland plant communities: how do mixed tree species plantations compare with monocultures?. *Forest Ecology and Management* **382**: 244-56.
- BPS Kabupaten Wonogiri. 2018. Kecamatan Karangtengah Dalam Angka 2018 . Wonogiri: Badan Pusat Statistik Kabupaten Wonogiri. <https://wonogirikab.bps.go.id/publication/2018/09/26/ff15c22040cc1446fac76641/kecamatan-karangtengah-dalam-angka-2018.html>.
- Bryan BA, Raymond CM, Crossman ND, and Macdonald DH. 2010. Targeting the management of ecosystem services based on social values: where, what, and how?. *Landscape and Urban Planning* **97**: 11-22.
- Cahyono SA, Wijaya WW. 2014. Identifikasi sektor ekonomi unggulan dan ketimpangan pendapatan antar kabupaten di sub das bengawan solo hulu. *Jurnal Penelitian Sosial dan Ekonomi Kehutanan* **11**(1): 32-43.
- Campbell SJ, Kartawijaya T, Yulianto I, Prasetya R, Clifton J. 2013. Co-management approaches and incentives improve management effectiveness in the Karimunjawa National Park, Indonesia. *Marine Policy* **41**: 72-79.
- Colfer C, Achdiawan R, Roshetko JM, Mulyoutami E, Yuliani EL, Mulyana A, Moeliono M, Adnan H, Erni. 2015. The balance of power in household decision-making: encouraging news on gender in Southern Sulawesi. *World Development* **76**: 147-64.
- Cruz-Garcia GS, Sachet E, Blundo-Canto G, Vanegas M, Quintero M. 2017. To what extent have the links between ecosystem services and human well-being been researched in Africa, Asia, and Latin America?. *Ecosystem Services* **25**: 201-12.
- Etikan I, Musa SA, Alkassim RS. 2016. Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics* **5**(1): 1.
- Fedele G, Locatelli B, Djoudi H. 2017. Mechanisms mediating the contribution of ecosystem services to human well-being and resilience. *Ecosystem Services* **28**: 43-54.
- Fonseca X, Lukosch S, Brazier F. 2018. Social cohesion revisited: a new definition and how to characterize it. *Innovation: The European Journal of Social Science Research* **32**(2): 231-53.
- Gross EM, Lahkar BP, Subedi N, Nyirenda VR, Lichtenfeld LL, Jakoby O. 2019. Does traditional and advanced guarding reduce crop losses due to wildlife? a comparative analysis from Africa and Asia. *Journal for Nature Conservation* **50**: 125712.
- Guo S, Hussey DL. 2004. Nonprobability sampling in social work research. *Journal of Social Service Research* **30**(3): 1-18.
- Harbi J, Erbaugh JT, Sidiq M, Haasler B, Nurrochmat DR. 2018. Making a bridge between livelihoods and forest conservation: lessons from non timber forest products' utilization in South Sumatera, Indonesia. *Forest Policy and Economics* **94**: 1-10.
- Herawati T, Rohadi D, Rahmat M, Winarno B. 2019. An exploration of gender equity in household: a case from a peatland-based community in Riau, Indonesia. *Biodiversitas Journal of Biological Diversity* **20**(3): 853-61.
- Higginbottom TP, Collar NJ, Symeonakis E, Marsden S. 2019. Deforestation dynamics in an endemic-rich mountain system: conservation successes and challenges in West Java 1990-2015. *Biological Conservation* **229**: 152-59.
- Indrawati DR, Awang SA, Faida LRW, Maryudi A. 2016. Pemberdayaan masyarakat dalam pengelolaan das mikro: konsep dan implementasi. *Kawistara* **7**(2): 113-224.
- Jariyah N, Pramono I. 2018. Kerentanan sosial ekonomi dan biofisik daerah aliran sungai solo (socio-economic and biophysical vulnerability of solo watershed). *Jurnal Penelitian Pengelolaan Daerah Aliran Sungai* **2**(2): 89-110.
- Kari S, Korhonen-Kurki K. 2013. Framing local outcomes of biodiversity conservation through ecosystem services: a case study from Ranomafana, Madagascar. *Ecosystem Services* **3**: e32-39.
- Kumar M, Kumar P. 2008. Valuation of the ecosystem services: a psycho-cultural perspective. *Ecological Economics* **64**: 808-19.
- Lelli C, Bruun HH, Chiarucci A, Donati D, Frascaroli F, Fritz Ö, Goldberg I, Nascimbene J, Tøttrup AP, Rahbek C, Heilmann-Clausen J. 2019. Biodiversity response to forest structure and management: comparing species richness, conservation relevant species and functional diversity as metrics in forest conservation. *Forest Ecology and Management* **432**: 707-17.
- Liu H, Wu J, Liao M. 2019. Ecosystem service trade-offs upstream and downstream of a dam: a case study of the Danjiangkou Dam, China. *Arabian Journal of Geoscience*: 1-17.
- Lukas MC. 2014. Eroding battlefields: land degradation in java reconsidered. *Geoforum* **56**: 87-100.
- Marjanović M, Krautblatter M, Abolmasov B, Đurić U, Sandić C, Nikolić V. 2017. The rainfall-induced landsliding in western serbia: a temporal prediction approach using decision tree technique. *Engineering Geology* **232**: 147-59.
- Marliana SN, Rühle F. 2014. Post-reforestation vegetation development on abandoned highland fields in Java, Indonesia. *Forest Ecology and Management* **328**: 245-53.

- Martín-López B, Iniesta-Arandia I, García-Llorente M, Palomo I, Casado-Arzuaga I, Amo DG, Gómez-Baggethun E, Oteros-Rozas E, Palacios-Agundez I, Willaarts B, González JA, Santos-Martín F, Onaindia M, López-Santiago C, Montes C. 2012. Uncovering ecosystem service bundles through social preferences. *PLoS ONE* 7(6): e38970–e38970.
- Menzel S, Teng J. 2009. Ecosystem services as a stakeholder-driven concept for conservation science. *Conservation Biology* 24(3): 907–9.
- Miettinen Jukka, Shi C, Liew SW. 2011. Deforestation rates in insular southeast asia between 2000 and 2010. *Global Change Biology* 17(7): 2261–70.
- Muhamad D, Okubo S, Harashina K, Gunawan B, Takeuchi K. 2014. Living close to forests enhances people's perception of ecosystem services in a forest-agricultural landscape of West Java, Indonesia. *Ecosystem Services* 8: 197–206.
- Nawir AA, Murniati, Rumboko L. 2008. Center for international forestry research (cifor) rehabilitasi hutan di indonesia: akan kemanakah arahnya setelah lebih dari tiga dasawarsa? Bogor: Center for International Forestry Research (CIFOR). <http://www.cifor.org/library/2455/rehabilitasi-hutan-di-indonesia-akan-kemanakah-arahnya-setelah-lebih-dari-tiga-dasawarsa>.
- Nepal S, Flügel WA, Shrestha AB. 2014. Upstream-downstream linkages of hydrological processes in the himalayan region. *Ecological Processes* 3:19.
- Nijman V, Nekaris K. 2014. Traditions, taboos and trade in slow lorises in sundanese communities in southern Java, Indonesia 25: 79–88.
- Ninan KN, Kontoleon A. 2016. Valuing forest ecosystem services and disservices – case study of a protected area in India. *Ecosystem Services* 20: 1–14.
- Nugroho P, Marsono D, Sudira P, Suryatmojo H. 2013. Impact of land-use changes on water balance. *Procedia Environmental Sciences* 17: 256–62.
- Nugroho P, Numata S. 2020. Resident support of community-based tourism development: evidence from Gunung Ciremai National Park, Indonesia. *Journal of Sustainable Tourism*. <https://www.tandfonline.com/doi/full/10.1080/09669582.2020.1755675>
- Nurrochmat DR, Nugroho IA, Hardjanto, Purwadianto A, Maryudi A, Erbaugh JT. 2017. Shifting contestation into cooperation: strategy to incorporate different interest of actors in medicinal plants in Meru Betiri National Park, Indonesia. *Forest Policy and Economics* 83: 162–68.
- Parrotta J, Yeo-Chang Y, Camacho LD. 2016. Traditional knowledge for sustainable forest management and provision of ecosystem services. *International Journal of Biodiversity Science, Ecosystem Services & Management* 12(1–2):1–4.
- Prasetyo LB, Wijaya CI, Setiawan Y. 2011. Spatial model approach for deforestation. In *Land Use, Climate Change and Biodiversity Modeling*. IGI Global, 376–87.
- Pudyatmoko S, Budiman A, Kristiansen S. 2018. Towards sustainable coexistence: people and wild mammals in Baluran National Park, Indonesia. *Forest Policy and Economics* 90: 151–59.
- Revelle W. 2018. Psych: Procedures for personality and psychological research. <https://cran.r-project.org/web/packages/psych/index.html>.
- Rivera JD. 2019. When attaining the best sample is out of reach: nonprobability alternatives when engaging in public administration research. *Journal of Public Affairs Education* 25(3): 314–42.
- Schmaltz EM, Steger S, Glade T. 2017. The influence of forest cover on landslide occurrence explored with spatio-temporal information. *Geomorphology* 290: 250–64.
- Sharma SK, Baral H, Laumonier Y, Okarda B, Komarudin H, Purnomo H, Pacheco P. 2019. Ecosystem services under future oil palm expansion scenarios in West Kalimantan, Indonesia. *Ecosystem Services* 39: 100978.
- Sirivongs K, Tsuchiya T. 2012. Relationship between local residents' perceptions, attitudes and participation towards national protected areas: a case study of Phou Khao Khouay National Protected Area, Central Lao PDR. *Forest Policy and Economics* 21: 92–100.
- Sudarsono B, Sukmono A, Santoso A. 2018. Analysis of vegetation density effect in bengawan solo watershed to the total suspended solid (tss) in Gajah Mungkur Reservoir. *IOP Conference Series: Earth and Environmental Science* 165: 12033.
- Suryatmojo H. 2015. Rainfall-runoff investigation of pine forest plantation in the upstream area of Gajah Mungkur Reservoir. *Procedia Environmental Sciences* 28(Sustain 2014): 307–14.
- Tsujino R, Yumoto T, Kitamura S, Djamaluddin I, Darnaedi D. 2016. History of forest loss and degradation in Indonesia. *Land Use Policy* 57: 335–47.
- Wibawa A. 2014. Pemberdayaan masyarakat dalam rehabilitasi hutan dan lahan melalui program kebun bibit rakyat di Desa Sumberrejo Kecamatan Tempel Kabupaten Sleman. *Jurnal Pembangunan Wilayah dan Kota* 10(2): 187–96.
- Wijayanto A, Wardhana TW. 2019. Produktivitas dan perbandingan produksi resin pinus merkusii jungh et de vriese terhadap net progress schedule (nps) yang ditetapkan perhutani. *Silva Tropika* 3(2): 199–205.