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Risk assessment of rubber plantations based on non-compliance with the FSC forest management certification standard

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Article Info

Abstract

The Forest Stewardship Council (FSC) certifies products from rubber plantations in Thailand for export worldwide. Therefore, access to FSC Forest Management (FM) certification is essential, as it influences the social, economic, and environmental sustainability of Thailand's rubber plantations. This study assessed the risk of rubber plantations due to non-compliance with the FSC-FM certification standard. The methodology involved four steps: collecting secondary data on rubber planting patterns relative to FSC-FM standard, determining initial risks using content analysis and brainstorming, conducting field risk assessments through in-depth interviews, FSC standard implementation checks, and a forest resource survey, and analyzing data to determine risk levels due to non-compliance using content analysis. Twenty-four rubber plantations were classified into four categories: rubber monocultures, rubber intercropping with wood-based plants, rubber intercropping with non-wood-based plants, and rubber intercropping with both wood and non-wood-based plants. The risk assessment revealed that most plantations were at very low risk (136 indicators), followed by high risk, moderate risk, and low risk (36, 20, and 19 indicators). High-risk factors were primarily associated with compliance with the law. The study suggests that risks related to each indicator should be addressed, and management strategies developed to mitigate these risks before seeking FSC-FM certification. The results of this research are beneficial to plantation managers, organization that promotes rubber plantations, and policymakers, who can use the findings to address the identified risks. They emphasize the development of management strategies and adherence to FSC principles to mitigate risks and improve compliance for expanded FSC certification for rubber plantations.

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Introduction

Thailand is the natural rubber world's largest producer and exporter (Department of International Trade Promotion, 2022). Thus, the rubber trees are one of the most important economic crops in Thailand that generate income and employ around one million families or up to six million people (Kongmanee et al., 2020) but also pose environmental challenges. Rubber plantations, if not managed sustainably, can lead to deforestation, loss of biodiversity, and soil degradation. The Forest Stewardship Council (FSC) certification promotes sustainable forest management practices globally. If forests are FSC certified, it confirms that forest products meet environmental, social and economic standards. This mechanism has had an impact on the industry and commerce that use wood and tree products as a production base as wood product importers may only prefer importing certified products (Duangsathaporn et al., 2019). Kuijk et al. (2009) provided a nuanced analysis, indicating that while FSC certification generally leads to improved management practices, the degree of compliance can vary significantly between different types of plantations. Natural forest operations often show higher compliance levels with FSC standards compared to monoculture plantations, which tend to struggle more with meeting biodiversity and social criteria. Forests vary from place to place, and management practices differ accordingly. Furthermore, the European Union (EU) has issued Deforestation-free products Regulation (EUDR), which the exporters of seven agriculture products must follow to be able to export products to the EU. They must adhere to these regulations to ensure that their products did not contribute to deforestation. The EUDR will have an impact on a range of Thai agriculture exports, in particular rubber and its derivatives, which are high-value Thai agriculture exports to the EU (European Union, 2023; Ministry of Foreign Affairs, 2023). If the rubber plantation can pass the FSC Forest Management (FSC-FM) standards, it will serve as a confirmation that at no point during the production was deforestation involved, in accordance with EUDR.

Despite the importance of FSC certification, many rubber plantations in Thailand face challenges in meeting the FSC standards. This is due to the lack of compliance and its implications for both the environment and the economy. A literature review found that forest management is certified by FSC, and there are only 19 certificates for rubber plantations in Thailand (Forest Stewardship Council [FSC], 2021), with only 0.6 percent of the total area under rubber plantation that have obtained an FSC-FM. Most of rubber plantations are under monoculture cultivation. Currently, given the crisis due to low rubber price, policies have been made to promote and support small landholders to use their land efficiently by having more biodiversity through intercropping rubber with other agricultural activities in the plantation. This would also increase the revenue and limit the use of resources (land) to maximize benefits. Thus, the rubber plantations in Thailand exhibit a great variety of types compared to plantations of other species. In the future, it is expected that the number of plantations involving the use of intercropping with rubber will increase.

A procedural method is employed during the formulation of new National Forest Stewardship Standards (NFSS) through the FSC for each country. This method involves either transitioning from an existing NFSS to Principles and Criteria Version 5-2 (P&C V5-2), or retrospectively integrating it into an approved NFSS. The objective of this procedural method is to outline steps for implementing a risk-based approach within NFSS, which involves evaluating, identifying, and addressing risks based on the likelihood and impact of non-conformity with NFSS indicators (FSC, 2018d). Currently, Thailand is waiting for the enforcement of FSC standard.

This research aims to assess the risk of rubber plantations under non-compliance with the FSC-FM standard in Thailand by classifying the rubber plantation types in Thailand, analyzing the risks in each rubber plantation type, and presenting guidelines to make recommendations for appropriate risk reduction. The outcomes of this study are used to evaluate the status of forest management certification of rubber plantations in order to improve rubber plantations in Thailand to be certified according to FSC-FM standards by using risk as a criterion. Moreover, the results of this research are beneficial to policymakers, organization that promotes rubber plantations, plantation managers, and the broader community, who can use the result to address the identified risks. They emphasize the development of management strategies and adherence to FSC principles to mitigate risks and improve compliance for expanded FSC certified rubber plantations.

Methodology

The methodology used in this study consisted of four steps: (1) collection of secondary data; (2) analysis of the primary risk associated with rubber plantations that are unable to meet the FSC-FM certification standard; (3) field risk assessment of rubber plantations that are non-compliant with respect to the FSC-FM certification standard; and (4) analysis of the data to determine the risk of non-compliant rubber plantations (Figure 1). These steps are described further below.
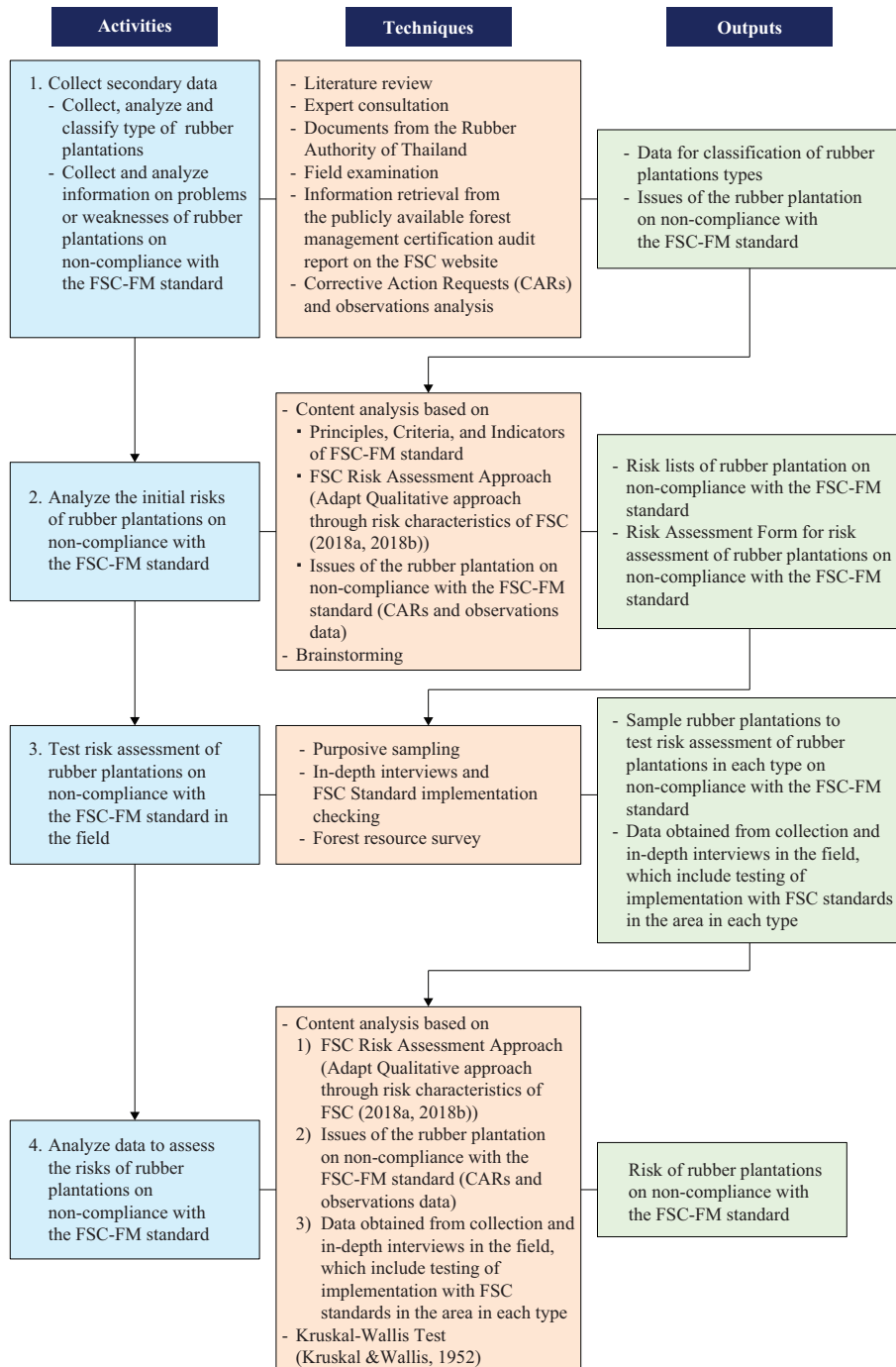

Figure 1 Schematic diagram of the study methodology, involving four steps (activities)

Secondary Data Collection

The data collection from the study sites in Thailand that were used for field risk assessment of non-compliant rubber plantations with the FSC-FM standard were divided into three categories. These included in-depth interviews with: (1) the leaders of Ban Na Prang Pattana Farmers Group in Ban Na Prang Pattana, Khlong Kwang Subdistrict, Na Thawi District, Songkhla Province, who had obtained an FSC group certification for a Small and Low-Intensity Managed Forest (SLIMF) type; (2) key persons of the Thai Rubber Land and Plantation Co., Ltd. who had obtained an individual FSC certification or a Single Management Unit which was located in Ang Thong Subdistrict, Chiang Kham District, Phayao Province; and (3) rubber plantations owners of each type.

In total, there were 24 sample rubber plantations (6 plantations for each type): in Songkhla province, southern Thailand (12 plantations), and in Rayong province, eastern Thailand (12 plantations). These rubber plantations were categorized and sorted according to the FSC-FM standard. Data from three sources were utilized: literature reviews, consultations with experts at the Rubber Research Institute which controls the management of rubber plantations, and documentation from the Rubber Authority of Thailand, that manages the country's rubber system (Rubber Authority of Thailand, 2020). Information on various planting styles and consultation with experts was used to classify the rubber plantation types. As a result, the rubber plantations were classified into four types using purposive sampling (Black, 2010):

1. Type A: a monoculture of only rubber trees in the area.

2. Type B: rubber trees with plants that are planted for wood yield at the end of rotation, such as teak or iron wood.

3. Type C: rubber trees along with plants that are planted to take advantage of parts other than wood such as fruits, leaves, roots, tubers, pods or seeds.

4. Type D: rubber intercropping with wood-based and non-wood based plants.

For the FSC-FM standard, data were collected to cover 10 principles, 70 criteria, and 211 indicators using document reference codes; FSC-STD-01-001 V5-2 EN and FSC-STD-60-004 V2-0 EN (FSC, 2015; FSC, 2018a).

Corrective Action Requests (CARs) analysis is used to assess the risk information of rubber plantations based on non-compliance with the FSC-FM certification standard. Each CARs identifies the nature of the problem

and classifies the issues according to FSC principles, criteria, and indicators to further consider the level of risk.

Data related to the FSC-FM certification of the rubber plantations in Thailand were collected from publicly available audit reports on the FSC website (https://info.fsc.org/certificate.php) during the years 2011–2019. These reports included valid, suspended, and terminated certificates states, totaling 61 public reports. Various types of audits, such as initial audits, main audits, surveillance audits, and complementary audits, were conducted on 16 certifications of rubber plantations. The collected data were analyzed to identify CARs, observations, evidence, and close-out evidence of non-conformities. Major CARs were 76 times covering 38 issues, minor CARs were found 199 times covering 58 issues, and observations were 2 times covering 2 issues. Based on these data, problems related to non-compliance of rubber plantations with the FSC certification standard were identified and grouped by non-categorizing them according to principles, criteria, and indicators. A total of 68 issues were identified from 211 indicators based on the FSC-FM standard (FSC, 2015; FSC, 2018a).

The rubber plantations not complying with the FSC-FM standard were grouped based on 211 indicators. This qualitative approach utilized the risk characteristics outlined in the FSC-FM standard and the risk-based approach recommended by the FSC. The Guidelines for Standard Developers provides techniques to include a risk-based approach into the National Forest Stewardship Standards, which divides risks into four levels: very low risk, low risk, moderate risk, and high risk. The categorization of various indicators into these risk levels were done according to the FSC guidelines (FSC, 2018c; FSC, 2018d), with each level determined based on the risk characteristics.

Analysis of the Initial Risks of Rubber Plantations on Non-Compliance with the FSC-FM Standard

We analyzed the initial risk using content analysis (Krippendorff, 2004) and brainstorming with five experts who have experience in forest management, FSC-FM certification process and are part of the team that drafts Thailand's FSC-FM standards. Experts jointly considered the risks in each indicator using data that consisted of (1) principles, criteria, and indicators of the FSC-FM standard; (2) FSC risk assessment through adapt qualitative approach based on risk characteristics of FSC (FSC, 2018c; FSC, 2018d),

in which the risk was divided into four levels; and (3) challenges related to adherence of rubber plantations to the FSC-FM standard, while accounting for CARs, observations, Non-Conformities, and close-out evidence. Using these points, we developed a risk assessment form to evaluate the compliance of rubber plantations to the FSC-FM standard. This form was constructed from the risk lists based on 211 indicators and initial risk designations for each indicator.

Field Testing of Risk Assessment Due to Non-Compliance of Rubber Plantations with the FSC-FM Standard

Risk assessments due to non-compliance of the rubber plantations with the FSC-FM certification standard used the risk assessment form tailored to the specific characteristics of each type of rubber plantation in Thailand. Data collection methods included in-depth interviews to identify practical challenges faced by plantation managers and activities that plantation managers perform. The key topics covered in the interviews included management practices, compliance with the law, workers' rights and employment conditions, community relations, benefits from the forest, environmental values and impacts, management planning, monitoring and assessment and High Conservation Values (HCV). Next, FSC standard implementation checks were done to evaluate on-the-ground implementation of FSC-FM standards, and forest resource surveys of the status of resources such as physical and biological resources were conducted with the leader of the Ban Na Prang Pattana Farmers Group, two key individuals from the Thai Rubber Land and Plantation Co., Ltd., and 24 sample rubber plantation owners and their respective plantations. All information obtained was used to assess and mitigate the initial risks of rubber plantations not complying with the FSC-FM standard.

Data Analysis to Determine the Non-Compliance Risk of Rubber Plantations with the FSC-FM Standard

The non-compliance risk of rubber plantations with the FSC-FM standard was assessed through a qualitative analysis. Content analysis (Krippendorff, 2004) was used for data from three sources of information. Firstly, the FSC risk assessment approach was adapted through a qualitative approach based on the FSC risk characteristics. Risk characteristics descriptions that served to classify indicators into categories of high risk, moderate risk, low risk, and very low risk were (FSC, 2018c; FSC, 2018d):

High risk: risk characteristics associated with high risk indicators includes the value represented by the indicator is known to be affected by forest management, the value represented by the indicator is of considerable social significance, the value represented by the indicator causes stakeholder concern or is considered a national priority, the value represented by the indicator is the subject of legal proceedings, the value represented by the indicator is declining in abundance/prevalence, little is known about the value represented by the indicator, there is a history of poor management of the value represented by the indicator, there is a history of contention regarding the value's status represented by the indicator, or the value represented by the indicator is a challenge for forest management in the national context.

Moderate risk: Risk characteristics associated with moderate risk indicators includes an important social, ecological or economic value represented by the indicator.

Low risk: Risk characteristics associated with low risk indicators includes low likelihood that the value represented by the indicator occurs in the forest, the value represented by the indicator is addressed well by regulatory instruments, the value represented by the indicator is common and not affected by forest management, negative effects carry little repercussion, there is low concern to stakeholders, or the value represented by the indicator is common practice for foresters.

Very low risk: List of risk characteristics associated with very low risk indicators includes very low likelihood of occurrence, and well evaluated and controlled by regulatory authorities, and no incidents of negative impact on the value represented by the indicator by forest management have been reported in the country within the last 5 years (either through a CARs issued by a certification body in an FSC audit, or through a formal complaint by a stakeholder), and there is demonstrated key stakeholder support across all chambers.

These criteria were used to consider CARs data and data from the field on each issue to improve the initial level of risk. Secondly, issues related to the non-compliance of rubber plantations in Thailand with the FSC-FM standard were identified through an analysis of CARs and observations. Lastly, data obtained from field collection and in-depth interviews, which also included testing of implementation of FSC standards in the area, were considered. Content analysis was used to categorize risks within each indicator for each type of rubber plantation. The research data analysis used nonparametric statistic, called the Kruskal-Wallis test

(Kruskal and Wallis, 1952), for more than two groups to compare risk levels across different rubber plantation types in Thailand (significance was tested at $p < .05$). SPSS software was applied for data analysis.

Using the three sources of information, experts can apply content analysis and brainstorming to summarize qualitative data and determine the risks for each indicator across different types of rubber plantations. Thus, the results of this research are significant for improving plantation management practices and informed policy recommendations.

Results and Discussion

Risk of Non-Compliance of Rubber Plantations with the FSC-FM Standard

Analysis based on the requirements of the FSC-FM standard, which includes 10 principles, 70 criteria, and 211 indicators, indicated varying levels of risk. The highest number of indicators were classified as very low risk with 136 indicators, followed by high risk with 36 (17.06%) indicators, moderate risk with 20 (9.48%) indicators, and low risk with 19 (9.00%) indicators. Figures 2 and Table 1 illustrate the distribution of indicators by risk level across the different principles.
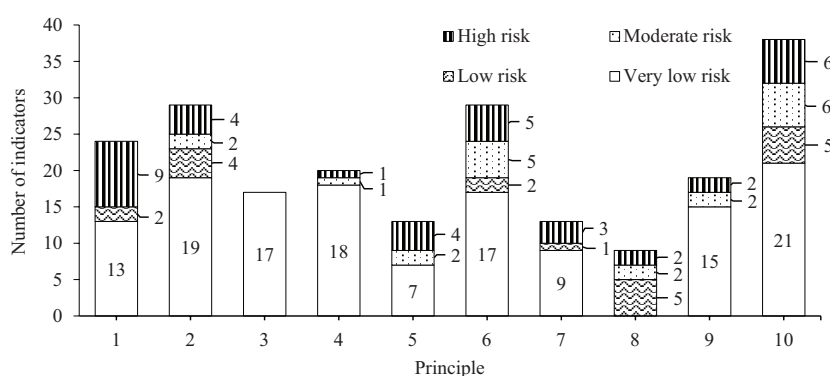

Figure 2 Number of indicators found at each risk level related to non-compliance of rubber plantations with the FSC-FM certification standards in Thailand, classified according to 10 principles

Table 1 Non-compliance risk of rubber plantations with the FSC-FM standard in Thailand for each principle, criteria, and indicator

Risk level			
Very low risk	Low risk	Moderate risk	High risk
1.1.1, 1.1.2, 1.3.3, 1.4.1, 1.4.2, 1.6.2, 1.6.4, 1.7.1, 1.7.2, 1.7.3, 1.7.4, 1.7.5, 1.8.2	1.2.2, 1.6.1	-	1.2.1, 1.2.3, 1.3.1, 1.3.2, 1.4.3, 1.5.1, 1.5.2, 1.6.3, 1.8.1
2.1.2, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.2.4, 2.2.5, 2.2.6, 2.2.8, 2.2.9, 2.3.5, 2.4.1, 2.4.2, 2.4.3, 2.4.4, 2.6.1, 2.6.2, 2.6.3, 2.6.4	2.2.7, 2.3.4, 2.5.1, 2.5.2	2.1.4, 2.3.6	2.1.1, 2.3.1, 2.3.2, 2.3.3
3.1.1, 3.1.2, 3.2.1, 3.2.2, 3.2.3, 3.2.4, 3.2.5, 3.3.1, 3.3.2, 3.3.3, 3.4.1, 3.4.2, 3.5.1, 3.5.2, 3.5.3, 3.6.1, 3.6.2	-	-	-
4.1.2, 4.2.1, 4.2.2, 4.2.3, 4.2.4, 4.2.5, 4.3.1, 4.4.1, 4.4.2, 4.6.1, 4.6.2, 4.6.3, 4.6.4, 4.7.1, 4.7.2, 4.7.3, 4.8.1, 4.8.2	-	4.1.1	4.5.1
5.1.1, 5.1.2, 5.1.3, 5.3.1, 5.3.2, 5.4.1, 5.4.2	-	5.5.1, 5.5.2	5.2.1, 5.2.2, 5.2.3, 5.2.4
6.1.1, 6.2.1, 6.3.2, 6.4.2, 6.4.3, 6.4.4, 6.5.2, 6.6.1, 6.6.2, 6.6.3, 6.6.4, 6.7.2, 6.7.3, 6.7.4, 6.8.2, 6.9.1, 6.10.1	6.3.3, 6.8.1	6.1.2, 6.2.2, 6.3.1, 6.5.1, 6.7.1	6.4.1, 6.5.3, 6.5.4, 6.5.5, 6.10.2
7.1.1, 7.1.2, 7.1.3, 7.3.1, 7.5.2, 7.6.1, 7.6.2, 7.6.3, 7.6.4	7.5.1	-	7.2.1, 7.2.2, 7.4.1
-	8.1.1, 8.3.1, 8.4.1, 8.5.2, 8.5.3	8.2.1, 8.2.2	8.3.2, 8.5.1
9.1.2, 9.2.1, 9.2.2, 9.2.4, 9.2.5, 9.2.6, 9.2.7, 9.3.1, 9.3.2, 9.3.3, 9.3.4, 9.3.5, 9.4.2, 9.4.3, 9.4.4	-	9.1.3, 9.2.3	9.1.1, 9.4.1
10.2.1, 10.2.2, 10.3.1, 10.3.2, 10.3.4, 10.4.1, 10.5.1, 10.6.2, 10.6.4, 10.6.5, 10.7.6, 10.7.7, 10.8.4, 10.9.1, 10.9.2, 10.9.3, 10.10.1, 10.10.2, 10.10.3, 10.11.2, 10.11.3	10.6.3, 10.7.3, 10.8.1, 10.8.3, 10.9.4	10.3.3, 10.6.1, 10.7.5, 10.8.2, 10.11.1, 10.12.1	10.1.1, 10.1.2, 10.7.1, 10.7.2, 10.7.4, 10.11.4

Principle 1, which focuses on compliance with the law, was the most frequent high-risk principle. Principle 10, relating to the implementation of management activities, was identified as the second most common high-risk principle. Principle 6, concerning environmental values and impacts, ranked third in terms of high-risk prevalence. Principles 2 and 5 that address workers' rights and employment conditions, and benefits from the forest, respectively, were the joint fourth most frequent high-risk principles. Principle 7, pertaining to management planning, was the fifth most common high-risk principle. Principles 8 and 9, covering monitoring and assessment and HCV, respectively, were also identified as high-risk principles. Principle 4, related to community relations, was the least frequently encountered high-risk principle.

Principle 1 is the most common high-risk principle, which involves legal challenges that are difficult to solve. Addressing these problems will likely require a significant amount of time because it involves many agencies, and compliance with the law has many steps. Problems found in each indicator include indicator 1.2.1: the absence of documentation indicating land tenure and use rights in compliance with the law, resulting in a high level of concern from stakeholders, indicator 1.2.3: the boundaries of plantation are not clearly defined, both boundary markers in the area and shown on maps. This lack of clarity affects various activities within the plantation. Additionally, land boundaries are also related to legal requirements. Indicator 1.3.1: there are activities that do not comply with the applicable laws, regulations and administrative requirements, legal and customary rights, and obligatory codes of practice. Indicator 1.3.2: delays in payment of legally prescribed charges related to forest management, indicator 1.4.3 Illegal or unauthorized activities are detected, measures are not implemented to address them. Indicator 1.5.1 no compliance with applicable national laws, local laws, ratified international conventions and obligatory codes of practice relating to the transportation and trade of forest products up to the point of first sale is demonstrated. Indicator 1.5.2 No compliance with Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) provisions, including through possession of certificates for harvest and trade in any CITES species. From indicator 1.3.1 to 1.5.2, these five areas are of high risk because they are subject of legal proceedings. Indicator 1.6.3 no Up-to-date records of disputes related to issues of applicable laws or customary law, are held including: steps, outcomes of all dispute resolution processes, and unresolved

disputes, the reasons they are not resolved, and how they will be resolved. This indicator is high risk due to considerable cultural or social significance and high level of concern from stakeholders. Last issue, indicator 1.8.1: no long-term commitment to forest management practices consistent with FSC principles and criteria and related policies and standards (for example, there was a change in the type of plant being grown while applying for certification). This is an important issue which shows a lack of compliance with FSC policy.

The indicators listed under high risk, as mentioned above, are all related to past instances of poor management, resulting in non-compliance with FSC-FM certification standards. These issues have had widespread ramifications within the forest plantation, necessitating the need for an immediate attention and resolution. However, addressing these problems would likely require a significant amount of time, particularly given the associated legal matters and FSC policies and standards. Despite the considerable concern expressed by stakeholders, little action has been taken to address these indicators. Nevertheless, it is important to promptly tackle these issues, as their potential to adversely affect other essential activities is high.

In addition, the high-risk issues found in other principles are listed in Table 1, for example, inadequate health and safety practices that fail to meet established standards. Moreover, deficiencies exist in ensuring workers' access to appropriate personal protective equipment (PPE), and in the implementation of measures to identify, avoid, and mitigate significant negative impacts of management activities on the local communities and environment. Failure to revise and update management plans periodically and the absence of data indicating sustainable harvest levels are additional concerns. When monitoring indicates non-conformities with the FSC Standard, the lack of subsequent revisions to management objectives, verifiable targets, and/or activities worsens the issue. Furthermore, there exists a shortfall in the allocation of Representative Sample Areas within the conservation areas network, constituting less than 10 percent of the total area under a management unit. Lastly, non-compliance with FSC's policy regarding the use and storage of chemical pesticides within a management unit further emphasizes the need for an immediate action.

The indicators categorized under moderate risk underline issues stemming from past non-compliance with Thailand's FSC-FM certification standards. Such problems can be promptly addressed without requiring extensive resolution time but necessitate

collective action involving the various stakeholders. They rely on data analysis for mitigation, and failure to address them will have adverse consequences related to economic, social, and environmental values. For example, failure to review and revise health and safety practices following major incidents or accidents, as well as the failure to identify local communities within and potentially impacted by management activities. Additionally, insufficient fund allocation for the implementation of a management plan can weaken the long-term economic viability. Lack of protection measures for natural watercourses, water bodies, and riparian zones, as well as inadequate monitoring of social and environmental impacts, can worsen these issues. Furthermore, failure to minimize or avoid fertilizer use and improper handling of waste material can further contribute to environmental degradation.

Low risk indicators highlight issues related to past non-compliance with Thailand's FSC-FM certification standards. However, these problems can be promptly addressed within a short time frame as they represent common operational practices that can be immediately implemented and have minimal or negligible effects on the forest plantation. Additionally, they are associated with a relatively low concern from the stakeholders. Examples include challenges associated with a lack of job-specific training and worker supervision to contribute safely and effectively to the implementation of a management plan and all associated activities. Additionally, there is a lack of records related to fertilizer usage, up-to-date training records for relevant workers, or records of pesticide usage, including essential information such as trade name, active ingredient, quantity used, and reasons for use. Furthermore, a publicly available summary of the management plan, presented in a comprehensible format including maps and excluding confidential information, is usually not provided.

Indicators categorized under very low risk are usually related to issues of past non-compliance with Thailand's FSC-FM certification standards. In such cases, the likelihood of recurrence is very low, with no complaints reported on this matter. These issues are well evaluated and controlled by regulatory authorities, and are also supported by the key stakeholders and can be addressed in accordance with the standards. Examples include policies that prohibit offering or receiving bribes, with these policies being publicly available at no cost. Additionally, job opportunities are open to both women and men under the same conditions, with no indigenous people found in or around the certified area.

Reasonable opportunities are communicated and provided to local communities, contractors, and suppliers for employment, training, and other services. Furthermore, equal pay is ensured for women and men performing the same work, and costs related to preventing, mitigating, or compensating for negative social and environmental impacts of the management activities are quantified and documented in the management plan. The strategies developed are effective in maintaining or enhancing HCV.

The results regarding principle 6, related to the environmental values and impacts, had the second-highest number of indicators that incurred a high level of risk. This finding corresponds with the research conducted by Sugiura and Yoshioka (2018) who reported about the companies certified by the FSC for forest management in Japan. Their survey revealed a significant improvement in the risk associated with principle 6 after the certification, ranking second only to principle 8. Conversely, principle 3 showed the least post-certification improvement, which was consistent with our findings. We found that every indicator had very low risk in non-compliance with the FSC-FM standard. This is because rubber plantations in Thailand have no indigenous people living in or around the certified area.

In addition, publicly available audit reports of rubber plantation in India indicate that the challenges faced by forest plantation managers in India are non-compliance with the FSC-FM standards most importantly HCV issues. This covers the lack of HCV assessment. This issue is similar to our study. Moreover, we also found that no names of stakeholders involved in HCV have been identified, no management plan has been developed, and no public summary of HCV has been published (FSC, 2018b).

Furthermore, an analysis of CARs from FSC audits of natural forest management in Indonesia indicated that most CARs were related to environmental and social issues (Hermudananto et al., 2018). Also, Halalisan et al. (2016) noted that principles 6 and 9 of the standard predominantly addressed the environmental concerns, although interpretations may vary by country. This finding is consistent with the study by Kuijk et al. (2009) that reported collecting data on non-compliance with the FSC-FM standards from some countries (predominantly temperate and boreal but also including tropical operations) and found that the most prevalent environmental requirements with issues related to principles 6 and 9. These included protection of riparian buffers and improved management of aquatic resources, woody debris, snags and legacy trees,

improved treatment of sensitive sites and the issue of HCV, and improved treatment of threatened and endangered species. Principles 6 and 9 issues were also found to be consistent in this study. We identified some high-risk issues within these principles, but the specific details of the risks differed. For instance, regarding the issue of HCV, previous studies improved treatment of HCV and endangered species. However, for most rubber plantations in Thailand, HCV has not been found, still the risk is high because the presence of HCV was not assessed, and little is known about the HCV. Furthermore, Sugiura et al. (2013) reported that the certification bodies frequently require improvements in community relations, workers' rights, environmental impact, management plans, and monitoring and assessment in Asian countries.

Non-compliance based on the FSC-FM standard was identified in rubber plantations of each type, and categorized by the number of indicators at risk at each level (see Table 2). The results indicated that over 64 percent of all indicators posed a very low risk. Among them, Type A, B, and C exhibited the highest number of very low risk, followed by high, moderate, and low risks, respectively. Notably, Type D had the most pronounced tendency towards low risk, followed by high, low, and moderate risks, respectively.

Figure 3 illustrates the distribution of indicators at each risk level for rubber plantations non-compliant with FSC-FM certification standards, categorized by principle. All the Types A, B, C, and D rubber plantations exhibited the highest risk to principle 1, which is related to compliance with laws, emphasizing an organization's obligation shall comply with all applicable laws, regulations and nationally- ratified international treaties, conventions, and agreements.
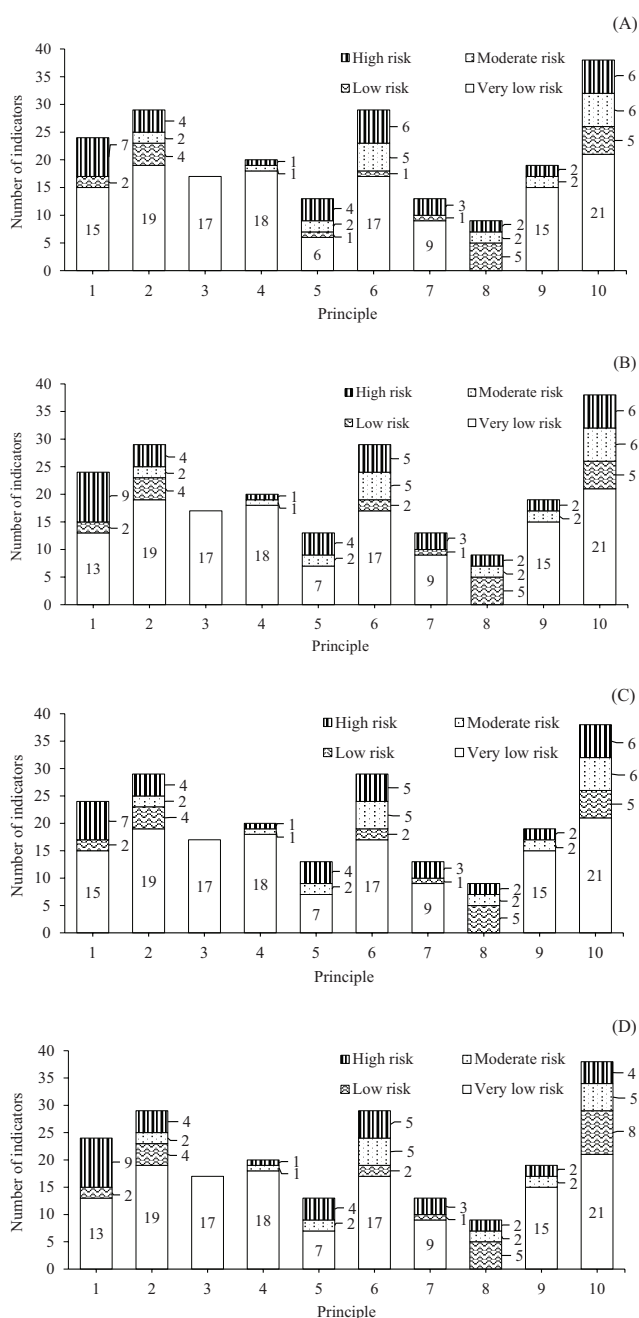

Figure 3 Number of indicators found at each risk level of rubber plantations non-compliant with the FSC-FM certification standards of each type, classified according to the 10 principles: (A) Type A - rubber monocultures; (B) Type B - rubber intercropping with wood based plants; (C) Type C - rubber intercropping with non-wood based plants; (D) Type D - rubber intercropping with wood and non-wood-based plants.

Table 2 Number of indicators at each risk level found in rubber plantations non-compliant with the FSC-FM standard.

Rubber plantation type	Number of indicators (%)				Total
	Very low risk	Low risk	Moderate risk	High risk	
Type A	137 (64.93)	19 (9.00)	20 (9.48)	35 (16.59)	211
Type B	136 (64.46)	19 (9.00)	20 (9.48)	36 (17.06)	211
Type C	138 (65.41)	19 (9.00)	20 (9.48)	34 (16.11)	211
Type D	136 (64.46)	22 (10.43)	19 (9.00)	34 (16.11)	211

Comparison of Differences in the Risk of Non-Compliance with the FSC-FM Standard Across Different Types of Rubber Plantations

We used the Kruskal-Wallis test to compare risk levels across different types of rubber plantations in Thailand. The results showed that the differences in risk related to non-compliance among the four types of rubber plantations with the FSC-FM standard were not statistically significant ($p = .997$). This suggests that the type of rubber plantation did not significantly influence the compliance with the FSC-FM standard. However, when examining the individual indicators, each type of rubber plantation exhibited varying number of indicators at different risk levels. In total, seven indicators were identified (see Figure 4), including:

1.5.1 Compliance with applicable national laws, local laws, ratified international conventions and obligatory codes of practice relating to the transportation and trade of forest products up to the point of first sale is demonstrated.

1.5.2 Compliance with CITES provisions is demonstrated, including through possession of certificates for harvest and trade in any CITES species.

5.1.1 The range of resources and ecosystem services that could strengthen and diversify the local economy are identified.

6.3.3 Where negative impacts to environmental values occur, measures are adopted to prevent further damage, and negative impacts are mitigated and/or repaired.

10.7.1 Integrated pest management, including selection of silviculture systems, is used to avoid, or aim to eliminate, the frequency, extent and amount of chemical pesticide applications, and result in non-use or overall reductions in applications.

Figure 4 Risks of rubber plantations in each type, classified by indicators.
Note: Risk level 1 = very low, 2 = low, 3 = moderate, and 4 = high.

10.7.2 Chemical pesticides prohibited by FSC's Pesticide Policy are not used or stored in the Management Unit unless FSC has granted derogation.

10.7.5 If pesticides are used, application methods minimize quantities used, while achieving effective results, and provide effective protection to surrounding landscapes.

In Figure 4, the first number on the x-axis denotes the principle, the second represents the criterion, and the third indicates the indicator. The figure indicates that indicators 1.5.1 and 1.5.2 for type B and D plantations have higher risk than type A and C plantations because some species shall comply with the applicable national laws, local laws, ratified international conventions and obligatory codes of practice relating to the transportation and trade of forest products up to the point of first sale is demonstrated. This compliance is the subject of legal proceedings and stakeholder concern. The plantations falling in this category accompany the possibility of planting species listed in CITES and the Convention on Biological Diversity (CBD) appendices, necessitating additional regulations for import, export, or transit permits, obtained from the Thailand Director-General of Agriculture. Upon inspection, two species listed in Appendix 2 were identified, namely, *Aquilaria crassna* Pierre ex H and *Dalbergia cochinchinensis* Pierre (Convention on International Trade in Endangered Species of Wild Fauna and Flora, 2023). If the planted species were restricted trees as per the Royal Decree on Restricted Timber, challenges may arise in relocating them, requiring certification of ownership and tenure rights. Type A and C plantations do not encounter such a problem because type A plantations is a monoculture of only rubber trees in the area. Type C most planted species do not have to comply with such laws.

Indicator 5.1.1: type A plantations have a higher risk compared to type B, C, and D plantations because they are less capable of utilizing a range of resources and ecosystem services that could strengthen and diversify the local economy. Type A plantations primarily produce only rubber wood and latex, which generate limited income, whereas type B, C, and D plantations have a broader range of resources and services.

Indicator 6.3.3: type A plantations are at high risk compared to type B, C, and D plantations, which have low risk, because type A challenges are associated with negative impacts to environmental values and various measures. It is not used to prevent damage, resulting in soil erosion and tree instability while type B, C, and D plantations can mitigate environmental impacts and had a positive impact on the environment by encouraging tree
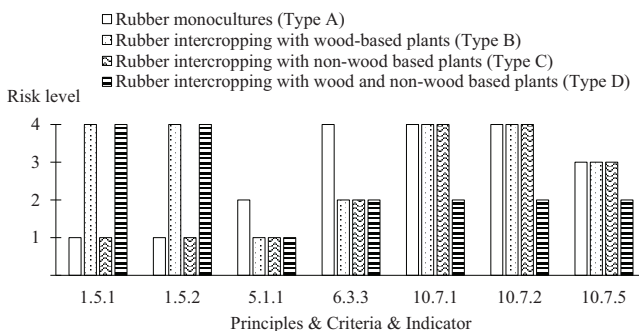
planting in rubber plantations, aiding in soil retention, moisture increase and, erosion reduction.

Indicators 10.7.1, 10.7.2 and 10.7.5: type A, B and C plantations have higher risk than type D plantations because such were identified involving the use of chemical pesticides which were prohibited by the FSC restricted list, such as Paraquat dichloride and Glyphosate-isopropylammonium. These chemicals are categorized as hazardous by the Department of Agriculture. Moreover, type D plantations do not use chemical pesticides within the rubber plantation, avoid and use no chemical pesticide use, aligning with FSC restricted guidelines. They also have minimal weed growth due to a dense canopy cover and pets brought into the area to use the grass as food.

From the results of this research, there are recommendations for specific actions that can be taken to mitigate risks for each plantation type as follows: type A plantations should prioritize diversifying the number of obtained products to strengthen the local economy, such as charcoal and mushrooms, and mitigate environmental risks, such as soil erosion by planting cover crops. Types B, C, and D plantations should exercise caution when dealing with species listed in CITES or any restricted trees, and strictly following the relevant legal procedures, conventions, and guidelines throughout the operations.

Conclusion and Recommendation

From the risk assessment of rubber plantations related to non-compliance with the FSC-FM standard, it was observed that out of the 211 indicators, 136 were categorized under very low risk, while 19, 20, and 36 indicators were classified under low, moderate, and high risk, respectively. This indicates a significant compliance among the sampled rubber plantations in Thailand. The high-risk indicators were mostly found in principle 1, which pertains to compliance with the law, followed by principle 10 related to management activities, implementation, and principle 6 related to environmental values and impacts. The most common high-risk indicators, involve legal challenges that are difficult to solve. Key issues include inadequate documentation of land tenure, unclear plantation boundaries, non-compliance with laws, and delays in payments, all of which have serious legal implications and require immediate attention. Moderate risks indicators are mainly found in the implementation of management activities and are issues that can be resolved immediately

without requiring extensive time. These issues have significant social, ecological, and economic value, such as failure to minimize or avoid fertilizer use and improper handling of waste material. Low risk indicators often involve problems arising from a lack of records or the absence of documentation prepared as evidence for each activity. Examples include a lack of records related to fertilizer usage, up-to-date training records for relevant workers, or records of pesticide usage. These problems can be promptly addressed within a short time frame as they represent common operational practices. Very low risk indicators are issues that agencies can easily implement. Examples include gender equality in employment and pay, disclosing information shall make publicly available information free of charge, excluding confidential information.

Addressing these risks requires proactive measures, which include the development of guidelines for prevention and mitigation, to ensure readiness for FSC certification. This study focused solely on rubber plantations. Thus, to have a comprehensive understanding of the adherence challenges related to FSC-FM standards, data collection should be extended to other forest plantations encompassing different tree species such as teak and eucalyptus in Thailand. Specific precautions need to be taken for each type of rubber plantation concerning compliance issues. Type A plantations should prioritize diversifying the number of obtained products to strengthen the local economy and mitigate environmental risks such as soil erosion. Types B, C, and D plantations should exercise caution when dealing with species listed in CITES or any restricted trees, and strictly following the relevant legal procedures, conventions, and guidelines throughout the operations.

The risk information from rubber plantations that are non-compliant with the FSC-FM standard can help streamline the related implementation plan to ensure compliance with FSC standards and is integral to understanding and addressing the problem that could compromise the long-term sustainability of rubber plantations. Effectively managing these risks is crucial not only for achieving, maintaining, and increasing FSC certification but also for ensuring that the plantations remain economically viable, socially responsible, and environmentally sustainable in the long term.

This research contributes to the sustainability of the forest plantation economics, society, and the environment values, such as biodiversity conservation, sustainable resource use, climate change mitigation, supporting local communities, labor rights, community benefits,

the economic viability of rubber plantations, market access and premium prices, and long-term forest productivity. This is an important part in driving the Sustainable Development Goals. Furthermore, this research can support plantation managers, policy makers, and other stakeholders (such as the Rubber Authority of Thailand, which is the central organization responsible for managing the country's rubber system) in developing their own rubber plantation management systems and setting local and national policies to expand the certification area of rubber plantations in Thailand. This includes promoting and access to forest certification system for rubber plantation owners and rubber wood consumers to organize a training program, and establish awareness and readiness to enter the forest management certification system of rubber plantation owners and rubber wood consumers at various levels. These tasks shall be conducted by the Thailand Rubber and other educational institutes.

This research focused on areas where rubber is predominantly grown in Thailand, specifically in the southern and eastern regions. Future research may collect data on rubber plantations in other areas, such as the northern and northeastern regions.

Conflict of Interest

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