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RESEARCH ARTICLE

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Co-Benefit Analysis from the Implementation of the REDD+ Program in West Kalimantan, Indonesia

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ABSTRACT

Reducing emissions from deforestation and forest degradation (REDD+) remains a key mechanism to mitigate climate change in developing nations. However, forest degradation in Indonesia often stems from local livelihoods that depend on forest resources. Standard REDD+ implementations frequently fail when they overlook livelihood co-benefits for local villagers. This study analyzes how stakeholders in West Kalimantan recognize and generate co-benefits through the REDD+ program. Structural critical discourse analysis (CDA) is employed to examine the entanglement of micro-level community practices and macro-level forest governance policies, particularly following the implementation of Law 23/2014. Field data were collected between 2018 and 2023 through focus group discussions (FGDs) and key informant interviews across intervention villages. The results demonstrate that aligning emission reduction targets with community socio-economic welfare—specifically through non-timber forest product (NTFP) development and silvofishery—enabled the program to achieve 293,142 tCO_2e in emission reductions (representing 97.71% of the planned minimum target). Furthermore, the welfare performance, evaluated qualitatively through the IDM's assessment, shows that the status of a very underdeveloped village, which was attributed to the intervened villages, has been reduced to none. Also, villages transitioning from "Developing" to "Developed" to "Independent" village status experienced reductions in village welfare. These all indicate > 80% improvement in villagers' livelihoods. I conclude that securing tangible local co-benefits is essential for sustaining long-term carbon mitigation outcomes in tropical forest landscapes.

Introduction

Reducing emissions from deforestation and forest degradation (REDD+) and implementing additional forest-related activities that protect the climate, such as sustainable forest management and the conservation and enhancement of forest carbon stocks, are widely regarded as key mechanisms for reducing atmospheric greenhouse gas emissions [1–3]. REDD+ mechanisms, implemented by national institutions, NGOs, or other partners, can improve governance and participation, resulting in more diverse authorities, including those from local communities [2]. Implementing a program-based REDD+ mechanism (REDD+ program) could benefit stakeholders through payments based on results-based incentives (RBIs) [3,4]. The REDD+ mechanism requires reducing deforestation and forest degradation (DD), as these events are the primary sources of greenhouse gas (GHG) emissions from the forestry sector and often result from human activities [2,5,6].

The Government of Indonesia (GOI) defined deforestation as the conversion of natural forest cover to other land-cover categories within the same area. Meanwhile, forest degradation involves the transition of primary forest classes — such as primary dryland, primary mangrove, and primary swamp forests — to secondary forest classes, thereby reducing the amount of carbon stored in these forests [7]. Such human activities,

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known as slash-and-burn or swidden cultivation, are carried out by forest-dependent people or villagers [8], and they have been accused of being the leading actors in forest loss and of contributing to increased GHG emissions [9–12]. The enactment of REDD+ cannot be decoupled from the 2007 Conference of the Parties (COP) in Bali, which resulted in the Bali action plan [13,14].

The REDD+ mechanism is further enshrined in Article 5 of the Paris Agreement, which requires parties to develop policy approaches and positive incentives for activities under the REDD+ mechanism [15,16]. Article 4 of the Paris Agreement asserts that the ultimate outcomes of the mitigation target, expressed as a reduction in aggregate greenhouse gas emissions, can be achieved by developing mitigation activities that create co-benefits through economic diversification. Article 7 states that any mitigation programs should be based on the traditional knowledge of Indigenous peoples to integrate their adaptive capability into relevant socioeconomic and environmental policies and actions. Therefore, villagers are essential to integrating their traditional knowledge and indigenous culture into climate change mitigation programs, such as the REDD+ program, to create better socioeconomic and environmental co-benefits. Co-benefits can be viewed as a 'win-win' discourse among stakeholders, aimed at reducing emissions while achieving additional positive effects through the implementation of specific initiatives and policies. This context aligns with several arguments that co-benefits encompass not only the intended mitigation target but also other expected positive effects, including social, economic, and environmental benefits, thereby improving well-being outcomes that sustain REDD+ initiatives [1,17]. Kane et al. [18] also state that targeted benefits from the REDD+ program include mitigating climate change, supporting sustainable livelihoods, maintaining vital ecosystem services, and preserving global biodiversity.

Studies across regions evaluating REDD+ outcomes yield diverse results regarding the benefits stakeholders are expected to achieve. This relates to the highlighted challenges to improving the socioeconomic situation across five broad areas of the REDD+ context [19], which are: (1) enhanced local infrastructure, (2) access to cleaner and affordable energy for heating and/or cooking, (3) improved income and employment, (4) improved access to electricity and/or energy-efficient lighting (also in Lei et al. [20]), and (5) improved natural resource and environmental services. Based on studies in Bangladesh [21,22], the primary issues hindering the implementation of the REDD+ program were corruption and policy failure in managing wildlife sanctuaries. In addition, Rahman and Mori [21] noted that the project manager failed to adequately define and communicate the co-benefits to community members, leading to low community acceptance of the program. The case of Sub-Saharan Africa [23] shows unclear co-benefits, creating stakeholder conflicts due to an absence of rights or "who gets what," such as weak land tenure arrangements. In the case of Zambia [17] and Bale Eco Region, Ethiopia [24], although the REDD+ mechanism has become a well-known strategy for mitigating climate change, there is potential conflict due to the absence of a carbon rights framework, unclear governance among local governments and local communities, and conflicting discourses and power dynamics at the international, national, and local levels that influence how it is implemented.

These challenges intensify because implementing the REDD+ program requires prohibiting swidden cultivation, which is considered a driver of the DD [10,16,25]. Such a prohibition creates further conflict, as Prihatmaja et al. [26] argued in a study conducted in Central Kalimantan, Indonesia. The prohibition of activities other than legal forest-based activities is a characteristic feature of forest management, albeit a specific type of management, that emerged because villagers had limited alternative livelihoods beyond traditional practices. Based on studies in North Kalimantan, Indonesia [27], with additional notes from Aryal et al. [14] that a REDD+ program can have positive indirect impacts by involving villagers to prevent activity displacement and induced deforestation, and to reduce carbon emissions; however, support from government organizations and the private sector, through incentives for sustainable forest management, the process of achieving tenure security, and clarifying the co-benefits villagers will receive before program implementation, could help overcome these challenges. It is also suggested that values that should be promoted among villagers during the implementation of the REDD+ program are: (a) place attachment, (b) nature connectedness, and (c) social norms, because the payment of monetary incentives will not necessarily motivate the villagers to engage in the REDD+ program [5].

Drawing on an analysis of nine case studies from four countries — Cambodia, Myanmar, Nepal, and Vietnam [18], it was found that the REDD+ program has the potential to simultaneously transform conflicts. Moreover, the program's co-benefits not only improve villagers' livelihoods but also enhance their adaptive capacity once they perceive the expected benefits, and they could become an influential factor in halting deforestation [16,25]. Therefore, it is essential to examine the relationship between co-benefit creation for stakeholders and the achievement of the REDD+ program's mitigation outcome, particularly through a

qualitative approach [28], as demonstrated by studies of carbon-related projects in Southeast Asian countries and along the Mekong River. The evidence shows that a qualitative investigation into the socio-economic benefits for villagers is necessary to address human development goals. These are closely associated with the sustainable development goals (SDGs), which focus on enhancing people's well-being and capabilities rather than solely on economic growth.

The qualitative approach is crucial for understanding the underlying social phenomenon behind the DD undertaken by villagers, as this resulted in significant carbon emissions and underscores the villagers' heavy reliance on forest resources. Apine et al. [29] defined local communities that rely heavily on natural resources for subsistence as vulnerable to natural disasters. This vulnerability leads to ongoing resource depletion, which in turn threatens human health and is closely linked to climate hazards. Pramova et al. [27] explained that the severity of adverse climate-hazard impacts depends on the system's vulnerability; that is, negative impacts arise not only from exposure to a climate hazard but also from high sensitivity to it and limited adaptive capacity.

Previous studies have gaps that direct the novelty of this article. First, most previous studies have highlighted unclear processes regarding stakeholders' expected co-benefits, as well as a lack of clarity on who receives what and how to overcome institutional barriers, leading to the general phenomenon of "lost in translation" between achieving the mitigation target and improving socio-economic livelihoods. Second, this research is conducted in West Kalimantan province because it hosts various climate change-related programs, including the REDD+ program. However, scientific studies on the REDD+ program in this region are scarce, and even the current studies are limited in highlighting that the common target of climate mitigation programs was to reduce emissions to the intended baseline [30], and highlighting that most of the stakeholders, especially villagers, had a poor understanding of the quantitative mitigation target due to a lack of knowledge about it and the required actions aligned with their livelihood intentions [11]. Apparently, the novelty of this article lies in the REDD+ program in West Kalimantan, which could address the situation and provide a translation strategy that can be investigated in a qualitative context. Thus, identifying the governance of the REDD+ program and the tool for sustainable land management enables stakeholders to maximize the utility of the intervened areas amid climate change mitigation actions, thereby sustaining agricultural-forestry activities in the region.

This paper aims to analyze stakeholders' recognition of co-benefits within the REDD+ mechanism. This objective is developed through two research questions formulated in response to the identified research gaps above. First, what conditions brought the stakeholders together to achieve the mitigation target while improving villagers' livelihoods? During implementation of the REDD+ program, villagers were actively involved and became key stakeholders, demonstrating their agreement and understanding of the program's mitigation target. Whenever villagers are reluctantly involved in the program and continue practicing traditional farming, this contradicts the REDD+ mechanism; therefore, achieving the mitigation target is more likely to fail. Second, what co-benefits could stakeholders derive from their involvement in the REDD+ program? Villagers involved in the program supported the mitigation target and participated to the extent of their capacity. Hypothetically, the recognized co-benefits are local and can offer greater economic benefits, thereby diverting livelihoods away from deforestation and forest degradation.

Materials and Methods

Study Area

The research focuses on the second intervention area, or Demonstration Area (DA) #2, which covers seven villages in Batang Lupar Sub-District, Kapuas Hulu District, West Kalimantan Province, Indonesia, between 2018 and 2019: Mensiau, Labian Ira'ang, Sungai Ajung, Sungai Abau, Lanjak Deras, Labian, and Melemba (Figure 1). The villages were involved in the REDD+ program, managed by FORCLIME (Forest and Climate) FC (Financial Cooperation), initiated by the Government of Indonesia (GOI) in cooperation with the Government of the Federal Republic of Germany (GOFG), implemented through the Kreditanstalt für Wiederaufbau (KfW), or the Investment and Development Bank of Germany, and carried out between 2013 and 2020.

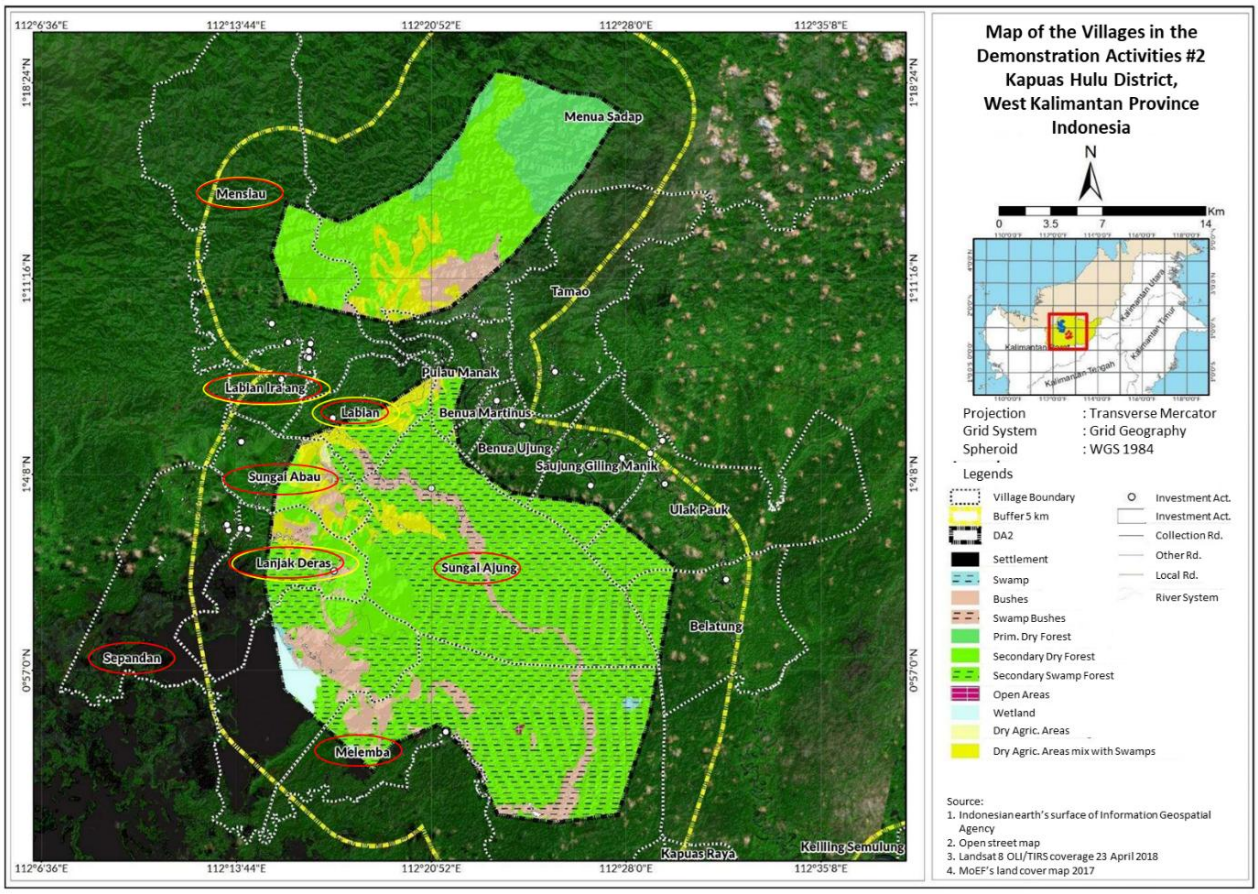


Figure 1. Research Sites of the DA#2 in the Batang Lupar Sub-District, Kapuas Hulu District, West Kalimantan Province, Indonesia. Analysis by the FORCLIME FC using the universal transverse mercator (UTM) WGS 1984 projection system, sourced from the Landsat 8 OLI/TIRS for the coverage dated April 23rd, 2018, and the land cover map issued by the Ministry of Environment and Forestry of Indonesia (MOEF) (now the Ministry of Forestry/MoFor) in 2017.

This site is characterized by upstream hilly terrain featuring secondary peat swamp areas, ecologically linked to the Betung Kerihun-Danau Sentarum National Park. Socially, the area is home to the Iban and Embaloh Dayak Sub-Tribes. Critically, portions of Labian and Mensiau occupy land previously held by the three former logging companies: PT Surya Ketapang Lestari, PT Alfa Teguh Prima, and PT Lanjak Deras Jaya Raya. Currently, the Forest Management Unit (FMU) for Production (*Kesatuan Pengelolaan Hutan Produksi*/KPHP Kapuas Hulu), a subordinate of the local government, manages these areas as the technical working unit (*Unit Pelaksana Teknis*/UPT) of the MoFor at the national level. Longitudinal follow-up in 2023 through visits to the Labian and Mensiau Villages to evaluate post-program situation variability.

Research Ethics, Informed Consent, and Positionality

Ethical approval for field investigations was granted in accordance with institutional research protocols. Before conducting focus group discussions (FGDs) and in-depth interviews, we obtained consent from all participating community members, village elders, and local government officials. I explicitly informed participants of the research objectives, the voluntary nature of their participation, and their right to stop or withdraw at any time without consequences. I anonymized all personal identities in transcripts and analytical records. Furthermore, the lead author maintained a professional working relationship with the FORCLIME FC program during the research activities and analysis phase. This includes research conducted after the program was discontinued in 2022. To minimize potential evaluator bias, the team had maintained data integrity through a rigorous processing phase in which all interviews and FGDs were recorded, transcribed into field notes, and systematically coded. Moreover, any findings were cross-validated through triangulation with official documents on the implementation of the FORCLIME FC programs, secondary administrative records, and peer debriefing with co-authors not affiliated with the program.

Focus Group Discussion (FGD)

This study adopts a qualitative research approach [31] and uses a case study strategy [32,33]. Data collection was conducted through FGD sessions within the Sub-District of Batang Lupar, attended by villagers from each village. The FGD sessions were attended by 33 villagers, comprising 7 females and 26 males, aged 25 to 50. Participants were invited through the FORCLIME FC network based on their several functions: 1) Village facilitators (code: FD), 2) Field assistants (code: PL), 3) Members of the demonstration plots, 4) Women's groups of demonstration plots, and 5) Village and sub-district authorities.

The session lasted approximately four 4 hours through a formal meeting format. To ensure data integrity and uphold the principle of openness, a researcher served as an independent moderator and facilitated dialogue on program familiarity, co-benefit recognition, and community sentiment regarding the shift from swidden cultivation. The FGD session was guided by the general questions with English translations, as follows: 1) Are you familiar with the FORCLIME FC program? 2) What activities does FORCLIME FC develop? 3) Which activities are your focus? 4) What individuals or institutions are involved in implementing the FORCLIME FC program? 5) What roles do these individuals or institutions play? Meanwhile, the key questions during the FGD as follow-up questions are: 1) What is your perception of the implementation of the FORCLIME FC program? 2) Do you think the FORCLIME FC program is beneficial, and who are the beneficiaries? 3) What advantages/benefits have you gained from the program? 4) If it is not beneficial, what should be done? 5) What are the obstacles and weaknesses of the program? 6) Is it necessary to continue the FORCLIME FC program, and who should oversee its sustainability? 7) What intervention activities can prepare the community to continue implementing the program? 8) Why are you willing to participate in these activities?

In-Depth Interviews and Sampling

The research transitioned from FGD to non-structured in-depth interviews to triangulate and deepen the dataset. Key informants from the villages of Labian, Labian Ira'ang, Lanjak Deras, and Mensiau were initially selected using a purposive sampling approach [34]. This was followed by snowball sampling, which proved essential for identifying the most reliable informants, including village leaders, customary (*adat*) heads, and active participants in alternative livelihood groups (e.g., non-timber forest product/NTFP processors and silvofishery managers), and among general villagers beyond the program's group, who were mimicking the implementation of program activities and the demonstration plot. The interviews were conducted in a casual setting over 40–75 minutes during visits to their homes, yards, the community's gathering place (*warung*), the village's educational hut (*pondok belajar*), and offices. While this strategy provided deep qualitative insights into adoption pathways, it introduces inherent selection bias. Community members who opted out of the program and were not selected to participate were still underrepresented during research activities. Consequently, the findings reflect the socio-economic dynamics of adopting households, and caution is warranted when generalizing these outcomes to non-adopting populations across broader tropical forest regions. The group of informants is depicted in Table 1.

Table 1. Groups and number of key informants divided into 7 groups with various numbers of interviewees. The number discrepancies were based on the interviewees' position in the community and/or local institution, completion of the data/information, and saturated information.

Groups	No. of Interviewees (persons)
General villagers	20
Villagers with a position in public administration	2
Villagers with a position in program management	10
Program manager at the district level	5
Program manager at the national level	4
Authorities from the district government	4
Authorities from the provincial government, including technical working units (UPT) of the national ministry	4

Data Collection Instruments

Data collection was guided by structured instruments focusing on the following thematic areas: 1) Program perception and governance: institutional roles, awareness of activities, and the efficacy of consensus-building versus stakeholder conflict; 2) Livelihood and behavioral shifts: changes in primary employment, perceptions of the current state of swidden cultivation (use of fire, potential for illegal logging), and forest encroachment; 3) Economic impact and sustainability: identification of beneficiaries, marketability of new products, business

opportunities, and the capacity for self-sustenance post-funding; and 4) Capacity building: development of soft skills and the necessity of continued external oversight. After transcription, the FGD and interview data were used to conduct macro- and micro-level analyses using structural critical discourse analysis (CDA).

Analytical Framework: Structural Critical Discourse Analysis (CDA)

The research utilizes structural critical discourse analysis (structural CDA) to examine the nexus of language, ideology, and power through the entanglement of micro- and macro-level analytical contexts. This framework draws on Fairclough's three-dimensional CDA, which employs a protocol integrating textual, discursive, and social practice analyses [35–37], and on van Dijk's focus on elite dominance and policy texts [38]. Crucially, this structural CDA also incorporates the work of Nikander and Vehviläinen, who use CDA to analyze official documents, identify discursive production and deconstruct power relations, revealing how policy-driven ideologies impact social context [39]. The structural CDA categorizes data into two distinct yet interacting levels of discourse (see table 2).

Table 2. Micro- and Macro-Level Analysis Based on the Structured CDA's Screening. The Focus Areas Represent the Social Phenomenon Embedded in Each Level of Analysis and are Interconnected.

Level of analysis	Focus areas
Micro-	Social phenomena shaped by social interaction and verbal communication; villager perceptions of the program; co-benefit recognition; impact of human resources and identity on reducing deforestation and degradation.
Macro-	Insitutional regimes and policy structures; knowledge co-production and facticity; the impact of Law 23/2014 on institutional change, stakeholder role-play, and program termination.

Hence, I developed the structural CDA in Figure 2 because it explains how institutional mechanisms enabled livelihood improvements through the co-benefits of the REDD+ program in contributing to emission-reduction performance. The analysis used a multi-tiered structural CDA framework, drawing on manually analyzed field notes, interview transcripts, and policy documents from Law 23/2014 concerning local government, which influences macro-level analysis as depicted in Table 2 above, integrating quantitative metrics from official project monitoring systems and government census data to connect qualitative evidence on livelihood change. It began with the social phenomenon through villagers' involvement in the program and the dynamics that emerged across the program timeline and then proceeded to a three-stage analytical procedure, as follows.

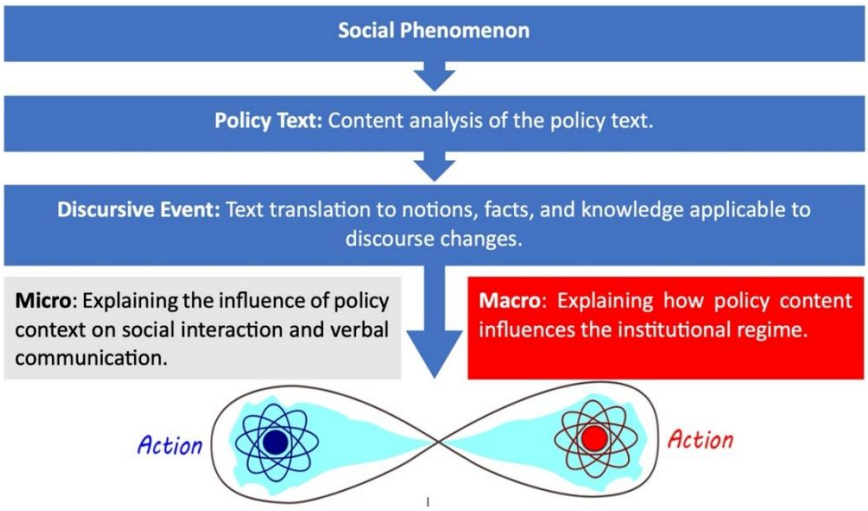


Figure 2. Workflow of structural critical discourse analysis in analyzing the interconnection of macro- and micro- level of analysis based on the factual social phenomenon. Adopted and modified from Fairclough's three-dimensional critical discourse analysis.

Finally, the synthesis examined the interaction between micro- and macro-level findings and interpreted them as grounded themes to answer the research questions. Practically, the workflow of structural CDA is initiated by a stage evaluation of social practice/micro-level analysis, as this stage identified recurring language, meanings, and social interactions surrounding "forest protection," "swidden cultivation," and

"livelihood benefits," with particular attention to how these discourses shaped villagers' perceptions and practices. It then evaluates discursive practices, examining how villagers' views of swidden cultivation and their participation in program activities interacted with institutional mechanisms, particularly how FORCLIME FC interventions reshaped perceptions of livelihoods based on forest resources. Finally, the textual policy governance/macro-level analysis assessed the structural power dynamics created by the implementation of Law 23/2014 and considered how these legal and institutional shifts enabled or constrained the generation of local co-benefits.

Results and Discussion

Results

Policy Dynamics

During the initial implementation of the REDD+ program in 2013, the management of the FORCLIME FC program was carried out under the KPHP Kapuas Hulu as a technical working unit of the MoFor for the District of Kapuas Hulu, serving as the technical coordinator of the investment management in the intervened areas (DA#2). Meanwhile, the Forestry Agency of the District of Kapuas Hulu served as the district-level investment manager for MoFor's assistant task force. Therefore, the FORCLIME FC's synchronized and integrated processes were carried out through collaborative management (co-management) between the KPHP Kapuas Hulu and the district forestry agency, both as district authorities working units (*Satuan Kerja Perangkat Daerah/SKPD Kabupaten*) and as the district program management unit (DPMU). This mechanism was ineffective in implementing the FORCLIME FC program because of its complex, extensive bureaucracy in program management and investment fund disbursement, which led to the program being deprioritized and considered less important (the district-level interviewees, personal communication, August 2018; January 2019; and June 2023). Additionally, the responsibility to disburse the investment fund was viewed as an additional burden, with no clear outcome for achieving each institution's mandates within the DPMU.

Then, Law No. 23 of 2014 on local government (Law 23/2014) was enacted, reorganizing the relationships among levels of government across all sectors, including fisheries, mining, and forestry. The enactment aimed to accelerate improvements in social welfare in the local context, given the separation of authority among national, provincial, and local governments [40,41]. Law 23/2014 introduced substantial changes to forestry governance, which was previously divided between the central and provincial governments. District governments had limited authority over the district, or only over the city's forest park.

Macro-level analysis shows that implementing Law 23/2014 led to the disbandment of DPMUs' co-management because the provincial government assumed authority over KPHP Kapuas Hulu. The district-level KPHP Kapuas Hulu was then divided into two types of FMU/KPH: the FMU for the Protection of Kapuas Hulu Utara (KPHL Kapuas Hulu Utara) and the FMU for the Production of Kapuas Hulu Selatan (KPHP Kapuas Hulu Selatan). The district-level management of the FORCLIME FC program became independent with the establishment of the DPMU, staffed by professionals rather than government-assigned personnel. The DPMU is directly responsible to the National Program Management Unit (NPMU) in the MoFor. This dynamic situation yields a positive outcome: the DPMU can now avoid the complex management arrangement, directly execute investment disbursements, and focus more on supporting the areas under intervention (FORCLIME FC Program's professional staff, also known as program managers, personal communication, August 2018). In practice, the changes manifested can be seen in Table 3 below:

Table 3. Governance change between the pre- and post-law 23/2014. The changes were identified through 5 features of program governance.

Feature	Pre-law 23/2014 (co-management)	Post-law 23/2014 (independent)
Management model	Collaborative (KPHP & District SKPD)	Independent and Professionalized
Reporting line	District-level SKPD/Local Government	Direct to NPMU/MoFor
Fund disbursement	Complex; perceived as an administrative burden	Direct execution; focused on intervention
Primary personnel	Government-assigned (SKPD)	Professional program managers
Institutional focus	Conflict between mandates and authority	Outcome-oriented; optimized functions

Particular Co-Benefits Obtained by the Villagers

Village and field observations were conducted concurrently with the FGD and in-depth interviews, as carried out in Mensiau Village, one of the Dayak Tribe's villages. Several findings related to intensive swidden cultivation were noted, including slash-and-burn activities and the production of dry-land paddy irrigated by rainfall. In particular, Mensiau Village had traditional indigenous longhouse wooden apartments, known as *rumah betang* (see Figure 3), where 25 families worked systematically during the swidden cultivation season to cultivate dry-land paddy. They then distributed the rice yields evenly among themselves, and the rice lasted until the following season. The villagers also received several by-products of swidden cultivation, including timber for building and repairing the *rumah betang*, as well as charcoal produced by burning activities commonly left in cultivation areas.

Following the end of the dry-land paddy cultivation period, the fallow period began, and cultivation of agroforestry products was initiated (Head of the Educational Hut of Mensiau Village, Personal communication, August 2018). Agroforestry cultivation includes a range of fruit trees, rubber, rattans, kelulut honey, and multi-purpose tree species (MPTS). In addition to charcoal application to the land, cultivating agroforestry products during the fallow period is intended to increase soil acidity, a process that takes at least 15 years and up to 25 years to complete one full rotation of primary succession and build soil fertility, and to restore forest land cover naturally.



Figure 3. *Rumah betang* of Mensiau Village. In the context of program management, the *Rumah betang* also functions as the institution for the program's general assembly.

These traditional practices depended on the agricultural calendar to determine cultivation timelines for the areas (field evidence during visits to the Mensiau Village and Labian Village, August 2018). The four main phases are slashing (June–August), burning (August–October), planting (October–December or January), and harvesting, including planting agroforestry commodities (January–February). Between March and June, they rest to hold indigenous and cultural ceremonies known as *Gawai Dayak*. Therefore, by maintaining this farming practice, they preserve their indigenous knowledge and way of life across generations as subsistence communities (Villagers of Mensiau Village, personal communication, August 2018).

The rice production during the swidden cultivation period is intended to fill the village's barns and serve as the village's and the family's savings without monetary value (Tribal elder of Mensiau Village, Personal communication, August 2018). This situation is reflected in the local proverb: "*Rice in the barns remains, so is our life.*" To generate quick cash to fulfill their subsistence needs, the villagers rely on agroforestry products, which are considered to have a higher monetary value than rice [8]. From the production of rubber latex by the villages, it is evident that the product was traded in cooperation with a private company called hock tong private limited (PT Hock Tong), based in Pontianak, the capital city of West Kalimantan province (Caretaker of Mensiau's educational hut, personal communication, August 2018 & June 2023, also by the Head of Labian Village, personal communication, June 2023). The other agroforestry products were traded in the local market and even exported to Malaysia, a neighboring country.

The traditional practices of swidden cultivation, including restoring soil fertility, meeting subsistence needs, and preserving indigenous culture, are considered the primary factors driving DD (FD and PL of FORCLIME FC, personal communication, August 2018 and January 2019). Additionally, increased annual cropping intensification in slashed-and-burned areas, such as palm oil and rubber, serves as a livelihood alternative because of its higher economic value. Villagers also emphasized that their unusually long current dry season has disrupted the planting period for both rice and agroforestry crops (general villagers of Labian Ira'ang, Mensiau, and Labian Villages, personal communication, August 2018). The agricultural calendar has become increasingly inaccurate at predicting weather conditions for cultivation seasons, and this risk is now widespread. The significant risk is the inability to finance needs beyond subsistence, including school tuition contributions, daily necessities, healthcare expenses, and other unexpected costs. This situation is exacerbated by the shortened fallow period, reduced to 5–10 years per full rotation.

Stakeholders had expressed awareness of the need to shift villagers' livelihood resources toward more permanent, ecologically sustainable, economically viable, and culturally acceptable ones. This awareness led the program managers to prohibit swidden cultivation, as it is a factor in the DD (DPMU team leader of Kapuas Hulu, personal communication, August 2018). But the FORCLIME FC faced backlash from the villagers over this prohibition due to the belief that swidden cultivation was the only means of supporting villagers' livelihoods, limited understanding of the program's mitigation targets and actions, and a lack of knowledge and experience (general villagers in all visited villages, personal communication, August 2018 & January 2019). Therefore, the strategy implemented to promote livelihood alternatives that could increase villagers' economic welfare required an approach that integrates both forest- and non-forest-based activities. The identified and agreed alternatives as co-benefits generated greater economic value than swidden cultivation, while still aligning with the REDD+ program target, are: (1) a permanent agricultural plot; (2) a horticulture demonstration plot; (3) a nursery plant; (4) cultivation of non-timber forest products: honey, rattan, bamboo, and natural dyes; (5) silvofishery upon the Arowana's pond; and (6) planting the medicinal plant of *Mitragyna speciosa*. These linkages between stakeholders, co-benefits, & respective outcomes can be seen in Table 4.

Table 4. Linkages between stakeholders, co-benefits, and respective outcomes. It is supposed to be evidence of the interconnection between mitigation (emission reduction) and welfare (socio-economic) outcomes.

Stakeholders	Selected co-benefits / activities	Mitigation & welfare outcomes
Villagers	Permanent agricultural plots. Horticulture demonstration plots. Nursery plants silvofishery (arowana ponds) medicinal plants (*Mitragyna speciosa*).	**Mitigation:** Advancing the sustainable livelihood approach **Welfare:** Increases economic welfare by providing permanent livelihood sources and ensuring food security.
Villagers & program managers	Non-timber forest products (NTFPs): honey, rattan, bamboo, and natural dyes.	**Mitigation:** Reduces dependence on swidden cultivation, aligning with REDD+ indicators. **Welfare:** Generates "quick cash" to support daily necessities and creates tradable commodities with higher monetary value than rice from swidden cultivation for local/export markets.
Program managers	Livelihood alternatives that integrate forest- and non-forest-based activities.	**Mitigation:** Achievement of carbon emissions reduction by limiting or shifting the swidden cultivation. **Welfare:** Increases an opportunity for the agreed-upon co-benefits by resolving inter-village conflicts over land-use disputes and creating access to forest resources for NTFP cultivation.

Authorization of Co-Benefits by the Program Manager

The program implemented the recognized co-benefits at the DA scale in each village. The program manager explained that FORCLIME FC developed the DA through participatory land use planning (PLUP), involving all relevant stakeholders. The PLUP process created an integrated area encompassing multiple land uses, including village areas, forests, and other land uses suitable for the effective scale of activities in which the program can intervene. Through negotiation, the process played a crucial role in determining the site's suitability based on its social, economic, and biophysical characteristics, clarifying ground checks, and establishing the agreed-upon area boundary among stakeholders. On the other hand, villagers' participation in the PLUP process was crucial to identifying the intended co-benefits in the DA and achieving a mutually agreed outcome, as implementing all co-benefits across all DAs is not feasible due to limitations in the local land-use context.

The PLUP facilitation was conducted to achieve mutual agreement among stakeholders on land use in specific areas within the village [11], ensuring sustainable land use that promotes economic productivity and carbon sequestration [42]. These efforts support the government program to enact and enforce village boundaries, resolve tenurial conflicts among villagers and between villages that arose from the prohibition's indirect impact on swidden cultivation, and establish mutual agreements among stakeholders [42]. Notably, PLUP processes involved village facilitators (FDs/*fasilitator desa*) in each village and a field assistant (PL/*pendamping lapang*), who helped determine the co-benefits for the assigned DAs during the villagers' general assembly meeting. The FD is a village resident selected to participate in the program, taking on a role to assist villagers in exploring potential co-benefits, developing the proposal for submission, and managing the disbursement of co-benefit investments, whereas a field assistant (PL) serves as a coordinator of the FDs at the sub-district level, bridging the DPMU and the village (FD and PL of FORCLIME FC, General villagers of Labian Ira'ang, Mensiau, and Labian Villages, and DPMU team leader of Kapuas Hulu, personal communication, August 2018 and January 2019).

Following the villagers' general assembly meeting, the recognized co-benefits were depicted in the proposal, and the results were forwarded to the DPMU through the PL. Furthermore, the proposal's suitability was reviewed to ensure that the scope of activities aligns with the program's mitigation mission (specialists of the DPMU Kapuas Hulu, personal communication, August 2018 and January 2019). Once approved, the proposal is submitted to the NPMU at the MoFor for final approval to ensure it aligns with the allocated budget (technical experts of the NPMU, personal communication, August 2018 and January 2019). The proposed co-benefits should align primarily with the intergovernmental agency's planning program at both the local and national levels, ensuring the activities are non-destructive, offer greater economic value, and can continue once the program is terminated. After NPMU authorization, the investment fund is disbursed for the respective co-benefits proposal.

The investment fund disbursement was intended as seed capital and represents the opportunity cost for villagers seeking to achieve the mitigation target without compromising their livelihoods (FD and PL of FORCLIME FC, personal communication, August 2018). While supporting the program, villagers must leave their business-as-usual activities, such as swidden cultivation, logging, or working as migrant workers in neighboring cities or even neighboring countries. The villagers' working group used the investment fund, and it consisted of villagers seeking to pursue a specific co-benefit (FD and PL of FORCLIME FC, personal communication, August 2018). Therefore, different working groups achieved several co-benefits in one village, guided by the REDD+ program's governance and involving a cycle of investment activities, as depicted in Figure 4. Afterward, the FD and PL evaluated co-benefit progress for reporting to the DPMU/NPMU and to obtain the NPMU's final evaluation. The evaluation aimed to determine whether the working group met the program's expectations for promptly calculating carbon emissions reduction performance (FD and PL of FORCLIME FC, personal communication, August 2018 and January 2019). During co-benefit implementation, members of the villagers' working group taught one another through activities such as commodity cultivation, market intelligence, and market negotiations. In addition, due to the program's limited capital, a revolving fund was introduced to reinvest in similar or other prospective working groups (general villagers of Labian Ira'ang, Mensiau, and Labian Villages, personal communication, August 2018).

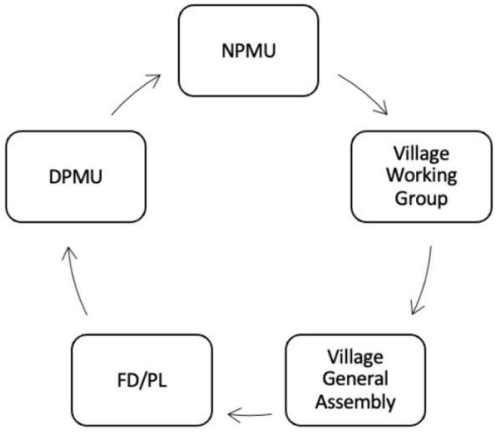


Figure 4. Governance of the REDD+ Program. Program actors engage in a continuous back-and-forth process to ensure investment integrity.

In addition, a transparent investment mechanism has been implemented, and an assisting mechanism has been established under the on-budget-on-treasury (*on-on*) mechanism. The on-on mechanism adheres to the budget allocation and disbursement process, in line with the financial commitment from the Government of the Federal Republic of Germany (GOFG) through the Kreditanstalt für Wiederaufbau (KfW) of 88.83% and the MoFor of 11.17% of the total budget [42]. Because the GOI's involved in the national budget, the on-on mechanism follows the GOI's state financial system. The *on-on* employs various approaches for the investment program, such as when the program cannot be executed promptly because villagers' preferences are influenced by seasonal calendars and natural disasters.

As a troubleshooting mechanism, the program introduced a non-objection letter (NOL), allowing any changes that would affect implementation to be noted under the NOL and then proposed and agreed upon at the national level (technical experts of the NPMU, personal communication, August 2018 and January 2019). This program's governance ensured financial rigidity, so the villagers needed an extended timeline to proceed with the co-benefit proposal (FD and PL of FORCLIME FC, personal communication, August 2018). To ensure the program's integrity, transparency, and proper handling of its complexity, a capable human resources team was necessary to analyze the system, assist with implementation, and produce accurate financial reports (specialists of the DPMU Kapuas Hulu, personal communication, August 2018 and January 2019). This rigidity was also intended to minimize program overlap among government institutions, ensure program continuity, and eliminate room for planning deviations that could compromise program integrity (DPMU team leader of Kapuas Hulu and the village community empowerment agency of Kapuas Hulu District, personal communication, August 2018). In line with this socio-economic intervention, the program's mitigation target showed a clear impact (Table 5).

Table 5. Carbon monitoring results at the DA#2 by the evaluators. The data were extracted from evaluation reports by the third-party organizations.

Evaluators	Year of evaluation	Emission reduction performance (tCO_2e)
3rd party – FORCI Dev	2018	47,411
In-house – FORCLIME FC	2020	293,142
3rd party – PT Remark Asia	2022	132,876

Source: [42,43].

As shown in Table 5 above, mitigation performance from different evaluators is assessed for the multi-year carbon monitoring outcomes across the period: for a mid-term program from 2013 to 2017 (2018), at the end of the program over the program timeline from 2013 to 2020 (2020), and post-program calculated from a mid-term period of 2015 to 2022 (2022). Eventually, the mitigation performance calculated at the end of the program in 2020 was 293,142 tCO_2e or –41,877.42 tCO_2e per annum over the program timeline. Meanwhile, the post-program evaluation shows continuous emission-reduction performance of 132,876 tCO_2e under two conditions: with program intervention from 2015 to 2020 and without program intervention from 2020 to 2022. These differences stem from variations in mitigation performance values, primarily due to differences in evaluation periods and objectives, reference emission levels, carbon pools considered, data resolution and satellite imagery used, and emission factors and equations [42,43].

Nevertheless, these emission trends strongly correlate with improvements in the Village Development Index (IDM) classifications, as detailed in Table 6, showing the socio-economic impact on the villagers' economic welfare. The program uses the IDM under five status categories [42], a national tool for evaluating villages' progress, independence, and welfare in Indonesia [44]. This is an important tool for the program to evaluate welfare progressiveness, since the intervened activities by the program or agreed-upon co-benefits were carried out as part of the community's empowerment program by the district government, as well; thus, the socio-economic target was set to achieve at least an 80% improvement compared to the initial program implementation (DPMU team leader of Kapuas Hulu and the village community empowerment agency of Kapuas Hulu District, personal communication, August 2018). The progress of village statuses over the program timeline indicates that in 2022, villages transitioned from very underdeveloped village status, which was attributed to the intervened villages, to none. Some other villages also transitioned from "Developing" to "Developed" to "Independent" village statuses.

Table 6. Village statuses based on the village development index (*Indeks Desa Membangun/IDM*) classification. The IDM is regulated under *Peraturan Menteri Desa, Pembangunan Daerah Tertinggal, Dan Transmigrasi Republik* Indonesia No. 2 of 2016, which shows welfare improvement based on 3 criteria: social, economic, and ecology/environmental.

Status	Number of villages in the year of evaluation	
	2016	2022
Independent village	-	4
Developed village	-	7
Developing village	1	4
Underdeveloped village	6	1
Very underdeveloped village	9	-

Source: [42].

Discussion

The policy dynamic stemmed from the DPMU situation prior to the enactment of Law 23/2014, due to discrepancies in mandates between the KPHP Kapuas Hulu and the district forestry agency. Starting with Government Regulation No. 6/2007 and the MoFor Decree No. P.6/2009, which regulates the KPHPs has authority over forests within the forest areas to establish the boundaries of working areas, conduct forest inventories, develop short- and long-term forest management plans, and communicate with local and indigenous communities [45,46]. These mandates are integral to the typical forested areas that the central government manages by transferring its authority to the MoFor [47]. Meanwhile, the district forest agency's authority is limited to forest management on private land or on forests managed by stakeholders beyond the MoFor, including various site-level forest management activities and the implementation of national, provincial, and district forest policies [47,48]. Therefore, KPHs must maximize their payoff based on how fully they implement their assigned mandate in accordance with regulations, whereas the district forestry agency, by contrast, has no specific payoff from its actions there because it lacks mandates related to the forest areas.

The enactment of Law 23/2014 introduced dynamic changes before and after its implementation and created a new form of stakeholder interaction, leading to institutional optimization of program governance. This outcome has helped stakeholders resolve jurisdictional authority discrepancies, streamline reporting lines, and reset the DPMU's function to a more professional one, giving it the agility needed to fulfill program objectives. Due to this policy dynamic, the district government can only take limited responsibility in sub-management aspects of forestry: (1) forest management, (2) biodiversity conservation and its ecosystem, (3) training and education, public counseling, and community development, and (4) inter- and intra-district/city watershed management within one province [7]. Meanwhile, MoFor also manages forestry-based programs beyond these four sub-management aspects through district management. After all, this new nature created by Law 23/2014 has become a strategic external environment factor that strongly influences stakeholders' actions to achieve their expected outcomes [49]. These changes, which created a new balance in stakeholders' relationships in the local context, resulted from each stakeholder responding to the others, forming a combination of action strategies that maximized each stakeholder's payoff [50]. In the context of implementing the FORCLIME FC program, the program continued until it was completed in 2022.

Policy changes or updates should be made when the existing policy can no longer resolve the social phenomenon [38]. Changes resulting from the implementation of Law 23/2014 become self-enforcing, self-sustaining, and can only be disrupted by another external factor that significantly affects the law, as it ensures the sustainability of the REDD+ program to shift villagers' livelihoods toward non-swidden cultivation and avoiding the DD in forest areas [10,11,24,47]. However, the shift was intended to remain aligned with customary practices and be based on natural resources, and it can be achieved by elevating the value of agroforestry products cultivated during the fallow period, all of which are in line with the philosophical essence of *rumah betang* (professional staff of the DPMU Kapuas Hulu, members of demonstration plot of Labian Village, and Head of the Educational Hut of Mensiau Village, personal communication, August 2018, January 2019, and June 2023). According to the Dayak's indigenous law, a *rumah betang* is the center of their indigenous territory, surrounded by rivers and ponds as water resources, dry farm fields from swidden cultivation, undisturbed primary forests as a source of natural regeneration, hunting grounds, bush and

secondary forests, and areas with various agroforestry products [51,52]. This latter outcome of indigenous law regarding the agroforestry product was increasingly seen as a sensible alternative to non-swidden cultivation [8]. Coupled with current socio-economic challenges, primarily due to population growth, market pressure, conservation policies, and the shortened fallow period, which was reduced to 5–10 years per full rotation (general villagers of Labian Ira'ang, Mensiau, and Labian Villages, personal communication, August 2018 and January 2019), that has significant impacts on soil fertility in swidden cultivated areas, potentially hindering nature's ability to complete primary succession; making the swidden cultivation tends to fail as a livelihood source [8,52–54].

These agroforestry products are integral to their customary daily lives, having long been practiced beyond their intended purpose of restoring soil fertility, and are tradable [8,51]. Moreover, it might be an answer to the concern of the opponent of swidden cultivation, highlighting that the conversion phase, which involves the clearing of forest land, is considered destructive, unsustainable, and poses a potential risk to the implementation of REDD+ programs, as it can release a substantial amount of carbon emissions [8]. Moreover, pressure from a shortened fallow period that intensifies annual cropping also comes at the expense of reductions in customary practices, socio-economic welfare, and livelihood options, leading to changes in land use [53–55]. Apparently, the products from agroforestry cultivation activities, as depicted in the agreed-upon co-benefits in Table 4 above, serve as villagers' livelihood strategies to address their high dependence on forest resources, particularly by shifting to non-swidden cultivation.

The shift relies on the understanding that the economic value of the co-benefits is comparable to or exceeds that of swidden cultivation [56]. The recognized co-benefits were also perceived as assets for sustaining the villagers' livelihoods, defined as the capabilities, goods, and activities necessary for survival [57]. Enhancing access to livelihood assets strengthens households' capacity to withstand stress and shocks, leading to better livelihood security and sustainable livelihood opportunities for the next generation [58]. The livelihood assets comprise five types of capital: natural (e.g., land, resources), physical (e.g., infrastructure, gear), financial (e.g., incomes, savings), human (e.g., health and education), and social capital (social ties within the community) [57,59]. These assets form a network of mutually influential factors, a pentagon of assets, that depicts the interconnections among the five capitals that shape one's livelihood, as seen in Figure 5 [59,60].

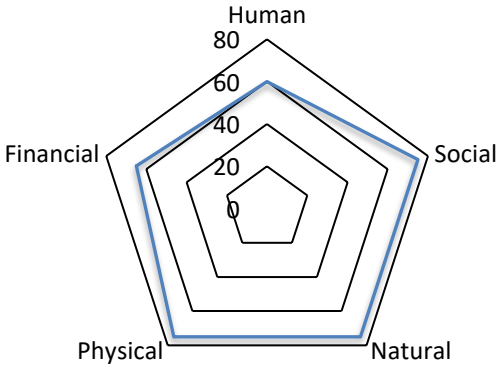


Figure 5. Case of the pentagon of assets in the REDD+ program of Labian Village. The pentagon assets were intensively used, as the village-dependent forest often lacks these 5 assets.

Tora et al. [58] noted that households lacking access to this asset are particularly vulnerable to any stresses and shocks that exacerbate their situation. Apine et al. [29] explained the context of vulnerability as the association of natural disasters as threats to human existence and ongoing resource depletion, all of which are intricately linked to the effects of climate hazards, such as crop failure, human health epidemics, extreme weather, and any significant changes to livelihood resources. The intertwining of these effects with the context of vulnerability reduced villagers' ability to adapt to subsequent climate-hazard impacts and increased their sensitivity to their severity [27].

Nonetheless, an asset-by-asset evaluation of the pentagon interconnection capital depicted in Figure 5 revealed systematic community capacity building. As seen from the human capital, capacity-building initiatives significantly elevated technical skills in non-timber-based activities and products, such as rattan weaving, wild honey harvesting, sustainable aqua-forest culture or silvofishery, and composting. At the

demonstration plot scale, the program replaced pre-swidden cultivation. Meanwhile, through social capital development, the program activities revitalized traditional *rumah betang* governance structures. Before the program, the *rumah betang* was necessary for fire-intensive land management practices. But the program intervention shifted its function to strengthening collective bargaining power and internal dispute resolution, up to the formalization of binding village regulations (*peraturan desa*) regarding customary land-use rules intra- or inter-village.

Moreover, regarding natural capital, the findings clearly show that ongoing efforts to shift swidden cultivation have preserved the remaining primary forest areas, thereby supporting reforestation and afforestation. It directly protects ecosystem services, water regulation, and natural habitat stocks while securing sustainable harvesting zones for NTFPs and promoting enhanced carbon sequestration. The physical capital evaluation also showed that program interventions facilitated land-based planning, through the PLUP, of well-designed physical infrastructure, including post-harvest processing facilities, solar drying units, and improved water-management setups for silvofishery ponds. Lastly, financial capital increased as households diversified their revenue streams. Access to micro-grants and village-owned enterprises (*Badan Usaha Milik Desa*/BUMDes) reduced dependence on high-risk seasonal swidden cultivation, creating more stable year-round cash flows.

The latter statement on financial capital is supported by findings that swidden cultivation is primarily for subsistence needs, rather than providing liquid capital to finance daily necessities (see comparison in Table 4). Alongside a social stigma that selling the rice produced during the swidden cultivation season is considered a sign of extreme poverty, the cultivation requires a full year of labor-intensive effort for a single harvest with an increasingly risky outcome due to unpredictable weather patterns and shortened fallow periods. Because of customary perspectives and social stigma toward swidden cultivation and its products and by-products (e.g., timber for building and repairing the *rumah betang* and charcoal), the economic value was not identified. However, compared with the program intervention, a horticulture demplot in Labian Village showed an initial investment of approximately IDR 20 million in 2017 and reached its break-even point in less than one year. This performance led to a second investment of IDR 38 million in 2018. At the time of the 2019 field observation, the second investment had grown to IDR 50 million, or 250% of the initial investment in 2017. Meanwhile, group members (Personal communication, August 2018, January 2019) reported monthly profits of up to IDR 3 million (USD 166) from program-supported activities. This is higher than monthly sectoral wages set by the Government of West Kalimantan Province for Kapuas Hulu District, which was IDR 2.5 million (USD 140) [7]. Under group management, this result was sustained until the program's termination in 2020, and by the time of field observation in 2023, the investment had been used as seed capital for the BUMDes, including its property (Head of Labian Village, personal communication, June 2023).

The qualitative comparison shows that the program intervention does not suddenly prohibit traditional practices but replaces them with a stronger economic engine. Therefore, while swidden cultivation continued, limited to customary preservation and its products as savings, the program-based activities were intended to generate liquid capital. Eventually, based on asset-by-asset evaluation and economic value comparison, the sustainable livelihood approach can be defined as the assets, mediated by institutions or organizations, that enable the development of a livelihood strategy for income, within the specific context of vulnerability, in line with current trends and conditions [26]. Under this elaboration, the FORCLIME FC acted as a facilitator, mediating conflict resolution through the PLUP process and defining the livelihood strategy by identifying appropriate co-benefits for the villagers. Together with assisting in capacity building for stakeholders, including the enactment of local regulations on village boundaries, defining the right person for the right task at the village and sub-district levels, proposal development, financial reporting systems, up to the point of investment disbursement, and the implementation of revolving funds, it creates an opportunity for other possibilities of sustained financial income.

Afterward, in discussing mitigation performance from the implementation of the REDD+ program through the agreed-upon co-benefits, non-compliance with the intended target of DA#2 for 300,000–400,000 tCO_2e is evident. The program has achieved 97.71% of its minimum mitigation target. However, the annual actual emission for DA#2 for the 7-year program was –41,877.42 tCO_2e per annum, exceeding the expected baseline of –39,187 tCO_2e per annum [43]. These figures indicate that the program's interventions successfully steered villagers' livelihoods toward maximizing co-benefits, shifting them away from swidden cultivation. Meanwhile, the qualitative evaluation, using the IDM as an effective qualitative and institutional proxy for localized economic growth, shows that the village's welfare performance and status transition demonstrate the village's capacity under the program's intervention. It eventually led to parallel reductions in activities that could threaten the forest's emission-reduction capability. In particular, this improvement highlights the

focus on the quality of budget assistance and the involvement of village facilitators (FD and PL), extending beyond government assistance and confirming that socio-economic stability directly supports forest protection enforcement.

Conclusions

The research concludes that stakeholders recognize co-benefits as an essential "win-win" outcome that aligns climate mitigation with socio-economic welfare through a governance-driven approach. The critical condition for achieving mitigation targets while improving livelihoods was reorganizing forest governance, influenced by the enactment of Law 23/2014. It shifted management to a professionalized, independent model that streamlined fund disbursement and supported the identification and endorsement of six key co-benefits through facilitated participatory land-use planning (PLUP). It provided sustainable alternatives to traditional swidden cultivation and led to more than an 80% improvement in village welfare status, according to the Village Development Index (IDM). Ultimately, integrating villagers' agreed co-benefits with transparent institutional support enabled the program to achieve 293,142 tCO_2e, or 97.71% of its minimum emission-reduction target. This mitigation performance fell slightly short of the program's intended target, despite annual performance exceeding the calculated annual baseline. Nonetheless, the research results demonstrate that sustainable land management is most effective when it bridges the gap between macro-level policy and micro-level socio-economic realities. Notably, findings from the research processes are limited to the scope appropriate to the cultural context of Dayak tribal communities practicing swidden cultivation, the biophysical characteristics of upstream hilly areas in West Kalimantan featuring secondary peat swamp biophysics, and proximity to protected areas. Therefore, researchers should address issues beyond these study limitations before generalizing to broader REDD+ interventions. Because this study uses a qualitative case study focused on deconstructing specific social phenomena, power relations, and governance change through structural CDA, future studies should consider a quantitative approach to investigate the relationship between welfare improvement and emission-mitigation performance.

Author Contributions

HP: Conceptualization, Methodology, Investigation, Writing - Review & Editing.

AI Writing Statement

The author used Grammarly Pro to proofread the article draft, ensure consistency with scientific writing, and check for AI and plagiarism. The author also used NotebookLM to re-transcribe the interview recording. After using these tools, the author reviewed and edited the content as needed and took full responsibility for the publication's content.

Conflicts of interest

There are no conflicts to declare.

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