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Stakeholder and Economic Valuation Dynamics of Land-based Biological Carbon Sequestration Activity

A case study of the Caterpillar Foundation ecosystem restoration project in Indonesia

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Thesis for the fulfilment of the
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Abstract

With a deforestation rate of 599,232 ha/year, the Indonesian government is pressured to bootstrap its ecosystem restoration process. The pressure also receives by the private sector to accelerate the process of their decarbonization, with the 2050 net-zero target as the main goal. Consequently, regulation stringency on corporate environmental responsibility and national environmental goals is rising. Private companies, such as Caterpillar utilise the ecosystem restoration project as one of their carbon removal strategies. Therefore, understanding the value of the restoration project and the role of stakeholders involved throughout the process is imminent for efficient ecosystem restoration. This thesis will address two research questions, discovering the economic valuation of the ecosystem restoration project from environmental, economic, and social standpoints, and discovering the stakeholder role throughout the process of restoring these degraded ecosystems. The mixed methodology employed in this research: the biomass and economic estimations and contingent valuation methods are utilized to gain insight into the economic valuation of the project, and interview content analysis is utilized to analyse the stakeholder role throughout the project implementation. From the analysis, it is discovered that over 20 years of estimation period, the Caterpillar project in Indonesia could sequester 10,085 tCO_2, bring undiscounted 190 Mn USD of direct and indirect economic benefit, and have a non-use existence value of USD 70 Mn/year. On the other hand, overlapping stakeholder role is discovered. But the line can be drawn as the government are consistently being a supervisor, the private sector often being a driver and capital source for the restoration project, and other stakeholder fill in the gap that the two major stakeholders are lacking. In conclusion, both valuation and stakeholder roles often blurred and change following the political-economy dynamics of the restoration location both at the local and national level. The only way to correctly estimates the total economic valuation and understand the stakeholder's role is by maintaining the continuous check-and-balance throughout the process of ecosystem restoration and conservation.

Keywords: economic valuation, restoration, stakeholders, terrestrial ecosystem, coastal ecosystem

Executive Summary

A company must decarbonize itself by increasing business efficiency, switching to renewable energy sources, and changing to more efficient production technologies. Only after all the carbon abatement has been exhausted, companies can use carbon removal strategies, such as carbon capture, storage, and utilization, as well as biological carbon sequestration through ecosystem restoration and conservation. Indonesia is home to a major carbon sequestration project. As the country was heavily criticized for the deforestation in Borneo due to land-use changes, in recent years various ecosystem restoration efforts have been taking place in the country. The government-led projects are unified under the REDD+ project, focusing on the area of Borneo and Sumatra. Meanwhile, the private sector also takes serious participation in ecosystem restoration and conservation projects across the country. However, currently, there's a market failure in ecosystem restoration and conservation investments. As capital is being poured into the projects, many projects face a setback due to target misalignment with the government, or the lack of collaboration between the private and public sectors due to different views of the project valuation.

Caterpillar Foundation, a non-profit arm of Caterpillar Inc., has been involved in various ecosystem restoration and conservation activities across the Asia Pacific. Since 2022, the foundation in cooperation with World Resources Institute (WRI) Indonesia has committed to the restoration of 125 ha of degraded terrestrial and coastal ecosystems in Northern, Southern and the archipelago of Sumatera, Indonesia. However, misinterpretation of project valuation and overlapping yet blurred delineation of stakeholders' role throughout the ecosystem restoration projects is rising. It cast doubt both on the private sector and public audiences. The private sector feared the risk of greenwashing and overestimating their project benefit, while the public audiences doubted the genuine intention of the private sector in conducting ecosystem restoration. Hence, a better understanding of the ecosystem restoration valuation and a clear delineation of the stakeholder role in the ecosystem restoration process is imminent for the success of restoration projects.

Problem Definition

The popularity of Carbon removal strategies, especially biological carbon sequestration projects are rising quickly, and Indonesia is a hotspot for such projects. However, the missing integration on the project valuation, as well as overlapping and unclear delineation of the stakeholder's role in the restoration project itself has cast doubt on both the private sector and its public audiences. Hence it requires an integrative yet dynamic model that could uncover the most relevant project valuation and understanding of the extent and limitations of a stakeholder in a restoration project.

Aim and Research Questions

This research aims to fill in a research gap in the economic valuation of ecosystem services in Indonesia through conducting the economic valuation of the land-based biological sequestration activities done by Caterpillar in Sumatera as a case study, and understanding the multiple stakeholder's roles in the ecosystem restoration process through mapping and delineating their involvement in the restoration project to better understands the political economy dynamics affecting the process of the ecosystem restoration project in Indonesia. To achieve the goals previously mentioned, the following research questions are proposed:

a. RQ1: What is the Total Economic Valuation (TEV) of the ecosystem restoration project of Caterpillar Foundation in Indonesia?

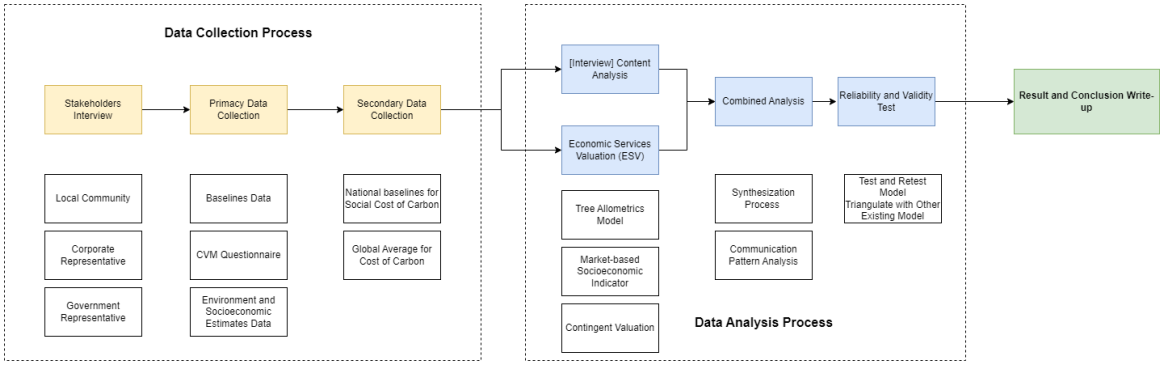
b. RQ2.1: How each stakeholder perceives their role in the ecosystem restoration project?
c. RQ2.2: What political economy dynamics affect the perceived role of each stakeholder?

Research Design

Mixed methodologies were carried out in this research. Quantitative estimations were employed for the economic valuation themes, while qualitative analysis through content analysis to the interview transcripts and utilizations of stakeholder salience theory was employed to understand the stakeholder's role and its political economy dynamics. The stakeholder salience theory provides metrics of assessment towards the stakeholders. Those metrics are power, legitimacy and urgency. Providing clear frameworks for analysis.

The research was carried out by following these steps shown in *Figure I*, divided into data collection and analysis processes. The data collection includes stakeholders' interviews, primary data collection, majorly to collect data for the ecosystem restoration valuation, and secondary data collection to support both interviews and primary data collection results. The data then analysed through selected methodologies, then results was concluded.

Figure I. Research process diagram



Main Findings

Supporting Findings

Findings #1. The average deforestation rate in Indonesia between 2006-2020 was 599,232 ha/year, with land-use change as the main factor for deforestation. This has created a land-use emission of 271.7 Mn tCO_2/year.

Findings #2. To combat the accelerating deforestation rate, the government unified the government-led restoration project under REDD+ and developed the community-based social forestry system to integrate the rural community back into the forest ecosystem.

RQ1: What is the Total Economic Valuation (TEV) of the ecosystem restoration project of Caterpillar Foundation in Indonesia?

Findings #3. From the database of tree biomass and number of trees being planted in all the restoration sites. The annual potential of sequestered carbon is calculated, and it is discovered that in 20 years, the combined sequestration power of the restoration site is at 10,085 tCO2.

Findings #4. The total investment Caterpillar provides for this project is USD 300,000, hence based on this number, the internal price of carbon for this project has a quasi-value at USD 29.47/tCO2 sequestered.

Findings #5. the Total Economic Benefit from the Caterpillar restoration project in 20 Years is IDR 2,801 billion (ca USD 190 Mn) and has an NPV of IDR 1,399 billion (ca USD 92.7 Mn) with a 5% discount rate and has an NPV of IDR 743 billion (ca USD 49.3 Mn) with a 10% discount rate.

Findings #6. The existence value of the restored ecosystem contingent on the disaster risk reduction is ca USD 70 Mn/year or ca USD 88.7 Mn/year when zero value is excluded. It is discovered that density and population size can be influential in determining the existence value of the restored ecosystem.

Findings #7. The total economic valuation before the discounting process is USD 1,546.8 Mn for a 20-year benefit period and USD 719.2 Mn for a 10-year benefit period. The negative discount rate will increase the number of final valuation numbers, and the positive rate will diminish the value. It should be noted that the number is dominated by the existence value which strongly specific to the area. Hence, this TEV number is not universal, and isolated to the restoration project with similar physical, environmental, and societal properties.

RQ2.1: How each stakeholder perceives their role in the ecosystem restoration project?

Findings #8. The government has an exclusive role as the planner, regulator, and supervisor in the restoration project. However, often their involvement in the field is limited, and misalignment with the private sector often occurs due to different target settings.

Findings #9. The private sector often takes the lead in the implementation process with the support of all intermediary institutions and supporting stakeholders to fill in the gap where both government and private sector are missing. Complementing the missing role and completing the role distribution for the ecosystem restoration.

RQ2.2: What political economy dynamics affect the perceived role of each stakeholder?

Findings #10. While the local community become a strong source of local wisdom, as a stakeholder, they lack the power to influence anything in the process of restoration, this makes the local community looks like a passive receiver instead of an active stakeholder in the process.

Findings #11. The private sector can be considered a complete trifecta in the eye of stakeholder salience theory. They have enough power to initiate the process of restoration in the form of utilitarian power represented by the financial power to finance the project from start to end. Legitimacy was based on its responsibility to the global community and its natural environment, and the urgency to do so under the legal pressure of national legislation and the global trend toward decarbonization.

Findings #12. Based on the stakeholder salience theory, the government's power is rather normative or coercive at the same time. Normative in the sense that they have a symbolic influence as a regulator and supervisor of a restoration project, but also coercive as they have punitive power to adjudicate the mishap in the process of restoration.

Findings #13. The intermediary institution's role falls into a vague territory, they neither implement nor initiate any project independently. In the end, their role can be seen as "Project

Manager/Organizer" in which the sole purpose is to optimize the process of restoration and conservation to reach optimum benefit based on the available resources.

Conclusions

The total economic valuation of an environmental project is affected by many factors. Environmental dimensions are affected by continuous conservation efforts done after the restoration is over. The economic dimension is affected by optimum resource utilization by the local community, market dynamics and social development of the community itself. On the other side, the contingent value of disaster risk reduction is a rather subjective number that relies on the perception of the affected communities. This says that the TEV is a local-dependent and has its accuracy diminishing following the increase length of the estimation period. Therefore, TEV requires multiple re-evaluations after a certain period.

Delineating stakeholders' role is a challenge on its own, stakeholder's roles is overlapping, yet are insignificant in circumstances when they are needed. The private sector and local community are expecting the government to actively involve throughout the restoration and conservation process when in reality, their role is minimum to ceremonial at best.

However, each stakeholder has its dominant roles they fulfil which complement each other throughout the ecosystem restoration process. On top of the main four stakeholders (local communities, private sectors, government, and intermediary institutions), financial institutions proved to be significant in recent years, as the climate finance industry is growing rather rapidly.

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Abbreviations

AFOLU	Agriculture, Forestry, and Land-Use
CCUS	Carbon Capture, Utilisation and Storage
CDM	Clean Development Mechanism
CVM	Contingent Valuation Methods
ESG	Environmental, Social and Governance
ES	Ecosystem Services
FLER	Forest and Land-Use Emissions Reference
GHG	Green House Gas
IPCC	Intergovernmental Panel on Climate Change
MACC	Marginal Abatement Cost Curve
MRV	Monitoring, Reporting and Verification
NGO	Non-Governmental Organizations
NPV	Net Present Value
RBPs	Result-based Payments
REDD	Reducing Emissions from Deforestation and Land Degradation
SBTi	Science-based Target Initiative
TEV	Total Economic Valuation
UNFCCC	United Nations Framework Convention on Climate Change
WRI	World Resources Institute
WTP	Willingness-to-Pay.

1 Introduction

Evolving perspectives surrounding carbon removal strategies take various forms. This research specifically focuses on how businesses manage reputation in their climate action, and how that helps create a sustainable climate impact. The research was funnelled from a general perspective of global decarbonization strategy and narrowed down to focus on land-based biological sequestration activities as a hotspot of corporate climate action.

This chapter explains how the issue is raised from a funnelling process from a broad decarbonization strategy to a focus on sequestration activity. Through that process, the research problems are formulated, and the research scope is defined.

1.1 Background and Significance

Climate change is an emerging issue, both for state actors, and non-state actors, such as private companies. Private companies' responses toward climate change differ based on their corporate background. Company size, business value proposition, geographical location, market coverage, product offers, and what benefits accrue to them because of their corporate environmental transformation could determine how a company reacts toward climate change. As mandated by the Paris Agreement 2015, global warming should not exceed 1.5° Celcius in 2050, and all industry sectors need to reach net zero by that time. Based on the recent report from COP27, on the current pace of decarbonization, we will likely overshoot the target, and global warming will peak at 1.8° Celsius in 2050 (The Economist, 2022). If the international community want to achieve the net-zero target by 2050, we need to implement all the well-proven environmental policy instruments and stop the subsidy for fossil fuels globally (Rockström et al., 2017). However, with the looming crisis now, we might not be able to achieve the Paris Agreement goal.

In the pathway toward net zero, decarbonization was introduced by Paris Agreement, which mandated that the global economy should decarbonize through a carbon reduction strategy first, follows by the carbon removal strategy to neutralize remaining emissions that can no longer be reduced (Rockström et al., 2017). This practical advice from the Paris Agreement signifies that carbon abatement and carbon removal are equally important. Carbon removal is a popular subject of climate action within the private sector, the most popular example is the nature-based sequestration activities (both in new planting projects and replanting activity to reinforce carbon sink levels) taking place in tropical rainforest countries such as Brazil and Indonesia. The sequestration activity includes the restoration of degraded ecosystems or the conservation of the current endangered or thriving ecosystem (Maiti & Ahirwal, 2019).

As a developing country, Indonesia faces a unique situation. Indonesia is a major producer of various commodities such as minerals (coal, tin, nickel, gold, and uranium) and products from Agriculture, Forestry, and Land-Use (AFOLU) such as palm oil, timber, and various tropical plantations. Its economy which is significantly based upon natural resources faces the dilemma of extensive domestic industrialization and natural resources exploration vs. natural ecosystem preservation(Elfaki et al., 2022). Indonesia has been subjected to constant criticism for massive deforestation in Kalimantan (Borneo) in the past three decades due to land opening for palm oil and mineral exploration and this concern had moved various global institutions to disburse funds for conducting carbon removal projects in Indonesia through forest restoration. Priority on forest restoration investment is based on two main reasons. First, it has been the government's long-term target to protect Indonesia's natural environment which has a rich biodiversity, which a large share of the population depends on it (DGB Group, 2021). Second, the only perceived as feasible is Carbon Capture, Utilization and Storage (CCUS). This is proven but not scaled—as the capital investments and operational cost is too high. However, the chance

to retrofit oil and gas infrastructure has recently been seen as a possible way to explore CCUS in a country like Indonesia (Takahashi, 2015).

Project-wise, there are more than 200 UNFCCC Clean Development Mechanisms (CDM), with numerous additional projects done independently under private companies' CSR mechanisms. Finance-wise, Result-Based Payments (RBPs) received by Indonesia averaged around USD 100 million annually, corporate restoration project value varied between USD 100,000 to millions of dollars, and restoration crowdfunding in a single project can reach up to USD 100,000. In Indonesia, NGOs serves a central role as the entity conducting most of the restoration project across the country, especially for the fund coming from private companies. Based on observation of several project implementations of corporate restoration projects, the fund is usually managed in two different ways. First, direct grants where the company transfers the fund to the planting partners. Second, indirect grants where the company grants the fund to the knowledge partner (such as WRI, Katingan Mentaya Project, Orang Utan Survival Fund, etc) to be managed. Hopefully, it will increase the likelihood of success – in such instances typically measured in terms of socio-economic benefits, environmental gains, and achievement of cost-effective carbon sequestration (WRI, 2022). The motivation behind why the company chose either pathway is unclear. One possible reason is cost-effectiveness. Disbursing directly to the planting partner could increase the level of complexity, as the company will be responsible for reporting, and direct management of the planting partners. While indirect grants will allow the company to trust a single knowledge partner that will increase the project's success rate through various means (i.e., a combination of partners, reporting indicators, etc). This current gap will be explored further by this research through means of an economic valuation and stakeholder analysis.

For a private company, motivation for doing a carbon sequestration activity can be grouped into four main reasons. *First*, a means for removing the remaining carbon from its decarbonization strategy. As the company usually first focuses on carbon reduction. However, it is highly unlikely that the company will reach carbon neutrality only by changing its technology. Carbon sequestration will give indirect carbon removal benefits for a company to remove its remaining carbon emissions (SBTi, 2023). *Second*, legal compliance stated by the government where it resides(Rim & Dong, 2018). It allows companies to operate in their respective markets, and carbon emissions reduction and removal targets have become a license which companies are required to obtain to continue their business. *Third*, non-targeted carbon offset activity, with various motivations (i.e., government relations, marketing, etc.), and *lastly*, corporate branding efforts (Brancalion et. al., 2012). The last two can be tied together as corporate branding, an activity to appeal to their growing environmentally conscious customers. These last two have potential usage in greenwashing practice, using impact numbers in sustainability reports, company presentations, and green claims for the product they sold to the public. These varied and even contrasting motivations are the foundation of public doubts toward land-based biological carbon sequestration projects done by a private company. The company is expected to deliver a credible and accountable claim about its product and business operations. Trust between the company and its customer could be threatened by the rise of these doubts. One study from an oil and gas company who are using a certain framing strategy for its activity can easily increase its brand value by concealing its real negative effect on the environment through pivoting risk and outcome of its business activity into positive energy development that speaks for its audience (Scanlan, 2017). However, once the framing is revealed and the brand is considered greenwashed its business activity, the reduction of trust from the public will negatively affect its business metrics, such as a decreased return in their stock performance, increase level of brand avoidance, and permanent damage for the recognition of their brand value in public (Du, 2015; Xiao et al., 2022).

Comparing the two sequestration initiatives by the public and private sectors. A report from Systemiq identifies that unsynchronized carbon removal initiatives create market failures due to misconduct of restoration, a gap in investment, and a blurry definition of stakeholder roles in the restoration project. The market failure here can be defined when the restoration creates more cost for all stakeholders instead of the benefit, with the subsequent output of (a) high deforestation rates due to unstoppable land-use change to support national development; (b) abandonment of degraded land; (c) loss of biodiversity that break the ecosystem chain, and (d) declining productivity of the area, which led to further land-use change and abandonment of degraded land (Systemiq & AYA Earth Partners, 2022).

Market failure in restoration efforts is the source of the low survival rate of a restored ecosystem. In Indonesia, the restored ecosystem faces economic development pressures. As a result of agrarian reforms, various protected ecosystems face a risk of land-use change. The agrarian reforms itself is a process of redistribution of state-owned land to private individuals (Nurrochmat et al., 2020). These reforms often included a protected ecosystem, that was sacrificed in the name of economic benefit. The political-economy dynamics occur not only at the high-stakeholder level. Within the local stakeholder level, local government, local NGOs and private companies often have a feud over the stewardship of restored areas and mechanisms for ecosystem protection. This led to various NGOs being reluctant to work together with the government and choosing to do a restoration in an area owned by the local community instead of the government. This repeated occurrence bears a question of the political economy dynamics of the ecosystem restoration project in Indonesia. Exploring the valuation of such projects, as well as how each stakeholder sees themselves in the ecosystem restoration can aid the process of understanding the underlying problem of such political economy dynamics.

1.2 Problem Definition

Carbon removal strategies are often undermined, despite their equal importance to carbon reduction strategies (Carton et. al., 2020). Carbon removal generally refers to the activity of removing already-emitted carbon from the atmosphere (IPCC, 2022). Carbon removal activity generally differentiates by carbon capture, storage, and utilization activity or land-based biological carbon sequestration through ecosystem restoration and conservation (Carton et al., 2020). Carbon sequestration is a popular climate action done by a corporate actor, hence this research put its focus on carbon sequestration activities.

Unfortunately, because of misleading communication (i.e., due to inaccurate reporting or exaggeration of positive environmental/economic impact for greater society) of such activities, carbon sequestration oftentimes faces challenges or displays weaknesses. A prime example is that carbon sequestration tends to be misunderstood and thus misapplied by the private sector. This can lead to distrust by the public for two reasons:

a. First, it is often perceived by many as an easy way out or permission to emit without trying to carbon reduction. Carbon removal projects are prone to greenwashing by an unresponsible private corporation looking to increase its sustainability image with minimum cost and effort (Torelli et al., 2020)
b. Second, the estimation of the potential tangible impact of the carbon removal project is often underestimated by the public (due to limited trust, leading to a perception that a corporate project is limitedly a legal obligation) and overestimated by the company who done it, due to practical gap of difficulty in capturing the tangible impact of a CSR activity (Rim & Dong, 2018; Yang & Stohl, 2020)

The second reason provides a window of opportunity for research to be done. Currently, the author can hypothesize that delineation of role among the relevant stakeholders aren't being

drawn by previous research, and there has been only limited single valuation exists to estimate the actual impact of a land-based carbon sequestration project in Indonesia. With the looming problem of land-use change, greenwashing practices, perceived as misleading policy frameworks, and lack of well-defined stakeholder roles on the horizon, the need to identify the solution for this issue is emerging quickly.

Understanding the total economic value is the first step to getting a full grasp of the importance of carbon sequestration activity. A lack of an integrative model for economic valuation that understands by all stakeholders is the key research gap for a restoration project in Indonesia. All the currently available models such as the one from Noor (2020) and Sharma et. al., (2019) are running only from the academic perspective and lack perspective from the private sector. By understanding the importance of the project through the valuation, we can start making the meaning of it by understanding how each stakeholder perceived themselves and defined how their role is supposed to be in a carbon sequestration activity. From there, the result of the study will fill the existing literature on the stakeholder role in carbon sequestration activity. Providing novel knowledge that ties stakeholder role to the ecosystem service value communication.

1.3 Aims and Research Questions

From the research problem defined above, the focus of this research is on finding an equal footing of how each stakeholder can talk about the project, and how each stakeholder perceived their role in the carbon sequestration activities, specifically that relevant to the case study mentioned in this research. This research has the Indonesian government (represented by the Ministry of Finance and National Development Agency), private sector (Caterpillar Foundation), think tank (WRI Indonesia) and local community (represented by the local environmental NGOs) as their audience. Concerning that audience, this research aims to:

a. Fill in a research gap in the economic valuation of ecosystem services in Indonesia through:
    1) Conduct the economic valuation of ecosystem services resulting from the land-based biological sequestration activities done by Caterpillar in Sumatera.
    2) Build a holistic model that defines the most relevant indicator of total economic value (TEV) from a restored ecosystem service.
b. Understanding the multiple stakeholder's roles in the ecosystem restoration process through:
    3) Mapping the multiple stakeholders involves in the restoration project.
    4) Delineating the role of each stakeholder in the ecosystem restoration project
    5) Analysing the dynamics to better understand the political economy factors affecting the process of the ecosystem restoration project in Indonesia.

To achieve the goals previously mentioned, the following research questions are proposed:

a. **RQ1**: What is the Total Economic Valuation (TEV) of the ecosystem restoration project of Caterpillar Foundation in Indonesia?
b. **RQ2.1**: How each stakeholder perceives their role in the ecosystem restoration project?
c. **RQ2.2**: What political economy dynamics affect the perceived role of each stakeholder?

1.4 Scope and Delimitation

The research scope is focused on nature-based solutions for carbon-removal activity, the land-based biological carbon sequestration activities. The scope is chosen because of the nature of Indonesia as a country that is globally targeted for such a project, hence the impact and audience of the research output can be greatly increased. This thesis project uses a case study of an

ecosystem restoration project done by the Caterpillar Foundation in Indonesia. The project covers 100 hectares of degraded rainforest region in *Leuser* National Park and *Kerinci* National Park in Sumatera, and 25 hectares of degraded coastal ecosystem in offshore Sumatera (Riau Islands).

The project is managed by World Resources Institute (WRI) Indonesia. The entity's main role is optimizing the impact of the ecosystem restoration by planning the restoration location, the local implementation partner, and the choice of species to be planted in the degraded region to ensure a high survival rate and optimum socio-economic impact.

The degraded region has a lot of use and non-use value for the local community. The most important value for the local community is because it relates to how they can gain economic benefits for their well-being, such as from direct payment from donors, and the value of harvested goods in the future. However, the government and private sector have a different focus on a carbon sequestration project, which mainly relates to the non-use value of regulating ecosystem services, especially the carbon sink and disaster risk reduction potential. Therefore, the ecosystem services evaluated for this thesis project are the regulating ecosystem services (carbon sink potential and disaster risk reduction effect) and provisioning ecosystem services (the economic value of the ecosystem existence that ties to local economic empowerment of the ecosystem restoration). Further details about the literature study on ecosystem restoration are explained in **Chapter 2: literature review.**

1.5 Ethical Consideration

The research was funded by two organizations, Caterpillar Foundation through World Resources Institute (WRI) Indonesia, and Indonesia's Ministry of Finance through National Endowment Fund for Education (LPDP). However, these two sponsors will not be affecting the research process and output in any way, as they give complete freedom in the usage of funds and research direction to the researcher. The two organizations give a general guideline that the research output should be generally used by the public after the research project is over. Therefore, the two expected outputs of this research: the valuation model of the sequestration activities and stakeholders' communication guidelines will be published by WRI Indonesia as the think-tank partner in this thesis.

The ethical consideration for this research widely revolves around the careful engagement with the local and indigenous communities where the research fieldwork is taking place. The three-research location is in a remote region, hence academic knowledge about the nature of the research shall be delivered contextually. The participation of respondents or informants (when necessary) is fully consensual and will be recorded through a consent form to avoid a disadvantageous situation to the research plan. In addition to that, the research data collection process is partially done by the thesis active partner (WRI Indonesia). The data collection done by the active partner is related to spreading the questionnaire to the local community. The partner already briefed about how they should approach the local community, to minimize biases and align with the researchers' goal in data collection.

The research outcomes will not directly affect the local community in any way. However, the valuation result might be affecting the government/public sector, as the valuation of the carbon sequestration project in Indonesia might be higher than their current valuation. In addition, the communication guidelines might be seen as critical to the government's current stakeholder communication practices. Upon writing this proposal, no sensitive data will be used in this research. However, all the collected empirical data will be stored in the author's data storage and will only be published when such needs arise in the future.

This research design has been reviewed against the criteria for research requiring an ethics board review at Lund University and has been found to not require a statement from the ethics committee. Those criteria are related to the legal implication of the research and relations to the research object such as personal data processing, direct physical intervention, indirect physical and mental intervention, and sampling of biological matters. From all these criteria, this research does not fall into any of those criteria which require ethic board clearance.

1.6 Audience

The findings can benefit four stakeholders: academics, the government of Indonesia, the private companies that plan to engage in land-based biological sequestration projects, and the local community as an integral part of the project. *First*, the result of this research will enrich the economic valuation research and add nuance to how the political and economic dynamics affect the quality of project delivery. *Second*, the government, the Ministry of Finance can benefit from knowing the value of the restoration project done by private companies and create access to further creating collaboration between public and private sectors. *Third*, the private companies, specifically Caterpillar Foundation gain benefits through more tangible impact valuation that benefits their sustainability reporting process, and communication with all relevant stakeholders. *Finally*, the local community, as they are deeply engaged in the process, can understand the meaning of a restored ecosystem, and is motivated to ensure its high survival rate.

1.7 Disposition

The structure of the paper will follow the mental map of a research process from problem identification to conclusions. **Chapter 1** serves to address the research background, problem identification, research scope, intended audience and ethical consideration of the study.

Chapter 2 focuses on the literature review and builds the research context for the study. This chapter presents the current knowledge, provides a deeper research gap analysis, and gradually builds up the theoretical background to the study that led to the economic valuation of the restored ecosystem and its communication problem.

Chapter 3 describes **the** research design and methodology, and covers the research philosophy, choice of methodology, data collection means and structures, data analysis, research process, and reliability and validity test to ensure that RQs are properly addressed.

Chapter 4 provides a detailed finding from the data analysis. It provides a clear and concise answer to the two RQs based on the analysis conducted towards the collected data within the research process. This chapter shows the survey results, economic valuation modelling, as well as interview data.

Chapter 5 discusses the findings, and their implications, both theoretical and practical implications.

The thesis concludes in **Chapter 6**, which provides the main conclusions, limitations throughout the research process, and possible studies for future research.

2 Literature Review

2.1 Corporate Decarbonization: Motivation and Capabilities

Comparing the state-level and corporate-level decarbonization strategies are two different things. State-level decarbonization strategy is following the IPCC Global categorization focusing on five sectors where the state has dominant control: energy, waste, Industrial Processes and Product Use (IPPU), Agriculture, and Forestry and Other Land Use (FOLU) (IPCC, 2006). Meanwhile, the corporate level industry decarbonizations follow on reduction based on direct and indirect emissions (ISO 14026) or Scope 1, 2 and 3 emissions (GHG Protocol). Despite the different approach in emissions separation, the strategy is following the same standards that focus on carbon reduction strategy through technological and behavioural change, then utilizing carbon removal activities as the final positive tipping point that create not only net-zero emissions but positive carbon sink (Mahardika, 2021). The current approach to decarbonization however observes these two strategies as two separate approach while they're entangled by each other. Efforts to avoid double counting on state-level decarbonization and corporate-level decarbonization have been done through mechanisms such as attributional analysis, border adjustment, and carbon trading mechanisms. These mechanisms especially focus on carbon abatement strategy (Schneider et al., 2015). However, the effort to openly count the attribution between the state-level and corporate-level carbon removal projects is still minimal. As the roles of state and corporate actors in carbon removal projects (especially nature-based solutions) are hardly delineated in developing countries (Thompson, 2018).

2.2 Carbon Removal Strategy: Problems on the Field

Carbon removal defines as an act of capturing carbon emissions from the atmospheric carbon cycle, and in the process improving the ecosystem process that supports life on Earth. This process could mean keeping them in a certain location (Carbon Storage), utilizing them for other means (Carbon Utilization), or absorbed by both terrestrial and ocean biomass (Carbon Sequestration) (Carton et al., 2020; Farrell et al., 2022; Garðarsdóttir et al., 2018; Lau et al., 2021; McQueen et al., 2020; Thompson, 2018). CCUS technology includes direct air capture technology, CCS retrofit, and Bioenergy CCS (Garðarsdóttir et al., 2018; Lau et al., 2021; McQueen et al., 2020). Land-based biological carbon sequestration often includes human-aided biomass restoration projects, natural forest regeneration, as well as urban nature-based solutions to increase carbon sinks and storage available in the natural environment (Carton et al., 2020; Farrell et al., 2022; Thompson, 2018)

Both carbon removal approaches have their problems. CCUS is known to require high capital investment, with minimum short-term return on investment (Lau et al., 2021). Hence, government incentives or higher price of carbon is required to increase the robustness of CCUS technological innovation (Garðarsdóttir et al., 2018; McQueen et al., 2020). On the other hand, land-based biological carbon sequestration faced the problem of the sustained cycle of failures. Where: (a) the government set a high ambition for carbon sequestration but lacks financial capabilities; (b) the corporate actor paying for the project, but only aimed for the bare minimum of achievement; (c) uneducated communities intentionally neglect the restored environment after planting, and finally (d) as the sequestration project is failing due to the companies lack determination and community lacks knowledge, the government repeat the cycle and back to point [a] (Carton et al., 2020; Thompson, 2018)

Land-based biological sequestration activities are strongly related to Indonesia as a country with at least 15% global rainforest reserves (Butler, 2020). The ongoing deforestation and land degradation due to land-use change in the country significantly invites green investment and

global ecosystem conservation funds to the country (Boyd et al., 2018). Indonesia faced similar market failures due to the mismanagement of ecosystem restoration projects as well.

The major cause of these failures can be seen from a multi-level perspective. The political dynamics distract the government from a rational implementation. The private sector lacks vision on the long-term benefit of progressive and collaborative restoration project impact. (Carton et al., 2020; Thompson, 2018). While the communities, becoming a pawn in these debates, are uneducated and creates a generational tunnel vision that only sees restoration project as a source of annual income (Carton et al., 2020). Carbon sequestration becomes an interesting topic to explore, not only in its governance but also in how we can put value to those impacts and make an economic case that is acceptable to all stakeholders.

These failures in achieving optimum carbon removal potential are also seen in Indonesia. For example, the Indonesian government often has a conflicting view on deforestation with an environmental think tank that researches on deforestation rate. Recently in 2020, Indonesia's ministry of environment and forestry accuses WRI Indonesia of publishing a misleading research article on Indonesia's deforestation rate (Saputra & Nugroho, 2020). This issue has caused the corporate actor to become hesitant in conducting early carbon removal as there has been a lot of mishap in the field due to communication issues that buried all the good efforts and intention. Understanding how the valuation works and how each stakeholder perceived this value could alleviate the tension between the stakeholder and provides a strong background for unison collaboration.

2.3 Carbon Sequestration Impact: Regulating and Provisioning Services

From the previous review on carbon sequestration, a lack of knowledge of the practical framework of estimating the value of carbon sequestration impact is the source of its mismanagement of it. The impact itself can be divided into five indicators. *First*, regulating ecosystem services (ES) value, which covers the near-term and long-term biomass carbon sinks and storage potential (assuming they are protected ad infinitum). This ES can be valued through the direct open market valuation of carbon or the social cost of carbon to discover its value in financial terms (Jakovac et al., 2020; Naime et al., 2020). *Second*, provisioning ES, which covers near-term economic benefits (i.e., forest products, fodder, ecotourism, increased crop quality and harvest volume, etc) and social benefits (i.e., employment, food security, farmers' education, indirect impact of biodiversity, etc) (Chazdon et al., 2020; Crookes & Blignaut, 2019; Faivre et al., 2018; Jakovac et al., 2020; Woolf et al., 2018; Young & Schwartz, 2019). *Third* is avoided cost from ES loss (i.e., avoided water loss, soil erosion, seasonal flood, coastal abrasion, etc, this function can also be considered as provisioning services as it relates to its function in natural settings (Crookes & Blignaut, 2019; Jakovac et al., 2020; Young & Schwartz, 2019). *Fourth* the cultural services, such as recreational, educational and spiritual functions ((Kosanic & Petzold, 2020)). Finally, the restored ecosystem also has a supporting function for habitat biodiversity, soil formation, and photosynthesis (Weiskopf et al., 2020). Which presumably means improvement of the non-use value and the potential use value in the future.

From all the studies on sequestration impact, provisioning services have the richest impact on research, with wide arrays of valuation possibilities and a combination of research methods to measure the actual impact. Currently, sequestration impact often calculates through 'avoided cost' or 'opportunity cost' assessment but lacks an integrative assessment of the socioeconomic impact (Carton et al., 2020). However, Chazdon et. al., (2020) mention that developing a business model and a simulation of impact on the more local level could increase the value of restoration projects in the eye of both government and the private sector. Because the value of

restoration projects is not only when the project is implemented, but it can create a regenerative economy that helps to sustain the rural economy and indirectly affects the national GDP of the country. For example, Ethiopia Food Security Program (FSR) revolves around the forest economy and has been stimulating the country's GDP by 1% in 2017 (Woolf et al., 2018). This involved sustainable agroforestry which involved the incorporation of agricultural practice, instead of focusing on timber supply from the forest ecosystem.

The main priority for many ecosystems services valuation is stressing on the regulating and provisioning services. For the area that is analysed within this thesis, the provisioning services that are seen as important are the carbon sink and disaster risk reduction effects. While for the provisioning services, priority is given to local economic empowerment, both in the short-term and long-term view.

2.4 Perceived role in ecosystem restoration activities

A stakeholder, in a broad view, is an entity, be it an individual or group, acting as themselves or representing certain organizations that can affect or be affected by the achievement of a certain activity/organization's objectives (Mitchell et al., 1997). In determining a stakeholder, the same author defined the three attributes of a stakeholder, namely: (a) *Power*, which is defined as a social relationship in which the stakeholder can carry their agenda despite resistance; (b) *Legitimacy*, or a social claim of socially accepted and expected structure of the practice of power, and (c) *Urgency*, defined as a situation in which a stakeholder holds a pressing circumstance concerning the activity or time-sensitive in nature(Mitchell et al., 1997).

Based on the three attributes of a stakeholder, the preliminary stakeholder in the ecosystem restoration activities is the government, private companies, and the local communities. Each has a distinct role depending on their position in the project. The current literature mentions the government's role as supervisor, regulator, and facilitator. The private sector as government ally, financial provider, enabler and implementor. Meanwhile, the local community serves as a protector, public-private facilitator, and source of local wisdom. However, this study won't limit itself to only the already studied role of each stakeholder, an open-ended question shall be put here to also expand the knowledge for the upcoming research. Further detail on the summary of the current literature is listed in the table below.

Table 2-1: Perceived role of stakeholders in ecosystem restoration activities

Entity	**Major Categorization**	**Indicator**	**Source**
Government	Supervisor	The supervisory function of all the projects within their jurisdiction	(Aronson & Alexander, 2013; Gann et al., 2019)
	Regulator	Regulation creation and enforcement, endorsing policy framework for a restoration project	(Aronson & Alexander, 2013; Gann et al., 2019; Murcia et al., 2016; Pérez et al., 2019)
		Long-term educational promotion and community integration	(Murcia et al., 2016)
		The ultimate owner of major land concessions	(Murcia et al., 2016)
		Nationwide goal alignment/baselines/target settings	(Murcia et al., 2016)
		Protecting the interest of future generation	(Pérez et al., 2019)
	Facilitator	Acquire and allocate resources from PES, royalties from trade, or bilateral agreement	(Aronson & Alexander, 2013; Murcia et al., 2016)
		Long-term educational promotion and community integration	(Murcia et al., 2016)

		Making a case for green investment for a private landowner	(Pérez et al., 2019)
		Formalization of informal forest protection activities by the local community	(Alexander et al., 2011; Aronson & Alexander, 2013)
		Levelling up the playing field for all stakeholders	(Aronson & Alexander, 2013)
		Large coalition coordinator for large ecosystem restoration, participatory governance	(Aronson & Alexander, 2013; Gann et al., 2019; Murcia et al., 2016; Pérez et al., 2019)
Private sector	Government ally	Government lobby	(Aronson & Alexander, 2013; Thompson, 2018)
	Financial Provider	Donor/Investment provider	(Aronson & Alexander, 2013; Richardson & Lefroy, 2016; Thompson, 2018)
	Financial Provider	Push factor for the financial sector for credit/ bonds/ funding supports	Systemiq (2022)
	Implementor	The implementor of restoration activities	(Aronson & Alexander, 2013; Thompson, 2018)
	Implementor	The actor with bigger freedom in managing the ecosystem restoration	(Richardson & Lefroy, 2016; Thompson, 2018)
	Enabler	Market enabler for regenerative forestry	Systemiq (2022)
	Enabler	Pioneer for the new sustainable business model	Richardson & Lefroy (2016), Systemiq (2022)
	Enabler	Marketer of the economic value of the ecosystem restoration	(Richardson & Lefroy, 2016)
	Enabler	Creative agents expanding the regenerative forests and local community empowerment	Richardson & Lefroy (2016), Systemiq (2022)
	Enabler	Network effects driver within the private sectors	Systemiq (2022)
Local Community	Protector	Stewards of the restored ecosystem	(Fischer et al., 2021; Reyes-García et al., 2019; Wehi & Lord, 2017)
	Protector	Pioneer in the ecosystem restoration effort	(Reyes-García et al., 2019)
	Facilitator	The bridge between private and public sectors	(Fischer et al., 2021)
	Facilitator	Wider community resilience enablers	(Lin, 2019; Reyes-García et al., 2019)
	Facilitator	Transforming local politics through the change in dynamics of local vulnerabilities	(Lin, 2019)
	Local Wisdom	Facilitating deeper leverage points exploration of sustainable and responsible ecosystem utilization	(Fischer et al., 2021; Wehi & Lord, 2017)
	Local Wisdom	Source of the local knowledge for planning, implementation, and monitoring	(Reyes-García et al., 2019; Urzedo et al., 2022)
	Local Wisdom	Providers of native seed supply with a high survival rate	(Urzedo et al., 2022)

Source: author's directory

From all the literature that explains each stakeholder's role, to our knowledge there hasn't been a study that ties these roles to the ecosystem services value communication. Each of the stakeholders has distinct yet interconnected roles, yet understanding of the ecosystem services value is often different depending on whom one speaking to. Government focuses on the intergenerational value of the restored ecosystem; the private sector focuses on the economic and financial value of the restored ecosystem and the local community focuses on the existential

value of the restored ecosystem. All that led to the same TEV, yet approach differently, causing a ruckus and mismanagement in implementation.

2.5 Total Economic Valuation Framework

2.5.1 Contemporary literature for Total Economic Valuation (TEV) of Ecosystem Services

The methodology to count the TEV of ecosystem services generally depends on the researcher's view on what is considered the use and non-use value of the ecosystem services. For example, research from Thapa et al (2020) first sweep through all the possible utilization of the ecosystem to understand the use value. The research comes up with the direct use-consumptive, direct use-non-consumptive, indirect use, and non-use-value of the ecosystem services. Then, the author utilises all the best practices of an economic valuation to evaluate each of the ecosystem services. To conclude their research, the authors aggregate all the results in a single model to reveal the TEV of the ecosystem services.

Vasquez and Rezende (2019) and Islam et al (2019), utilise contingent valuation methods to understand the total value of ecosystem services by interviewing the local community on all ecosystem services categories (provisioning, regulating, cultural and supporting). This choice of methods is strong in understanding the perceived value of the ecosystem services by understanding how the locals treat its ecosystem. Other studies like Petterson and Cole (2013) use a metadata analysis from various studies to draw a benefit transfer function that can be utilized for the case of New Zealand and benchmark it with the national data. These methods are quantitatively proven but face a limitation in that the characteristics of the study used for the meta-analysis should have similar characteristics to the subject of the study.

Table 2-2 Existing Studies on Total Economic Valuation

Source	**Ecosystem Type**	**Location**	**Data Used**	**Methodology**
(Noor et al., 2020)	Terrestrial and Coastal	Indonesia	Direct observation on tree growth	Tree Allometrics on 22 years Conservative Estimates
(Thapa et al., 2020)	Wetland	Nepal	Regional statistics data, metadata from other studies, and WTP/A surveys through various forms for various estimation purposes	Market price method, travel cost method, revealed price method, contingent valuation method, and benefits transfer method
(Vásquez & de Rezende, 2019)	Rainforest	Brazil	CVM Questionnaire	Contingent Valuation
(Islam et al., 2019)	Coastal	Bangladesh	CVM Questionnaire	Contingent Valuation
(Nitanan et al., 2020)	Rainforest	Malaysia	Stumpage Value National Park's annual revenue Choice experiments data	Choice Experiment
(Patterson & Cole, 2013)	Terrestrial (unspecified)	New Zealand	Metadata from 54 studies	Benefit transfer
(Perez-Verdin et al., 2016)	Terrestrial	Mexico	Meta-data from 43 valuation studies	Benefit transfer

(Aryal et al., 2021)	Wetland	Nepal	Regional statistics data, metadata from 2 studies, and CVM survey	Market-Price Method, Benefit Transfer and Contingent valuation

Source: author's directory

From this study, we can draw that contingent valuation is among the most-used methodology along with the benefit transfer methods. The reason is due to its simplicity in deployment. However, the limitation of contingent valuation and benefit transfer is on its reliability that only valid to certain geographical regions, ecosystem types, and local contexts, making its replicability rather limited.

2.5.2 Theoretical Background on Valuation of Environmental Projects

Total Economic Value (TEV)

Economic valuation of ecosystem services can be defined as a process of determining an appropriate monetary value of natural capital stocks that provides different services to human well-being (Gómez-Baggethun & Ruiz-Pérez, 2011; Salles, 2011). This process includes the discovery of ecosystem services, and their benefit to societal well-being (Salles, 2011). The value of ecosystem services is hence defined as an ascription economic value that aimed to quantify the benefits that human receives from an ecosystem service. In practice, the concept of Total Economic Value developed as an integrative framework that covers direct and indirect use values that covers this dynamic interaction between human and their environment (Gómez-Baggethun & Ruiz-Pérez, 2011; Salles, 2011).

The valuation process provides three main values. First, it provides a tool for communicating societal dependence on the ecosystem they attached to and conceptualizing the structure of the relationship between humans and their natural environment (Abson & Termansen, 2010; Salles, 2011). Second, it provides legitimacy for assessing the benefit of an ecosystem service, allowing easy comparison to another phenomenon (Salles, 2011). Lastly, it provides an aggregative value of ecosystem services, that aid decision-makers to create informed decision-making for ecosystem management (Abson & Termansen, 2010)

Tree Allometric Estimation and Carbon Market Valuation

For this research, the valuation of the ecosystem services will cover three valuation approaches. First, for the environmental impact, the monetary value will be assigned based on the market value of the potential of the sequestered carbon, which is calculated through tree allometric estimates, specifically above-ground biomass (Noor et al., 2020).

Calculating the carbon sequestration potential is generally done in two different approaches. *First,* is utilizing the stock difference that utilises the data of total biomass, dead organic matter, and soil organic matter estimates (Noor et al., 2020). *The second* methods are the carbon input-output estimates that count the difference between net primary carbon absorption (input), and the emissions output (Basuki et al., 2019). However, to increase the utilization of the methods across different landscapes and land use, the earlier methods are more relevant (Aalde et al., 2006). Noor et. al. (2020) shows the following models as the most preferable tree allometric model:

$$B = f(D), B = f(D, H)$$

Where B is the biomass carbon sink expansion factor, f(D) is the tree biomass based on diameter estimates, and f (D, H) is the diameter estimates based on the expansion of diameter and height of the trees. There are no carbon pricing mechanisms set in place in Indonesia. Hence, the IPCC

standards for carbon pricing will be utilised. The implicit carbon pricing itself calculates the total cost of the initiatives and the actual carbon sink potential. The formula is as follows:

$$Carbon\ Price = \frac{\sum Total\ Cost\ of\ the\ Initiatives}{\sum\ tCO_2\ Potentially\ Sinked}$$

The key to these methods is understanding the carbon sink potential and understanding the carbon cost of the initiatives. This process will lead to an easier understanding of the indirect impact of land-based carbon sequestration activity.

Socio-economic Valuation and Market Valuation

Second, the socioeconomic impact will be assigned monetary value through the study of the financial value-added of the project to the local community. Utilizing the factor utilised by Thapa et al (2020), the economic value that can be calculated through its market price is direct consumption value (i.e., sold/consumed value of harvested commodities and timber-related products), meanwhile, WRI Indonesia also models the economic value given to the local community during the restoration project with includes the direct payment to the local community and the local factor during the procurement process (WRI, 2020). To combine, the combination of both economic values can be put into the following equation.

$$Economic\ Value = \sum(HP\ x\ MP_{HP}) + (TP\ x\ MP_{TP}) + (RC) + e$$

Where HP is the harvested product, TP is a timber-related product, MP is a market price, RC is the capital spent on the local community for the restoration activities, and *e* is an error/discount rate to compensate for bias and economic uncertainty in market price estimation.

Disaster Risk Reduction and Contingent Valuation

Lastly, disaster risk reduction will be evaluated through contingent valuation methods. The contingent valuation methods are widely used to evaluate the non-use value of ecosystem services. Within this study, the CVM can be implemented through a Willingness to Pay (WTP) survey to ask the local community about the value of certain (avoided) environmental conditions. The result then can be aggregated and compared against the baseline study which will provide an understanding of the value of disaster risk reduction (Venkatachalam, 2004; Liu et. al., 2019).

The key to conducting CVM is to use the correct guidance for the interview with the sample of respondents. A study by Liu et al (2019) utilised payment card surveys where the respondents are given several cards with a number written on them and asked to choose their highest willingness to pay. This method's limitation is on the bias of the upper bound of the WTP that is pre-estimated by the authors. For the context of developing countries where the respondents have a limited educational background, Alberini and Cooper (2000) recommend the dichotomous choice CVM interview where the interviewer guides the respondents in answering the series of WTP questions in a series of Yes/No questions until they decline the payment/incentives or until the number reaches zero/infinite number. These methods can help capture the data and avoid researcher bias in the process. But this method also has a limitation in the delivery that if not well executed, might create a respondent bias.

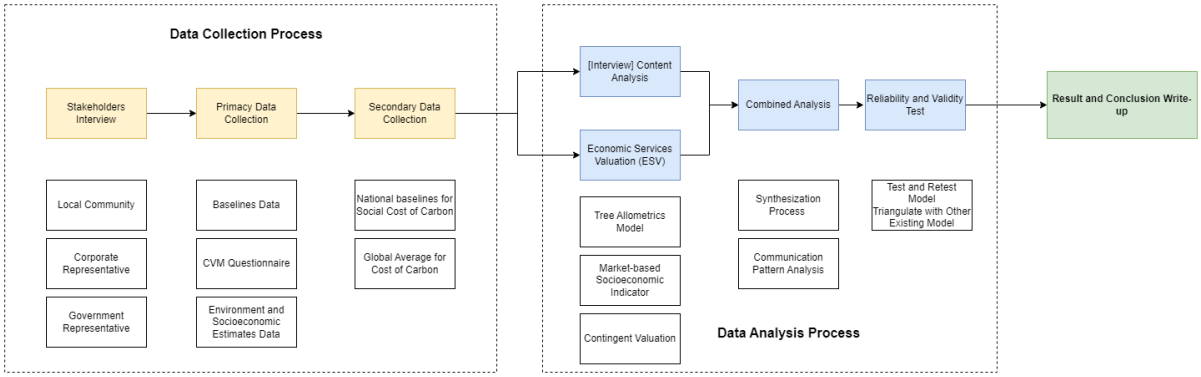
3 Research Design and Methodology

3.1 Research Philosophy and Research Design

Mixed methodologies were carried out with quantitative economic valuation analysis and qualitative measurements to study the above-mentioned research questions. Anchoring from Cresswell & Cresswell (2018), the mixed methods enabled the research result to explain the phenomenon beyond the number provided by the quantitative modelling, by adding a nuance of philosophical standing that can help translate the research into more relevant practical settings. The research took a heavy influence from the postpositivist worldviews as this research is reductionist, trying to outline an estimated value of certain ecosystem services and finding best practices for communicating it. This research generally lies on the premise on strengthen the current discourse of environmental services valuation theory, by providing an integrative model to complement existing knowledge.

The research process followed the below diagram. The data collection process *started* by a series of interviews with the stakeholders involved in the restoration project: the corporate representative, the government representative, and the local community representative to gain knowledge on the role and obligations of each stakeholder in the forest restoration. *Second*, the primary data collection at the project site, within this data collection process, the number of trees will be calculated for the environmental indicator. Project financial structures will be recorded for the socio-economic indicator, and the CVM Questionnaire will be spread to the local community to be filled. This part of data collection will be done in an integrative capacity-building process from the thesis partner (Caterpillar Foundation and WRI Indonesia) to the local community and restoration partner throughout January-February 2023. *Lastly*, the literature study on the cost of carbon across the globe to create a comparative analysis of the value of sequestration projects.

Figure 3-1. Research process diagram



Source: researcher's document

The data analysis part is driven by how each research question is answered by a different type of data and analysis process. *For the first research question*, the ecosystem services valuation analysis used, and the data collected from the primary and secondary data collection analysed through the following preliminary model to understand the total impact value of the project over a certain period. To understand the actual value of the project in the present times, the sum of the project value discounted using a certain discount rate. This method of providing NPV for a project has been widely used in various studies and practical usage by consulting firms:

$$\sum ESV_n = \frac{(Env_n + Econ_n + DRR_n)}{(1+r)^n}$$

Where:
ESV_n : Total environmental services value at the end of the estimated period.
Env_n : total value of potential sequestered carbon at the end of the estimated period
$Econ_n$: total value of economic improvement at the end of the estimated period
DRR_n : total value of disaster risk reduction at the end of the estimated period
r : discount rate

In assessing the project, the usage of the discount rate is different from the normal business valuation. A World Bank study mentions that zero rates should be applied to an environmental project, as we cannot ethically put a discount on basic human rights (Brumby & Cloutier, 2022). Besides, the environmental issue is an existential issue, not a marginal issue with diminishing relevance. Understanding the continuously increasing importance of environmental services, and the continuously increasing price of carbon. It only makes sense to have a negative discount rate at this level. This question of the discount rate will also be discussed in the findings and analysis part, to deepen the analysis for answering RQ1. The range of discount rate will be from -25% to 25%. The range of this discount rate is rather arbitrary as there's no rigid rule-of-thumb in NPV of environmental projects. Hence, the choice is rather chosen based on limited studies from the World Bank and IMF(Brumby & Cloutier, 2022; Haksar & Kopp, 2020).

The environmental services value is using tree allometric methodology to estimate the potential sequestered carbon (Noor et al., 2020). Then the potential carbon sequestered multiplied by the cost of carbon in the market to gain final monetary value. The socioeconomic impact estimation used the methods estimates from the WRI which covered the economic value of the project and the product derived from the project. While the contingent value of disaster risk reduction be estimated through contingent valuation methodologies derived from the study of Ventakachalam (2004) and Liu et. al., (2019). The result will be the total impact of the sequestration project in monetary terms. To address result reliability, the test-retest design for the ecosystem services valuation will be done in this project. The reliability of the environmental services valuation methods can be addressed through this method and by comparing the difference in standard deviation (Bishop & Boyle, 2019).

For the interview result, it was deductively coded, to gain an organic code that represents an actual landscape in the field. The coded data then being analysed to answer the *second research question*. Furthermore, the result from the first research questions is also communicated to the interviewee after the first interview is conducted to capture the change of impressions toward the ESV process. This way, the difference in interviewee impressions could enrich the research result in understanding the best practices for communicating such ESV.

The methods selected were the result of the long discussions occurring within the pre-study phases conducted before the writing of this thesis proposal. Solely relying on quantitative analysis will make the research overly reductionist, while relying on the qualitative measures alone won't enable a complete assessment of the meaning of the carbon sequestration project The mixed methods will enable a more holistic approach to the economic valuation, as the research is not stopped when the monetary value is discovered but is extended to how this value can be communicated to relevant stakeholders and aid in the deeper stakeholders engagement.

3.2 Data Collection

3.2.1 Data Source

The data source of this research comes from primary and secondary data. Table 3-1 shows what data is collected in this research, how it is being collected, and how it will be analysed in this research. The data collection process is further explained in 3.2 and the data analysis process is explained in 3.3.

Table 3-1 Data Source Identification

Type	Data Description	Data Collection Methods	Data Analysis Methods
Secondary	Tree Biomass	Literature	Tree Allometric
Primary and Secondary	Economic Value of Ecosystem	Project Documentation Literature Rev9eiew Site Visit	Market valuation
Primary	Disaster risk reduction	Guided Survey Site Visit	CVM and descriptive statistical analysis
Primary	Perceived roles of stakeholders	Semi-structured interviews	Content analysis

Source: researcher's directory

3.2.2 Tree Biomass Survey

In collecting the tree data, the researcher used the case study project activity data to gain all the trees that were planted in a restoration project. The tree species are the following species:

Table 3-2. Tree species planted in the region.

Location	Species Planted
Bintan	Bakau (*Rhizopora sp*)
Kerinci	Kayu Manis (*Cinnamomum verum*)
Aceh Tenggara	Meranti (*Shorea sp*)
	Durian (*Malvaceae sp*)
	Cempedak (*Artocarpus Integer*)
	Asam Gelugur (*Garnicia Atrovirdis*)
	Petai (*Parkia sp*)
	Aren (*A. pinnata*)

Source: WRI Indonesia project documentation

From the known tree species planted, the research then will be conducted to get the base of tree biomass data and expansion estimates. The tree biomass will be taken from Indonesia forestry statistics, to increase the data accuracy. The tree expansion and allometric estimates will follow IPCC guidelines (Noor et al., 2020).

3.2.3 Economic Value of the Restored Ecosystem

The economic valuation of the restored ecosystem will consider all the direct-consumptive value of the ecosystem services. Based on the previous studies as well as the contextualization based on the case studies. The following data will be used, and its value will be estimated based on the local market valuation to increase its accuracy.

Table 3-3. Economic Value Data Sources

Direct Economic Value	Data Description	Valuation Methods
Direct payment to the local community	Payment/tree planted	Actual value
Local procurement factor	The fund used for procuring all required equipment and supplies for restoration that bought from the local community	Actual value
Harvested commodities potential	Commodities sold or consumed by the local community	Estimated market value

Source: WRI Indonesia project documentation (2022)

3.2.4 Contingent Valuation Survey

A contingent valuation survey is a method of trying to understand what value a person put on certain goods (Alberini & Cooper, 2000). In this research, the goods itself is an ecosystem service of disaster risk reduction. The survey starts by understanding the monetary value of a disaster perceived by the subject and continues with an understanding of their willingness to pay to avoid such disaster, in a form of an annual premium. The survey also discussed the amount of money the subject willing to accept to protect their environment to avoid disaster from happening.

Population and Sampling

The population for this study can be divided into two categories. *First*, the research related to the economic valuation of the restored ecosystem, the population will be the total population in the restoration area. The following table shows the population in all restoration sites:

Table 3-4. Population affected by the restored ecosystem.

Location	Population (2021)	Shares
Kabupaten Kerinci	254,241	39.25 %
Batu Hamparan, Aceh Tenggara	227,456	35.12 %
Kabupaten Bintan	165,920	25.63%
Total	**647,617**	**100%**

Source: Indonesia Statistics Agency

From the population of the study, the sampling process is done through non-probability sampling, as the researcher does not have the capability nor access to reach the population. The sample of this research will be part of the population who have direct involvement with the restoration activities. To consider the number of people that need to be contacted, the Schaeffer sampling formula is used to get the number of samples sufficient for the study (Liu et al, 2019). This sampling methodology is widely used for the willingness to pay surveys, as it could efficiently capture the information from a large population where researchers don't have possible access to reach all of them. The formula is:

$$N = \frac{n}{(n-1)e^2 + 1}$$

Where N is the total sampling required for the study, n is the total population, and e is the sampling error estimate (5% by default). From that number, it was estimated that 399.7 samples are needed, or at least 400 samples for the survey. Considering the local engagement of the

household base, the interview will be done with 1 person in each household, the average household in Indonesia consists of 4 people, hence the total number of samplings required for this survey is at least 100 households spread based on the share of the total population. This method is determined based on the practice in rural Indonesia, regarding the delegation of authority to the head of the family. As observed in the area, the role of the family head is strong, and interviewing individuals is considered a hard cultural barrier. Therefore, this method can be justified for the questionnaire data collection process. Hence, the survey of the economic valuation will be conducted on 40 households in Kerinci, 35 households in Aceh Tenggara, and 25 households in Bintan.

Questionnaire Delivery Design

The questionnaire is conducted through a guided paper-based questionnaire. Considering the relatively low level of education in the rural community in the restoration area. The questionnaire was specially designed to be delivered in the local language by the local partner of the research. The questionnaire was designed in *Bahasa Indonesia* and delivered by a local partner, but the process of delivery is delivered in the local language of the respective location (Aceh language for Aceh Tenggara, and Melayu for Kerinci and Bintan). The questionnaire is filled out by the researcher's team in the field, and the subject sample is asked the question one by one. To some extent, the researcher's team takes a local context when asking the questionnaire question to make them familiar with what the researcher is asking. For example, when a researcher is asking about their WTP for the conservation of their ecosystem, the researcher used the analogy of a farmer insurance system from the local government as an example of how paying a certain premium can protect them from uncertain future risk/damages. This example is used across the sample, as its nationwide program is easily understandable by the sample.

The questionnaire is then divided into four different sections. *The first* section is the demographic question that consists of age, income, occupation, and gender. *The second* section is a general understanding and perceives a sense of stewardship to their ecosystem. *The third* section is a series of WTP questions. In practice, the researcher's team are asking the question in a dichotomous model, asking the sample whether they will pay a certain amount of money to protect their environment, until at a certain price level, they refuse to pay anymore. The *fourth* section is a willingness to accept incentives, the model of the question is the same. In total, there are 19 questions, and each interview takes around 20 minutes to complete. The construct of the questionnaire can be seen in Tables 3-4 and an example of the questionnaire is provided in Appendix *1*.

Construct

The questionnaire is constructed based on the previous literature reference that researched a similar ecosystem service. Liu et al (2019), Vasquez and Rezende (2019), and Islam et al (2020), is the main source of this questionnaire design. The design is also adapted for the developing country and rural community context based on the advice first delivered by Alberini and Cooper (2000) and more recently by Bishop and Boyle (2018).

Table 3-5. Questionnaire Construct

Question Category	Indicator	Data Capture Methods
Demographic	Age	Single Answer Question
	Gender	Single Answer Question
	Occupation	Single Answer Question
	Income	Single Answer Question
Ecosystem Stewardship	General Understanding	Likert Scale
	Disaster Risk Attributes	Likert Scale

	Economic Attributes	Likert Scale
	Ecotourism Attributes	Likert Scale
	Ecosystem Importance	Likert Scale
	Stewardships	Likert Scale
Willingness to Pay	Baselines	Dichotomous Non-Exhaustive Question
	Direct Willingness to Pay	Dichotomous Non-Exhaustive Question
	Aided Willingness to Pay	Dichotomous Non-Exhaustive Question
	Ecosystem Valuation	Open-ended
Willingness to Accept	Direct Willingness to Accept	Dichotomous Non-Exhaustive Question

Source: Researcher's directory

3.2.5 Key Stakeholder Interview

For the stakeholder interview, the research interviewed all the involved stakeholders in the restoration project, namely: (a) the Indonesian government; (b) private companies; (c) the restoration partner/intermediary institutions; and (d) the local community. The interview was directly taken by the author through online and offline engagement. For the Indonesian government, the interview was directed to the ministries dealing with environmental issues or its local representatives in the area. For private companies, the interview was directed to two companies conducting similar projects in Indonesia. For the restoration partner, the interview was directed to WRI Indonesia as the restoration partner of the case study. For the local community, it will be represented by the local implementor who managed the restoration activity. The following is the list of interviews conducted for this thesis project and their relevance of responsibility.

Table 3-6. Stakeholder interviewed.

Organizations	Responsibility	Data Collected
Low Carbon Development Initiative (LCDI) Indonesia	A consortium focuses on the management of nation-wide low-carbon development	Interview
WRI Indonesia on behalf of Caterpillar Foundation	An intermediary organization manages the Caterpillar Foundation carbon removal project in Indonesia	Interview
Indonesia National Development and Planning Agency (Bappenas)	The government agency is responsible for the macro planning of national development.	Interview
National Research Agency and Ministry of Environment	The government agency responsible for research and environmental affairs	Meeting Minutes
Mangrove Nusantara Foundation	Local organizations focus on the implementation of projects	Interview
Leuser National Park Communication Forum	Local organizations focus on the implementation of projects	Interview
CSR Department, GoTo Group	Indonesia's largest ride-hailing company, with a strong community-based CSR.	Interview
First Climate AG	Consulting firm providing carbon credit for European companies with a recent focus on attaining carbon credit from Indonesia	Interview

Source: author's directory

The interview design is a semi-structured interview based on the pre-determined themes of the perceived roles of stakeholders as stated in Table 2-1. The interview designed to answer research question 2 of this research. The interview was conducted online through Zoom, Microsoft Teams, and Google Meet depending on the technological capability of each interviewee. The interview was conducted from the second week of February 2023 to the third week of March 2023. There has been a change in the list of interviewees due to availability, however, each stakeholder is still represented well.

3.3 Data Cleaning

The data collection process conducted between February-March 2023. After the data collection is done, the data then categorized based on its category stated in Table 3-1. The tree biomass and economic value will be stored and processed in excel sheets. The questionnaire result is digitized in an excel sheet as well. While the interview results are transcribed.

The data from the questionnaire then screened for incomplete data, and only the complete data will be utilized for the data analysis process. Some question serves as warming question, and answering these questions aren't required, however, the question related to WTP is a key component which needs to be answered. Within the questionnaire, the researcher put a question that will separate the sample who pay attention to the interviewer and answer the questionnaire honestly and the one who doesn't pay attention to what is being talked about. A total of 120 households were interviewed, and from that data, the researcher determined 90 questionnaire result representing 90 households is valid for data analysis.

3.4 Data Analysis

3.4.1 Data Analysis Tools

All the data is collected from paper-based sources. The first step of the data analysis is manual input to the chosen spreadsheeting tool (Microsoft Excel). The data analysis for the tree biomass and economic value will also be modelled through an excel sheet. The data processing from the contingent valuation questionnaire will be done through **SPSS**[1], a statistical analysis software. The software is widely used for data management and analysis for various research purposes. The SPSS is used to extract descriptive analysis data and construct a multiple regression model to understand what might affect the result of the contingent valuation survey. The final part of the research will then be using Microsoft Excel again to extrapolate the data to the population and aggregate all the valuation results into a single TEV model.

3.4.2 Data Analysis Techniques

Tree Carbon Sequestration Potential

The available data will be the number of trees planted for each species and its tree allometric number, which are the ***average*** total tree biomass per year. The data is coming from Indonesia Tree Allometric databases. To analyse this data, an aggregation will be drawn, to sum up, all the carbon sequestration potential for the next 20 years. The aggregation of carbon sequestration potential will be:

$$TCSP = \sum N_{sp} TTB_{sp}$$

[1] More on SPSS, visit https://www.ibm.com/products/spss-statistics

Where TCSP is the total carbon sequestration potential, N_{sp} is the total number of trees planted in each species, and TTB_{sp} is the tree allometric factor which is equal to tree biomass. The data then analysed in terms of descriptive analysis of each tree's carbon sequestration potential, and the different expansion factors the tree has in becoming a natural carbon sink.

The total carbon sequestration potential then also analysed to discover the implicit carbon price of the initiatives, which based on the IPCC standards read as follows:

$$Internal\ Carbon\ Pricing = \frac{\sum\ Investment\ of\ the\ initiatives}{\sum\ total\ potentially\ carbon\ sequestered\ from\ the\ initiatives}$$

Besides the internal carbon pricing analysis, other analyses also drawn by multiplying the potential carbon sequestration by the Indonesia carbon price level, to understand the level of monetary benefit the project has. This analysis is important to understand the efficiency of the project and understand how each stakeholder has a different dynamic that results in different carbon price mechanisms.

Direct Economic Valuation of the Restored Ecosystem

All the economic data analysed according to its market value. Referring to Table 3-2. The direct payment and procurement value will simply be using its actual value. For the harvested commodities, the author estimate the number of harvested commodities and estimate the commodities price for the next 20 years, as per IPCC guidelines in impact estimation of ecosystem restorations (Noor et al., 2020). The total direct economic benefit can estimate through the following formula:

$$Econonic\ Value = Direct\ Payments + Local\ Procurements + Harvested\ Goods$$

Where direct payments are calculated from the number of trees multiplied by the incentives per tree; local procurements are the sum of all the funds used for the restoration activities that are procured locally, and the market value of the harvested goods is the annual harvest multiplied by its average market value. The harvested goods are non-timber goods, such as cinnamon tree skin or durian fruit coming from the trees.

Descriptive WTP Analysis

Before analysing the data, descriptive analysis is done to understand the distribution of the data based on its attributes/characteristics. The descriptive analysis of this study covers the following analysis: (a) demographic characteristics of the sample; (b) WTP results based on each price level; (c) extrapolation of the sample to the population number.

The first section will cover the distribution of data throughout all the demographic indicators. For certain indicators, the result such as the mean of income, gender and occupational distribution can be drawn. For the perceived importance of the ecosystem/ sense of stewardship, mean, median and modes of the data can be drawn and presented to understand the whole landscape of the sample's identity.

For the second section, the analysis is drawn by presenting the distribution of the WTP across all the price categories. Then the data is aggregated and the mean of WTP analysed through the following formula (Liu et al., 2019)

$$E(WTP) = \sum_{i=1}^{m} X_i W_i$$

Where E(WTP) is the mean of willingness to pay, X is the bidding price level, and W is the rate of a sample of the corresponding price level. The data analysis can be done in two ways. Either by including the number of people who has zero willingness to pay/accept or by excluding those who choose zero. Liu et. al., (2019) mention that by comparing the two results, we can assess the difference and understand the bias in our studies. Which in a sense, can be a source of data reliability tests.

Regression Model on WTP

The analysis of WTP output is numerous, but the most useful in understanding the perceived value is correlating the result with the demographic attributes relevant to the local context (Alberini & Cooper, 2000; Vásquez & de Rezende, 2019). The equation shall be the following:

$$V(y - WTP, p, q_1, ; Z) = V(y, p, q_0; Z)$$

Where V is the indirect utility function, y is income, p is the price level faced by the respondents, q is an environmental condition (where $q_1 > q_0$), and Z is other contextual internal characteristics that might affect the WTP result (Alberini & Cooper, 2000; Vásquez & de Rezende, 2019). Hence, the WTP will be depending on (a) the initial and improved environmental condition; (b) the income of the respondents; (c) the price level faced by the respondents during the interview, and (d) other characteristics that might affect the result.

The following explanatory variables are the attributes that are being asked within the WTP questionnaire. The following variables will be tested against the WTP value to understand how each variable affects the WTP output. A similar model is applied in previous studies such as Liu et al. (2019) and Islam et al (2019). Correlating the WTP to the relevant demographic information is a general norm adopted by various studies. However, in this study, the researcher trying to correlate the WTP results to the degree of familiarity and sense of stewardship to understand how people with a higher/lower sense of environmental protection reacts to such question. The decision to take the last two explanatory variables stem from the researcher's experience talking to a member of the local community and seeing how different groups of people a wide range of responses had when talking about their willingness to protect the environment and how they position the environment in their life, which greatly affects their behaviour to the ecosystem they closely lived in.

Table 3-7. Explanatory variables for the regression analysis

Explanatory Variables	Mutator
GENDER	1=Male, 2=Female
AGE	1= <18 years old, 2=18-25 years old, 3=26-35 years old, 4=36-45 years old, 5=46-55 years old, 6= >55 years old
INCOME	1= <IDR 1,000,000, 2= IDR 1,000,000- IDR 3,000,000, 3= IDR 3,000,001-IDR 5,000,000, 4= IDR 5,000,001- IDR 10,000,000, 5= > 10,000,001
FAMILIARITY	1=Not familiar, 2=less familiar, 3= neutral, 4= familiar, 5= strongly familiar
STEWARDSHIP	1=have no sense of stewardship, 2=little sense of stewardship, 3=neutral, 4=have considerably strong sense of stewardship, 5=strong sense of stewardship

Source: researcher's directory

Content Analysis

The content analysis done through thematic content analysis (TCA). The analysis was conducted through NVivo. This analysis provides a detailed analysis based on the pre-determined themes stated in Table 2-1. The important part in this analysis is to form a deeper understanding of the

stakeholder's perception of their role in restoration projects and how they perceived the impact of restoration itself. The interview transcript is coded based on the pre-determined themes. However, when new themes arise, the researcher acknowledge this and consider it as new knowledge that provides new value-added to the research process. Thematic content analysis is useful in analysing the narratives of a phenomenon, providing a strong contextual analysis, and combining the research result that is directly manifested from the narratives, or indirectly presented by the subject research (Vaismoradi et al., 2013). Earlier research provides a framework of analysis for a thematic content analysis, which consists of (a) familiarizing with data; (b) generating initial codes; (c) searching for themes; (d) reviewing themes; (d) defining and naming themes; (e) producing the report (Braun & Clarke, 2006).

This model is considered appropriate for the thesis, as the research aims to understand the perceived role of each stakeholder in the restoration project. These roles are not something always directly manifested by the subject but often need to be explored as they are implicitly implored by the subject. However, this content analysis method also has shortcomings, researchers' bias. Researchers' bias toward these methods of analysis stems from the subjectivity of analysis, which makes peer-checking not possible (Vaismoradi et al., 2013). Hence, based on the same literature, there are two possible ways to increase the reliability of analysis: (a) by providing a researcher diary that provides all the information that might affect the analysis during the data collection process and (b) by judging whether there are new insights generated from the content analysis that increase the understanding of the practical phenomenon being analysed.

4 Findings and Analysis

Land-based biological carbon sequestration projects in the form of restoration of the degraded ecosystem located in Indonesia presented a dynamic yet segregated multi-stakeholder model. The main collaborator will be the public sector (as the government of Indonesia) and the private sector (dominated by private enterprises). Each of the two main collaborators has its own MRV (monitoring, reporting and verification) system. Which despite the government's efforts to integrate, are still segregated.

The difference is not only limited to the natural ecosystem management but also goes to the estimation of total economic value which takes a different approach. The government often takes an IPCC approach which is aligned with the extended nationally determined contribution (ENDC) submitted by the government to the UNFCCC. While the private sector uses various methods that reflect the interest of their major business stakeholders.

Thus, this chapter will cover three parts of the findings. The first part will cover the government planning, implementation and value estimation based on the interview conducted with relevant government employees and additional documents provided post-engagement. The second part will cover the case study brought in this thesis, which is the Caterpillar Forest restoration project. The data that will be presented is project documentation and analysis based on the model stated in subchapter 3.2.2-3.2.4 and analyse through the model stated in Subchapter 3.4.2. The final part is the stakeholder analysis, which analysed the data from an interview conducted with several stakeholders presented in Table 3.6. The analysis will follow the already predetermined model presented in subchapter 2.4, with additional stakeholders and roles that will be explained as an additional discovery of this research.

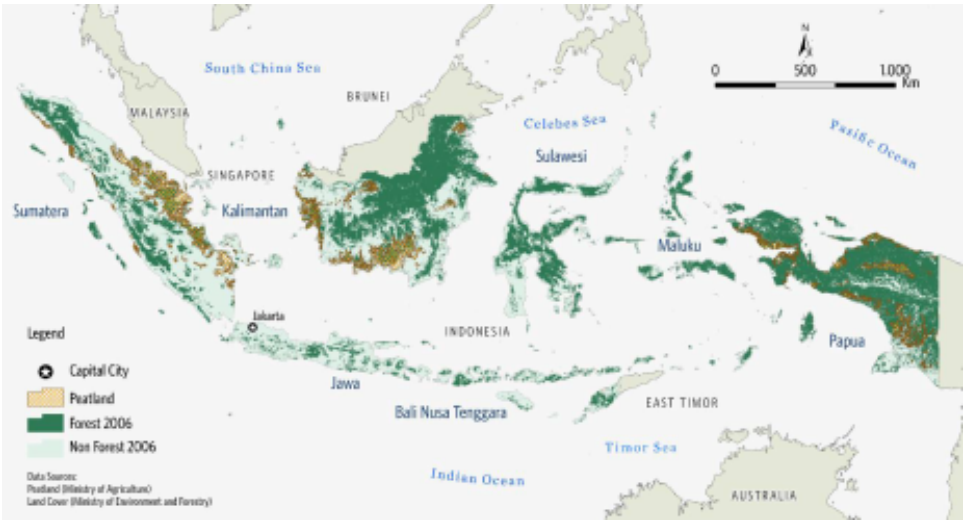
4.1 The Government and Status of Indonesia Forest Restoration

4.1.1 State of Indonesia Forest Cover

At the state level, Indonesia complies with UNFCCC guidelines on forest management and carbon emissions reduction from the conversion of natural forests into other use. Since 2000 Indonesia is continuously working on creating Forest and Land Emissions Reference (FLER) that can be used as a baseline for any project under the government of Indonesia. The first study takes a baseline of 1990-2012 and was approved by UNFCCC in 2016. The update is made in 2022 and approved by UNFCCC in 2023 with a baseline of 2006-2020. The updated version of FLER will be summarized within this study.

Figure 4-1. below showing the state of the Indonesian forest which was recorded as baselines in 2006. Which includes 94.8 million hectares of natural forest, of which 48.4 million hectares of it were natural primary forest.

Figure 4-1. State of Indonesian Forest Cover in 2006 (baselines)



Source: Ministry of Forestry and Environment (2022)

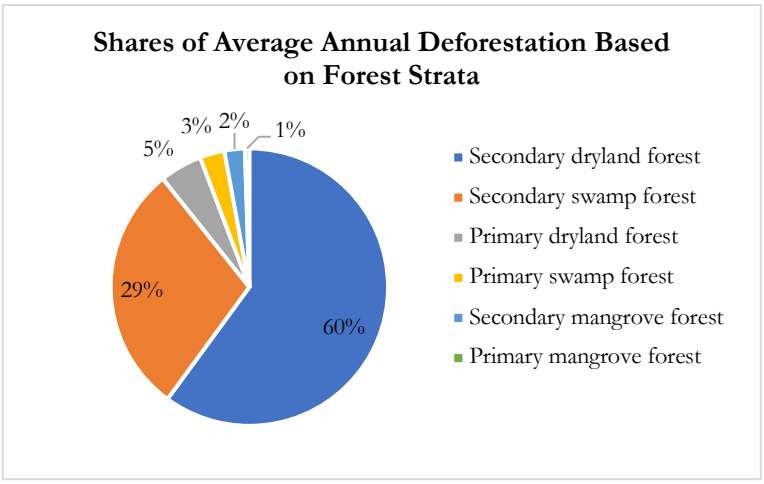
This chapter will highlight certain statistics that are relevant to the boundary of this thesis, which include the average deforestation and forest degradation rate, average forest gain throughout the baseline period, and average carbon stock loss from forest degradation and deforestation.

Deforestation

Deforestation defined as a process of converting natural forest into non-natural forest cover categories, including the conversion into forest plantations (i.e., rubber plantations, or eucalyptus plantations for an active pulp industry) (Ministry of Forestry and Environment, 2022).

Between 2006-2020, the average annual deforestation in Indonesia was around 599,232 hectares with a margin of error of 5%. This deforestation can be considered massive in comparison to Amazon Forest deforestation which reach around 1,012,900 hectares/year in 2019 (Silva Junior et al., 2020).

Figure 4-2. Shares of Annual Deforestation Based on Forest Strata in Indonesia 2006-2020

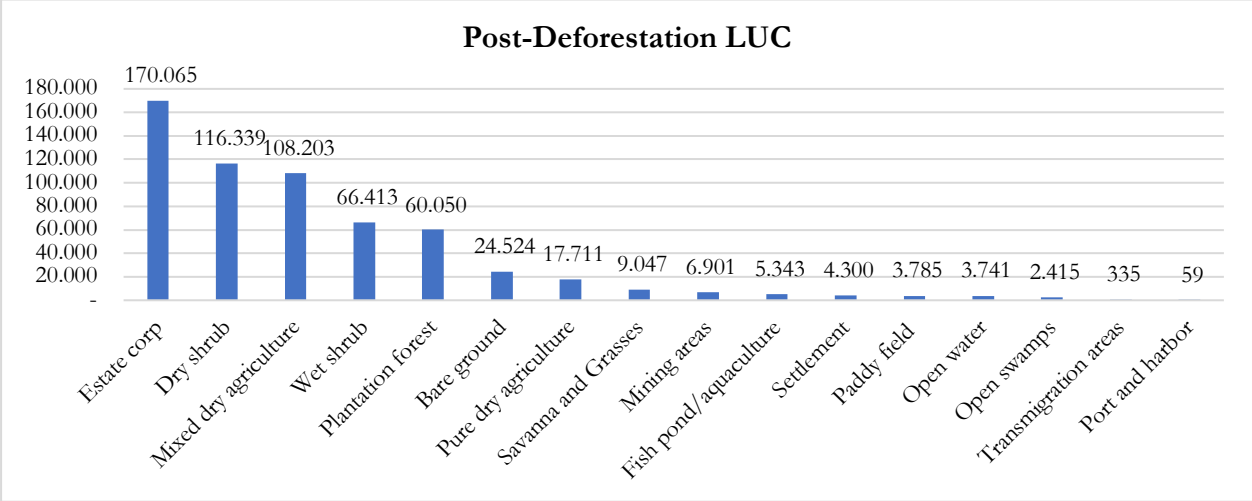


Source: Ministry of Environment and Forestry of Indonesia

The main root causes of deforestation in Indonesia are the high demand for land-use change in the country. The data from the Ministry of Environment below (Figure 4.3.) shows a high

number of deforestations attributed to the establishment of estate crops, dry shrubs, and mixed dry agriculture. The growth of Indonesia's palm oil industry and the sporadic growth of the small and medium-scale agriculture industry is the main direct drivers of deforestation in Indonesia. Meanwhile, Indonesia's population increase of 13.7% between 2010-2020 is an indirect driver for deforestation in the country (BPS, 2021).

Figure 4-3. Average Annual Post-Deforestation Land -Use Change (LUC) in Indonesia 2006-2020



Source: Ministry of Environment and Forestry of Indonesia

Deforestation has caused enormous indirect land emissions due to the decrease of carbon stock from the forest. The annual carbon emissions from deforestation reach 271.7 Mn tCO_2/year. The carbon stocks from the post-deforestation land-use (Figure 4.3.) only provide a carbon stock of 132.05 Mn tCO_2/year. Thus, the final net emissions from deforestation are 139.65 Mn tCO_2/year. This emission is equal to burning 58 Mn tons of industrial coal every year[2]. Despite the deforestation is done to achieve a higher economic output for the country, the environmental output is not entirely considered. The government projects on reforestation, forest rehabilitation and conservation are not fast enough to cover the deforestation rate in the country. The Ministry of Environment data was only able to gain 75,092 ha/year of forest gain compared to the 599,232 ha/year of deforestation. These forests gain, mainly dominated by secondary dryland (47.9%) and plantation forest (31.8%), which have a lower degree of carbon stock compared to the primary forest. These number is warranted and verified by UNFCCC.

Land Degradation

To compare the extent of primary and secondary forest function as carbon storage. Land degradation data provides a compelling analysis. Land degradation is defined by the Indonesian Minister of Forestry and Environment Decree No.30/2009 as a deterioration of forest cover and carbon stock over a certain period due to disruptive human activities. The degradation process includes the conversion of forests of any kind from primary to secondary forests (Ministry of Forestry and Environment, 2009). The primary forest itself can be defined as forests with mainly native trees where humans haven't disturbed any natural process within the ecosystem. Conversely, secondary forests are forests in which human activity has been observed,

[2] Assumption used: BEIS 2022 Emission Factor Database for Industrial coal: 2403.84 kg CO2/t coal combusted.

with visible activities such as agriculture and agroforestry, which reduce the forest canopy, resulting in more warmth and light reaching the forest floor (Kaltimber, 2019).

Table 4.1. below shows the annual rate of land degradation in Indonesia between 2006-2020. The land degradation from primary to secondary dryland forest essentially reduces the carbon stock at a weighted average rate of 194 tCO2/ha/year. In comparison to mangrove forest degradation, the emissions are 30% lower, however considering the size of the annual degradation, the forest biome will remain in government and other stakeholders' priority.

Table 4-1. Annual Rate of Land Degradation in Indonesia 2006-2020

Conversion Type	Annual Rate (ha/yr)	Emissions (tCO2/yr)	Emissions/ Hectare (tCO2/ha/year)
Primary to Secondary Dryland Forest	175,741	34,045,684	194
Primary to Secondary Mangrove Forest	6,509	1,996,844	307
Primary to Secondary Swamp Forest	26,596	2,470,716	93
Total	**208,845**	**38,513,244**	**184***

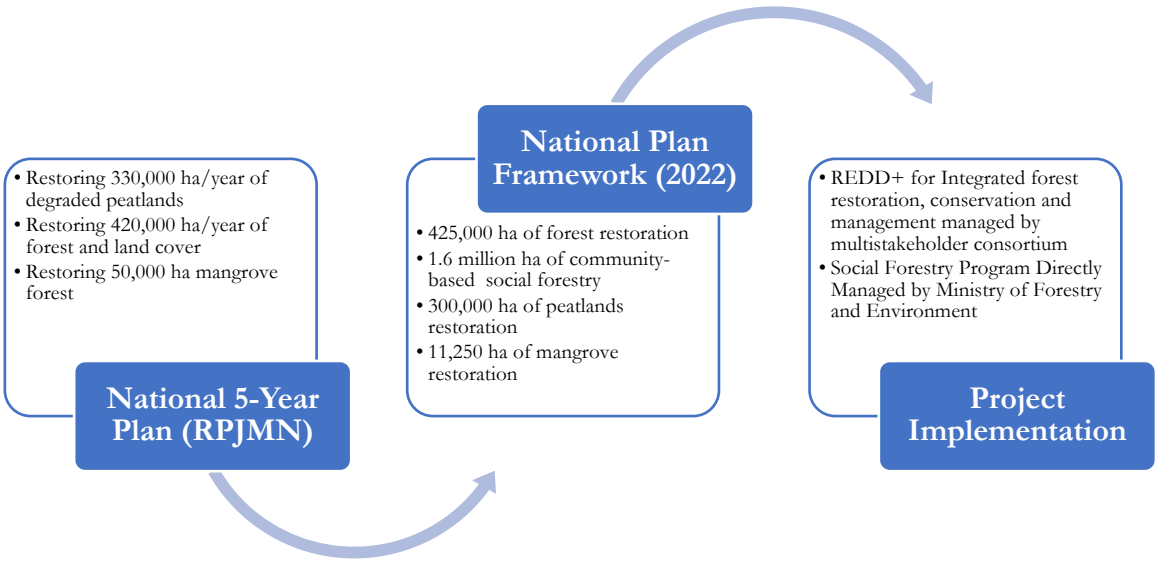
**Total in a weighted average.*

Source: Ministry of Environment and Forestry of Indonesia

4.1.2 From 5-year plan to Implementation

State planning in Indonesia takes the form of stages. From a long-term plan that lasted for a decade, medium-term that lasted for 5 year, to annual and project-specific planning. Forest restoration, conservation and management in Indonesia take a similar approach. The following figure represents the planning and implementation process.

Figure 4-4. Stage of Planning in Indonesia Forest Restoration



Source: Ministry of Forestry and Environment, National Planning Agency, and UNDP Indonesia

The planning process usually takes place in an agency called an umbrella ministry. For forest restoration, the Ministry for National Planning/National Planning Agency takes charge of medium and long-term planning for the project done by all development-related ministries including the Ministry of Forestry and Environment. The National Plan Framework is also

under the umbrella ministry but with more detailing entails to it. The implementation was then delivered to each corresponding ministry.

For forest restoration, conservation and management, the project is divided into two major projects which interrelated each other, the unified forest management that is done through a consortium of REDD+ and the Community-based Social Forestry that is managed directly by the Ministry of Forestry and Environment.

Unified Forest Management

The unified forest management is established in 1999 through Law No.41/1999 about forestry. The purpose of the law is to achieve the national goal of forest ecosystem rehabilitation as stated in the medium and annual national plan through a multi-stakeholder consortium. In 2010, this program management is integrated to REDD+ management which encompasses broader forest management. The key elements of this project are (1) development of forest management infrastructure; (2) land rehabilitation; (3) forest fire control, and (4) sustainable community development.

The project goes beyond forest rehabilitation, but it also creates a strong information ecosystem for national Measurement, Reporting and Verification (MRV) that can be utilized by all involved stakeholders. Besides, the project also maintains the Forest and Land-Use Emissions Reference (FLER) with baselines that are continuously updated that also utilized by this thesis project (Subchapter 4.1.1.). Every forest restoration in Indonesia, both done by the government and private enterprises is registered in this system. However, the actual data isn't fully available to the public. But proceedings are disseminated annually.

Community-based Social Forestry System

Based on the interview with the government agency, the social forestry system is a community-based forest management that integrated society with the forest ecosystem by utilizing the key ecosystem service provided by the forest ecosystem to the needs of the community. Currently, Indonesia plans to build a social forestry model for 1.5 million ha of forest spread across Sumatera, Kalimantan, Sulawesi, and Papua. The pilot project started in 2010 in Sumatera and Kalimantan and resulted in economic benefits for the local community.

The Indonesia social forestry model aimed to have four main functions. *Rules and procedural function* which defined as a governance model that is either state-led or community-led in managing the forests. *The business function* connects the forests, local community, and private enterprises to create ripple economic benefit. *The mentoring function* between all stakeholder is to continuously learn the optimum way of utilizing the forest ecosystem service, and *sustainability function* that enable the community to live side-by-side with the forest ecosystem and maintain its ecosystem service.

4.2 Caterpillar Forest Restoration Project in Indonesia

The following section will cover the result of the case study of the total economic valuation of the Caterpillar restoration project in Sumatera, Indonesia

4.2.1 Beneficiaries Demography

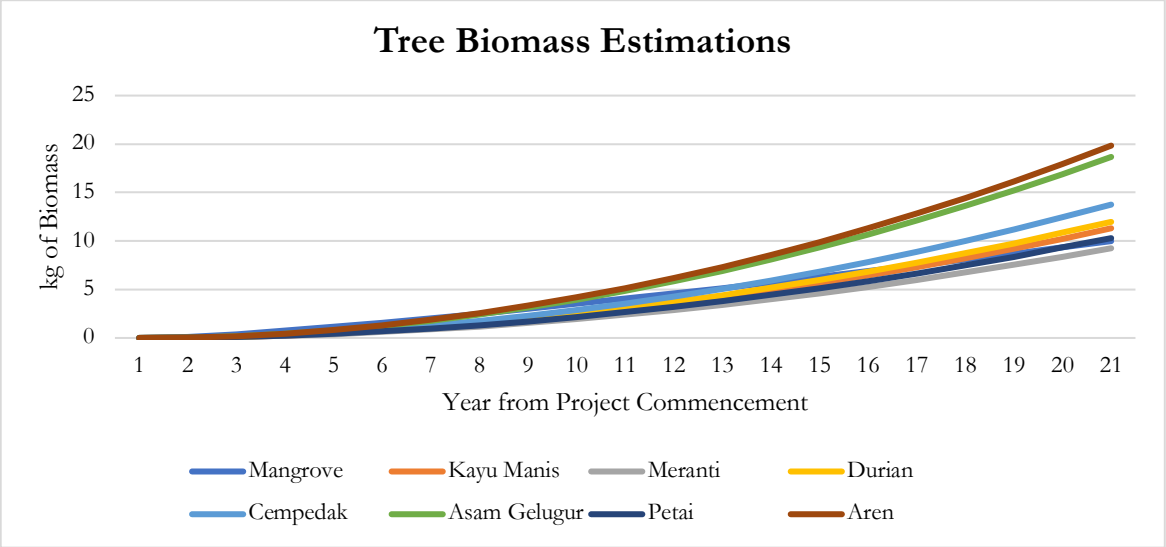
A total of 90 heads of families were interviewed. All of them are the local community who directly engage in the forest restoration project and will be the main stakeholders that reaped the benefit from the restored ecosystem. Of all the families, the family represented by the male is dominating the sample (92.2%) while a female is underrepresented by only 7.8%. This is due to the nature of women in the remote community that generally do not work and stay in

domestic labour at home. Age-wise, the sample is dominated by individuals between the age of 36-45 years old (41.1%), follows by 26-35 years old (22.2%), 46-55 years old (20.0%), 18-15 years old (11.1%), and finally >55 years old (5.6%). Economy-wise, the level of income is generally low across all the samples, with the income of below IDR 1,000,000 (USD 80)/month and IDR 1,000,001, IDR 3,000,000 (USD 80-240)/month dominating the sample with shares of 40.0% and 47.8% respectively. While 11.1% of the sample earn between IDR 3,000,000-10,000,000 (USD 240-800)/per month and only 1 sample earns more than IDR 10,000,000 (>USD 800) per month. Primary farmer/fisherman dominated the occupation of the sample at 57.8%, followed by fish boat/farm workers at 21.1%, while the rest is distributed across various occupations.

4.2.2 The Environmental Benefit

The estimation of tree biomass is taken from Noor et. al., (2020) the provides a complete database for tree species in the Caterpillar project for the context of Indonesia. The following chart shows the tree estimation, with *aren* and *asam gelugur* trees having the highest biomass compared to the rest of the species.

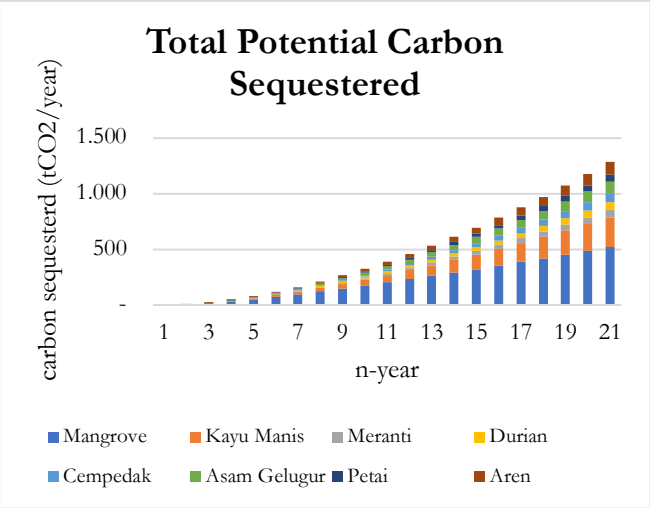
Figure 4-5. Chart of average tree biomass of selected tree species.



Source: Noor et. al (2020)

From the database of tree biomass and number of trees being planted in all the restoration sites. The annual potential of sequestered carbon is calculated. And it is discovered that in 20 years, the combined sequestration power of the restoration site is at 10,085 tCO_2. This number is equal to less than 20% of Caterpillar's annual global carbon emissions. Based on figure 4-6 below, annually the forest has an average sequestration power of ca. 504 tCO_2. The average annual number is considerably low because the biomass of recently planted trees is small. For the Caterpillar project, Year 2 sequestration power is only at 3.7 tCO_2. However, after the forest matured, the sequestration power peaked at 1,285 tCO_2/year for the whole restored area in this project. The number itself is an estimation, with the standard of error ranging between 5-10% based on various recent studies on carbon sequestration power.

Figure 4-6. Total Potential Carbon Sequestered from Caterpillar Project.



Tree Species	Sequestered Carbon- 20 years (tCO2)	Annual Mean (tCO2)
Mangrove	4,643	232
Kayu Manis	1,905	95
Meranti	475	24
Durian	492	25
Cempedak	565	28
Asam Gelugur	767	38
Petai	423	21
Aren	815	41
Total	10,086	504

Source: Author directory

The total investment Caterpillar provides for this project is USD 300,000, hence based on this number, the internal price of carbon for this project has a quasi-value at USD 29.47/tCO_2 sequestered. It is considerably cheaper than major carbon reduction measures such as technological change. However, carbon removal itself will only be the last effort that Caterpillar will pursue to neutralize its emissions. Various net-zero and decarbonization initiatives are aware of the difficult challenge of achieving net zero through 100% carbon reduction. Therefore, it is acknowledged that the company is allowed to use carbon-offsets to remove its remaining emissions that otherwise can't be reduced when all the carbon reduction measures have been used.

The claim of this potential carbon sequestration will also be on an annual basis upon the verification of third-party quality assurance organizations such as "the Gold Standards" or Verra. Which, the number of the sequestered carbon might change, therefore changing the internal price of the carbon. The global average on the price of carbon-offsets is currently averaged at USD 11.76/tCO_2 (Ecosystem Marketplace). This means that the current price of carbon Caterpillar invested in is still higher than the global average. However, we cannot dismiss that Caterpillar's investment also goes beyond environmental benefit, but also restoring the economic and social benefit of the restored ecosystem which will be defined in the following subchapter.

4.2.3 The Direct Economic Benefit

The economic benefit of the project as stated in chapter 3.2.3. are coming from three sources: direct payment to farmers, rural economic empowerment through supplying the needs of restoration locally, and an indirect benefit from the value of harvested goods. The first two are short-term benefits which are summarized in the following table. These short-term economic benefits are related to the restoration activity itself, which runs between 2022-2023.

Table 4-2. The short-term benefit of restoration.

	Bangka	Jambi	Aceh	Total
Direct Payment	IDR 134,550,000	IDR 94,677,755	IDR 1,821,600,000	IDR 2,050,827,755
Rural Economy	IDR 403,650,000	IDR 186,300,000	IDR 454,453,222	IDR 1,044,403,222

Source: Author directory

The long-term benefit includes what the farmer can get from maintaining the ecosystem they live in. Based on the species planted. The table below summarizes the economic factors of the restored area.

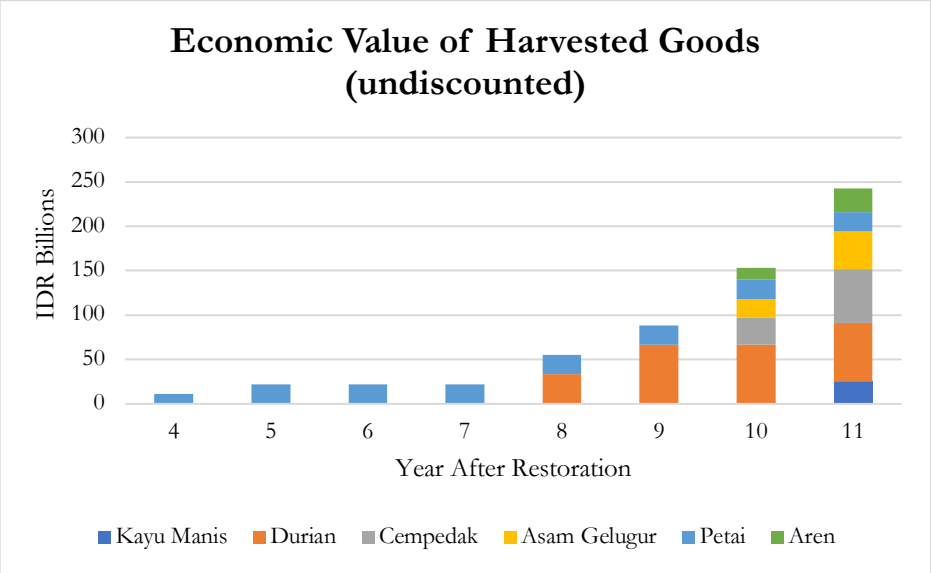
Table 4-3. Economic Factor of the Harvested Goods

Tree Portfolio	# of trees	Marketable?	Harvest Form	Yield/Tree/ Harvest	Harvest /Year	Market Price/kg (IDR)
Mangrove	53,820	No	None	N/A	N/A	N/A
Cinnamon	24,840	Yes	Tree bark	20	1	50,000
Meranti	7,754	No				
Durian	6,059	Yes	Fruit	200	1	55,000
Cempedak	6,059	Yes	Fruit	250	2	20,000
Asam Gelugur	6,059	Yes	Fruit	500	2	7,000
Petai	6,059	Yes	Fruit	450	1	8,000
Aren	6,059	Yes	Fruits	36	12	10,000

Source: WRI Indonesia

From that factor, it is estimated that the total value of harvested goods from the 125 ha of the area restored by Caterpillar by the end of Year 20, will yield the potential economic benefit of IDR 2,797 billion (ca USD 185.5 Million). However, each tree species has its own maturity time which differs from one to another. The following chart shows when each of the species can be harvested after being planted. Cinnamon can be harvested as early as in its fourth year, however, other species like *Petai* can only be harvested after 10 years from being planted.

Figure 4-7. Total Economic Value of Harvested Goods.



Source: Author directory

Furthermore, combined with the short-term economic benefit, the Total Economic Benefit from the Caterpillar restoration project in 20 Years is IDR 2,801 billion (ca USD 190 Million).

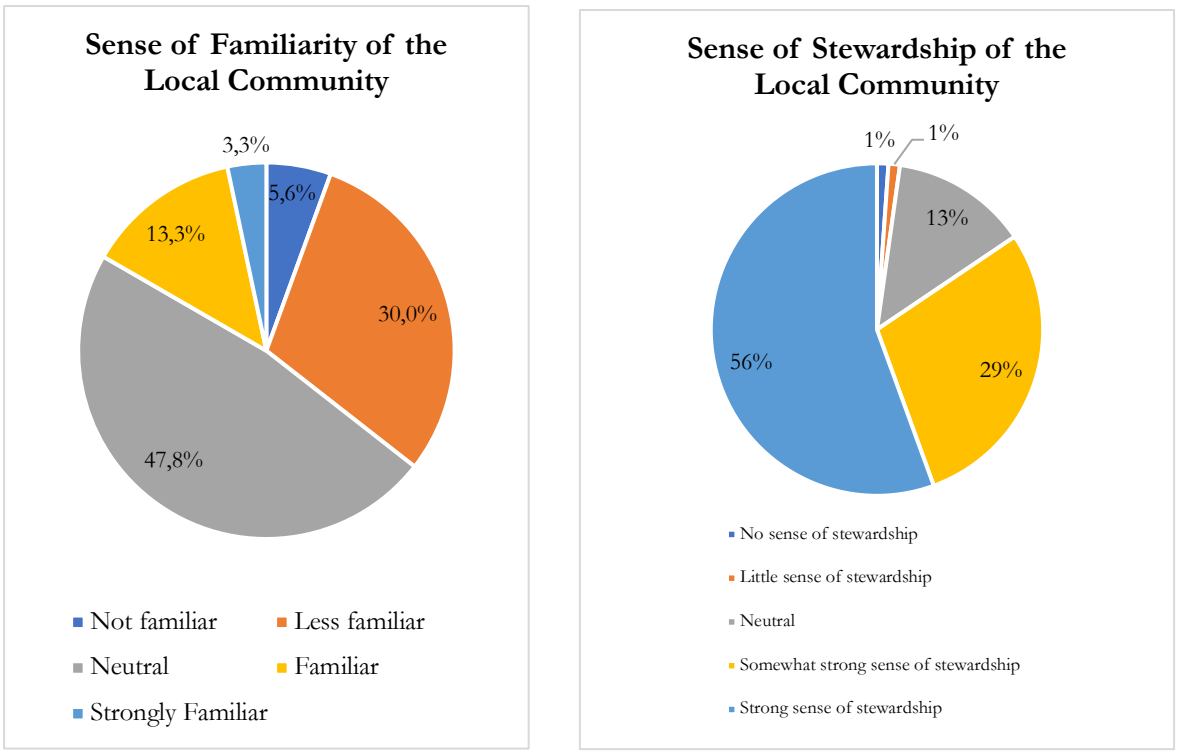
If discounted to the present value with a 5% discount rate is valued at IDR 1,399 billion (ca USD 92.7 Million) or if discounted with a 10% rate is valued at IDR 743 billion (ca USD 49.3 Million).

4.2.4 The Indirect Benefit: Estimation of Local Community's WTP

Estimation of WTP

Of all 90 families interviewed, 71 families are willing to pay the annual fee for the protection of their natural ecosystem against the disaster risk relevant to their community. This value is discovered by triggering them by stating a "what-if" scenario of the amount of money they are willing to pay if any disaster can be avoided by paying a certain amount of money to protect the ecosystem that can protect them from such disaster. This represents the willingness to pay at a rate of 78.9%. In the study, we also asked them what their sense of familiarity with the function of the ecosystem services is, and the sense of stewardship they have toward the natural ecosystem they are living side-by-side with. The following shows how the local community perceived these two indicators in the following figures.

Figure 4-8. Sense of Familiarity and Stewardship of Local Community towards the Natural Ecosystem they lived in



Source: Author directory

In this study, we set the interview process by using the analogy of farm/fish boat insurance to create an understanding of the meaning of willingness to pay to protect the ecosystem mentioned in this study. Based on the background study on the sense of familiarity of the local community with the ecosystem services, after being explained in layman's terms, 1/3 of the population doesn't understand the entirety of the ecosystem services provided by their environment. Hence, it will likely affect how they perceive their willingness to pay to protect the said ecosystem. However, when the question of stewardship and sense of responsibility to protect the environment, they lived in, only 2 respondents say they have no sense of stewardship

toward the environment. This result is aligned with the researchers' expectations, as the whole community makes a living off the forest/ coastal ecosystem.

In the current study, we set the possible payment option from IDR 500,000 (ca USD 33) to IDR 7,500,000 (ca USD 500) based on the preliminary study which was taken through understanding what the local community spend on their farmers/fisherman insurance and the amount of money they spend to renovate their homes during the annual monsoon season which generally broke certain parts of their home or the annual home repair fee forest community need to pay for renovation due to flood and landslide, as their area is prone to such disaster. The data is then analysed through a selected spreadsheet tool to assess the statistical frequency (Table 4-4.)

Table 4-4. Frequency distribution of local community WTP for protecting the environment against the risk of natural disasters.

WTP Values (IDR)	Freq.	Percentage (%)
0	19	21.1%
500,000	36	40.0%
1,000,000	15	16.7%
1,500,000	3	3.3%
2,000,000	2	2.2%
2,500,000	0	0.0%
3,000,000	1	1.1%
4,500,000	2	2.2%
5,000,000	1	1.1%
7,500,000	11	12.2%

Source: Author directory

To understand the value of willingness to pay, the mean WTP is calculated using the mathematical equation stated in Chapter 3.4.2. It is discovered that the mean WTP of the local community to protect their environment is ca IDR 2 million (ca USD 150) per year (zero values excluded). However, the value zero is occurring due to the low economic level of the local community, upon follow-up questions to the respondents, they mention that they don't want to pay for anything, because they simply have no means to pay beyond their current expenses. Even in a hypothetical situation where they have additional income, the answer remains the same. To allow the study to be more representative, we cannot allow the exclusion of the non-payers. Therefore, the Kristrom model is used to correct the mean of WTP by multiplying the mean WTP by the rate of WTP (Saz-Salazar et al., 2020). In this study, the rate of WTP is 78.9%. From this model, we then discover that the actual rate of WTP for the study (with zero included) is ca IDR 1,6 Mn (ca USD 110).

Factors Affecting WTP

In this study, a logistic regression model is employed to understand the factors affecting the probability of respondent choice to pay for their environment's protection. The demographic aspects of the respondents, which are gender, income, and age are the main determinant. The two additional indicators of familiarity and stewardship of the ecosystem.

From the regression analysis, it is discovered that the ***Income*** variable is significant (0.030) at 0.05 confidence internal., and the correlation is negative, meaning that in this study, the higher the income, the lower the probability for the respondent to pay for the environmental protection. The reason can be attributed to their lack of dependency on the environment. Or it

could also be due to the contingent cost of damage for them is not too high in comparison to their income. Whereas the poorer community see the cost of home repair as a bigger cost for their household. Community members from lower-income groups generally highly depend on what the ecosystem provides. While the higher income group generally receive a monthly salary from was occupation. Other factors are observed to be insignificant. Gender is insignificant as the sample is strongly skewed into males, while the age group is insignificant, as the spread of the probability is distributed equally across age groups.

An interesting discovery is stewardship has a positive relationship, while familiarity has a negative relationship with the probability of respondents' willingness to pay. Meaning only because the respondent is familiar with doesn't mean they are willing to pay to protect the environment, but for respondents with a strong sense of stewardship to their environment, the probability is high. It could be due to their utilization of the ecosystem that is higher compared to the remaining the sample in population.

Table 4-5. The result of the logistic regression model

Variable	Coefficient	Standard Error	Sig. Level
Gender	-0.904	0.979	0.356
Income	-0.629	0.290	0.030[a]
Age	-0.002	0.000	0.996
Familiarity	-0.127	0.160	0.689
Stewardship	0.181	0.323	0.570

[a]: significant level under 5% Confidence Interval

Source: Author directory

Evaluation of the existence value of the restored ecosystem

Based on the evaluation mentioned in the previous section, the mean of WTP is observed at ca IDR 1.6 Mn (ca USD 110). In this study, the WTP is discovered from interviews with the local community directly lived and/or affected by the restored ecosystem. The final total value of the local community's willingness to pay is calculated by multiplying the mean WTP by the total population of the area surrounding the restored ecosystem. Based on the national statistics mentioned in Table 3-4, the total population of the surrounding region of the restored region is 647,617. Therefore, the existence value of the restored ecosystem contingent on the disaster risk reduction is IDR 1,015 Bn (ca USD 70 Mn) or IDR 1,286 Bn (ca USD 88.7 Million) when zero value is excluded. The individual WTP is generally low, however, due to data extrapolation to the population, the final WTP for the restored area is high. Meaning that density and population size can be influential in determining the existence value of the restored ecosystem.

4.2.5 Total Economic Value of the Land-Based Carbon Sequestration Project

Based on the formula provided in Chapter 3, Table 4-6 shows the total economic valuation range based on three scenarios, 20 years estimates based on IPCC standards, as well as 15 and 10 years estimates that are being considered to analyse the range of valuation difference. As seen in the table, a huge difference between 20 years and the 15 or10 years estimates is apparent, meanwhile, the differences in the discount rate used are linear throughout the three estimates, meaning the discount rate has a linear distribution when it comes to valuation, while the length of estimation period has an exponential effect to the economic valuation. It should also be noted that these number combined all the value of the restoration, including the existence value of the forest itself, which highly depending on how a society perceived the roles of the environment

they lived in. Henceforth, it should be note, that the TEV is rather isolated to the area with similar physical, environmental, and societal characteristics with this case study.

The original TEV before the discounting process is USD 1,546.8 Mn for a 20-year benefit period, USD 1,131.2 Mn for a 15-year benefit period, and USD 719.2 Mn for a 10-year benefit period. The negative discount rate will increase the number of final valuation numbers, and the positive rate will diminish the value. The real discount rate starts at -10%, however, it is being adjusted to incorporate economic benefit which has the opposite effect on the remaining ecosystem services benefit. While economic benefit diminished following the rate of inflation, and increase scarcity, the other benefit will not become scarce and even yield higher exponential benefits.

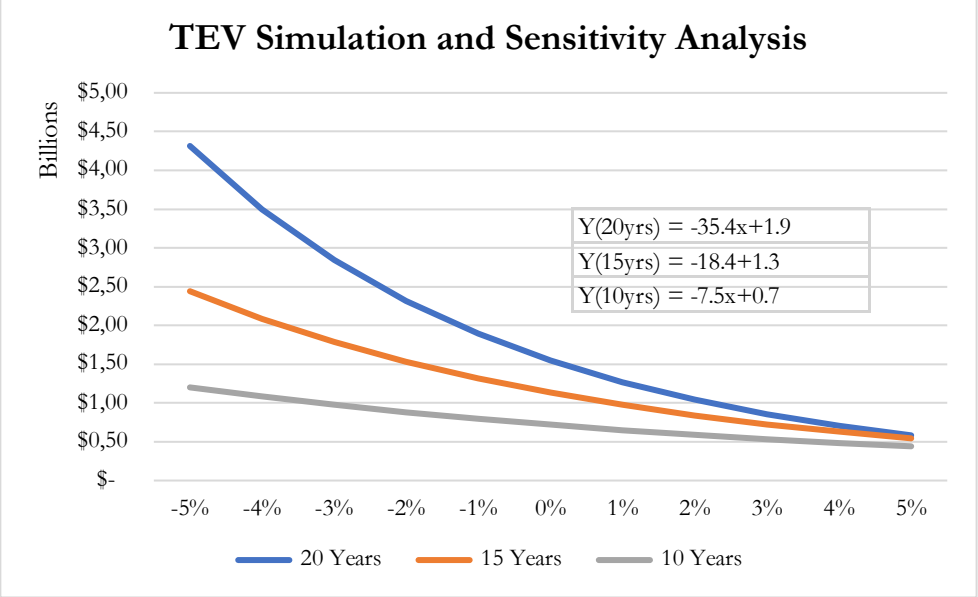
Table 4-6. Total Economic Simulation Summary

Rate	20 Years	15 Years	10 Years
-5%	$ 4.314.959.218,92	$ 2.441.630.748,72	$ 1.201.290.467,14
-4%	$ 3.499.646.194,65	$ 2.086.726.682,68	$ 1.081.861.717,51
-3%	$ 2.844.553.563,07	$ 1.786.315.024,08	$ 975.364.042,48
-2%	$ 2.317.006.688,35	$ 1.531.591.436,90	$ 880.285.050,94
-1%	$ 1.891.232.443,01	$ 1.315.243.444,90	$ 795.302.115,45
0%	$ 1.546.852.135,75	$ 1.131.186.113,17	$ 719.256.977,43
1%	$ 1.267.714.114,28	$ 974.346.564,51	$ 651.133.958,74
2%	$ 1.040.987.143,92	$ 840.487.944,45	$ 590.041.238,61
3%	$ 856.454.522,88	$ 726.065.321,47	$ 535.194.740,15
4%	$ 705.963.122,46	$ 628.107.494,61	$ 485.904.242,13
5%	$ 582.992.301,52	$ 544.119.861,56	$ 441.561.391,15

Source: Author directory

The following figure shows that in all scenarios, the discount rate has a similar effect to the total valuation, as the linear regression formula shows scalability between the three benefit period estimates.

Figure 4-9. TEV Simulation Linear Slope and Sensitivity Analysis



Source: Author directory

4.3 Multi-Stakeholders Model in Indonesia Forest Restoration Project

4.3.1 Mapping the Existing and Potential Stakeholders

The initial stakeholder that was deemed essential was stated in Table 2-2 in Chapter 2. However, during the data collection process, three more stakeholders are highly entangled with the existing stakeholders explored in this research. The additional stakeholders are intermediary institutions (such as WRI, WWF, Greenpeace, and Southpole), financial institutions, and third-party carbon credit verification agencies (Verra, Bureau Veritas, Gold Standards).

To gain this insight, the stakeholders stated in Table 3.6. were interviewed, and the process of mapping the stakeholders including the process of understanding how the land-based biological carbon sequestration is being commissioned from the private companies funding delivery to the local community life-long forest stewardship activity.

The first step in the commission of the project usually starts in three scenarios: (1) direct communication between the private companies to the community; (2) commissioning the project to the intermediary organizations, and (3) private companies engaging with the government and supports the government project in certain pre-arranged boundaries stated by the national plan.

The second step is the project planning process, which includes deciding the location, running a feasibility study, first engagement, project alignment, and finally fixation of the project. In scenario (1), the whole process is done by companies' Corporate Social Responsibility department, the company in this scenario generally have their non-profit entities in the form of a foundation to manage these activities. Caterpillar, one of the beneficiaries of this study owns Caterpillar Foundation which conducts the sequestration effort both directly and indirectly through the intermediary organizations. The benefit of this scenario is the whole internal ownership and control of the project by the capital owner, allowing the optimization of funds to the company's interest.

In scenario (2), the intermediary organizations take the whole responsibility of the planning, project management and MRV (measurement, reporting and verification). But only some of them managed the implementation directly. Environmental organization such as Worldwide Fund (WWF) and World Resource Institute (WRI) mostly acts as a brain, and sub-granting the forest management fund to local organizations. These local organizations generally have smaller geographical coverage, which covers certain forest area, such as Leuser Communication Forum (FKL) which only cover forest management in the Northern part of Sumatera, Indonesia, and Mitra Aksi Foundation which only forest management in Kerinci National Park in Southern part of Sumatera, Indonesia. This scenario is the most used scenario by private companies. The interview with the private companies provides three main reasons: a) optimizing the impact between environment, socio-economy, and financial efficiency of the project; b) serve as a check-and-balance to boost the public's trust towards the company project, and c) time-efficient, as the capital owner will receive the result in due time, with less internal human capital involves.

The third scenario is the rarest in Indonesia, only a company from an industry that is deemed a strategic industry by the government has a chance to collaborate. Industry ties with natural resources exploration are the most frequent cases, with the palm oil industry strongly engaging with the government from time-to-time to strike a balance between the profitability of the company and the environmental target of the government. Political dynamics affect this relationship a lot, one of the stakeholders interviewed provided information that engagement between palm oil and the government for ecosystem restoration and forest management

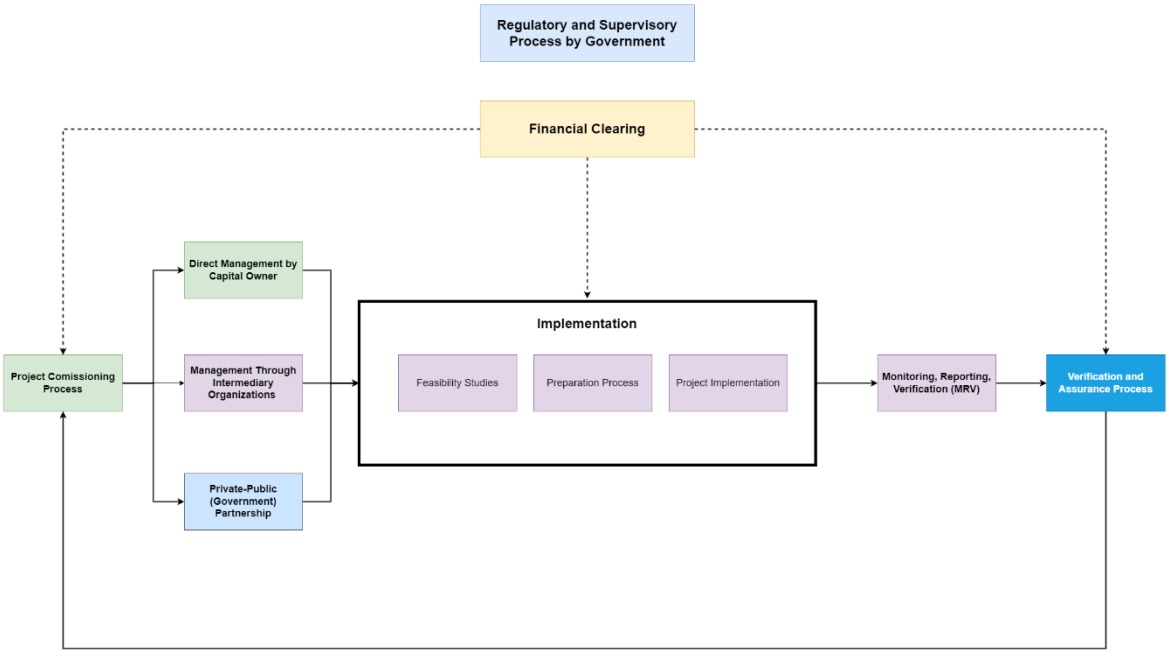
fluctuates depending on the ruling government. It provides them with leverage for macro decision-making but also comes with a risk of continuous realignment with government target that often changes every year.

The third step in the process is project implementation which involves the preparation of the restoration area (i.e., clearing the land, preparing the seeds, and engaging with the local community for the manual labour). In all three scenarios, the research found that it follows the same pathway. First, each of the project management entities will engage with the local organization to establish contact with the local community, then the discussion is taken place with bargaining over the benefit for the local community. These include the land-ownership status, the right for the harvested goods, and other direct or indirect economic and financial compensation from the project. Second, the preparation and implementation will be conducted by the local organizations with manual labour that comes from the local community. These local organizations hold an important function as a) accumulators of local knowledge and wisdom; b) community builders, and c) empowering the people financially through various vocational education and optimizing the agroforestry results from the restored ecosystem.

The final step is MRV, which generally involves the project management entities directly monitoring the project results, calculating the impact and comparing it to the estimation provided in the planning process. This process will then be verified by third-party assurance organizations such as Bureau Veritas and Verra and then reported to the capital owner.

Besides the four steps, there are also three additional steps running in the background. Regulatory and supervisory processes are done by the government, the financial clearing and financial motivations from the financial institutions, and the indirect value dissemination process from the capital owner to its industry community. All these processes can be seen in the following chart below.

Figure 4-10. The process of the Ecosystem Restoration Project



Source: Author directory

4.3.2 Perceived Roles and Future Model of Stakeholder Communications

From the process of interview and analysis of how each stakeholder is involved in the ecosystem restoration project, the following table defines each stakeholder's role in the ecosystem restoration project. The part marked green is the functions which are exclusive to only one stakeholder, showing their significance in the restoration project. The following subchapter will explain how each stakeholder involves and views themselves in a restoration project.

Table 4-7. Stakeholders Role Mapping

Functional Category	Roles	Local Community	Intermediary Institutions	Private Companies	Government	Financial Institutions	Carbon Verificator
Educational Process	Source of Local Wisdom	Yes					
	Educator	Yes	Yes		Yes		
	Community Builder		Yes				
Financial Function	Common Capital Source				Yes		
	Financial Provider			Yes			
	Fund Accumulator					Yes	
	Financial Empowerment		Yes				
Implementation Process	Planning				Yes		
	Regulatory				Yes		
	Standard-Settings				Yes	Yes	
	Provider of Legitimacy				Yes		
	Facilitator/Enabler	Yes	Yes	Yes	Yes		
	Project Manager/Optimizer		Yes	Yes	Yes		
	Supervisory				Yes		
Post-Project Assurance	Validation						Yes
	Quality Assurance						
	Credibility Source						
Value Dissemination	Government Ally			Yes			
	Leveling Playing Field						

Source: Author directory

Source of Local Wisdom

The local community holds an exclusive role as the source of local wisdom. This local wisdom includes the way of preparing the lands for restoring the ecosystem, choosing the right species to be planted, and finally a protection mechanism to keep the forest from any disruptive human activities. This local wisdom might not be the best practice based on the most available scientific findings. However, this approach is a softer approach of gradual incorporation of local wisdom to the best available scientific findings.

From the interview with the local community, each of the locations has different ways of prepping the degraded lands. It's common to clean the area by burning the whole degraded area in northern Sumatera, but the process of cleaning the area is done manually in the southern part of Sumatera. Despite these might not be the best science-based land cleaning practice for forest restoration, all the stakeholders have to respect these ways of life to smoothen the process of ecosystem restoration by accommodating the local custom instead of dictating the process. The government of Indonesia receives a backlash from the local community in certain remote locations by pushing their methods in the early 1990s and decides to follow local customs afterwards for restoration projects under REDD+.

The choice of species is also important. It needs to be something that provides the most benefit for the local community but should also be trees that the community are familiar with. For example, redwood trees might have the highest sequestration power, but the local community in Sumatera doesn't know how to utilize them, therefore the choice of species depends on the local ecosystem. These efforts are also made to reduce the risk of invasive species impacting the local ecosystem.

The last function of local wisdom is as a means of long-term protection. Indonesian remote forest ecosystem is protected by a system of *taboos* such as *awik-awik* and *pararem* law in Bali and the sacred forest systems in Sumatra and Kalimantan. National legislation barely reaches the remote region; hence enforcement isn't always feasible. Therefore, the government acknowledged the traditional/ethnic rule of law such as sacred forest punishment as an effective way to protect the forest from any disruptive human activities.

Educator

The educator roles are held by the local community, intermediary institutions, and the government. All with a distinct kind of education that complements each other. The local community educates the other stakeholders about local customs and knowledge, the intermediary institutions often bring science-based processes that optimize the ecosystem restoration, and government brings governance and legal knowledge about the rights and responsibilities of the local community to the natural ecosystem it attaches to.

The government educates the local community in a multi-level process through the active participation of the local leaders from the provincial to the community-based leadership. The government education program includes workshops and community outreach on the topic of land ownership, forest rehabilitation and conservation, and ecotourism. For the government, educating the local community is an important stage for sustaining a restored ecosystem. The key to the government model of ecosystem restoration is a decentralization of power and knowledge.

The government pushed the establishment of a local agroforestry community each supervised by a local government officer in direct coordination with the municipality-level office for forestry and environment. These supervisors are the ones that are responsible for the dissemination of information and vocational education related to each community's potential based on the natural ecosystem they are attached to. However, they will only do this community education only for government-related forest restoration and conservation projects. When the project is coming from the private capital owner, the roles are then shifted to the intermediary organizations, which for this study use similar methods of building smaller agroforestry communities and educating the community based on the goals and priorities of the capital owner.

Community Builder

The process of community building is exclusively shown by the intermediary organizations, especially by the organizations that directly engage with the local community. The process of community building includes a gradual change of behaviour of the community into more sustainable forest management. A notable example is done by FKL in northern Sumatera which over 20 years has reduced the number of slash-and-burn practices into a more sustainable land-clearing practice by slowly educating the local community, engaging and incorporating the local community in every decision regarding their surrounding forest.

Government has a minimum role in this, as in the boundaries of this study, the government of Indonesia is often rejected by the local community due to the nature of the standard of practice

being enforced that often disregards the local knowledge and characteristics. Hence, this role has been dominantly present in the engagement of intermediary organizations.

Common Capital Source

This role is an exclusive role of government that can pool the national budget from taxes and other sources and provides the fund for certain forest restoration activities. However, this role is not managed well by the Indonesian government, with the massive bureaucratic problem and corruption cases in the country surrounding ecosystem restoration and conservation, the management seems to be fallen below the optimum level. The government of Indonesia utilises the Unified Forest Management program and Social Forestry program explained in Subchapter 4.1. for the capital utilization from the national budget. Another source of government fund recently is the RBPs from the achievement of forest gain from the REDD+ project delivered by the Global Climate Fund (GCF) that utilizes for the MRV infrastructure development that can be used by both public and private stakeholders who manages the forest restoration and conservation.

Financial Provider

The private company's main roles are generally capital providing, providing financials means for the restoration projects and the conservation of it. Four different sources of capital are delivered by private companies for forest restoration projects. *First*, in the eyes of private companies, they are conducting their corporate responsibility to the environment by allocating certain shares of their net profit for the ESG indicator that fits their business activities. *Second*, the capital allocation also comes from corporate decarbonization investment that includes carbon removal projects. As explained in chapter 2, includes a land-based biological carbon sequestration project which comes in the form of forest ecosystem restoration. *Third*, it is coming from the engagement between the private company with its user. Such as airports with aeroplane passengers, or taxi companies with their passengers. In Indonesia, many transportations company offer an add-on service called 'carbon neutral fund' to offset the emissions from the user's daily commutes. This fund is then accumulated, pooled, and delivered to intermediary organizations for planning and implementation. *Fourth*, the capital for forest restoration can also be accumulated through a carbon offsets fund that is managed by environmental firms. One stakeholder interviewed for this research provides such services that pooled funds from various companies, branded it as 'carbon offset fund/credit' and deliver the fund to the intermediary organizations for planning and implementation as well.

However, private companies can also provide financial provisions through the management of the harvested products. One of the projects in north Sumatera not only includes the forest restoration, but a decade after the project restoration is conducted, the same company comes back to provide additional financial means by buying all the harvested goods from the community above the market price. The reason was that the product is directly delivered from the primary producer to the primary customer, so the economic value added that is normally distributed to the distributor and secondary seller is directly delivered to the primary producer (farmers). Despite a rare case, this indirect financial provision is a role that a capital owner can also claim in the future that provides additional value added for both the company and the local community.

Financial Accumulator

Financial institutions such as banks/venture capital/sovereign wealth funds in Asia recently showed their rising interests over environmental projects. In South-east Asia, Lestari Capital is a Singapore-based venture capital focus on pooling global investment into environmental projects in Southeast Asia. These investments' return isn't cashflow like usual investment, but

rather an on-paper value of the project benefit assess in multiple valuations such as what this research also concludes in subchapter 4.2. Direct evaluation for the hard evidence come by rather occasionally, and act as a supplementary form of evidence to the estimates resulting from the multiple valuation. They have an advantageous position as financial institutions that could provide additional value for forest restoration. Temasek Foundation, a non-profit arm of Singapore Sovereign Wealth Fund's Temasek Holdings, engage all its company portfolio to invest in an environmental project, pooled the fund into one pot and deliver the fund to intermediary organizations under the name of Temasek Trust.

Financial institutions aren't stakeholders that were previously considered dominant actors in an environmental project as capital providers. But with this function of a capital accumulator, their presence is expected to grow exponentially, especially the institutions with considerable huge bargaining power such as Temasek Holdings and GIC in South-east Asia.

Financial Empowerment

The intermediary institutions are the dominant power players here. The financial empowerment roles define as a role that increases the value added of the forest restoration project for the local community. They are the ones that identify how to best utilize the fund from all the capital owners, both from short-term and long-term perspectives. From a short-term perspective, they will try to source all the supplies locally from the local community they engage with, and also provide certain incentives for every tree the community planted and protect within the project period. In the long run, the empowerment includes financial empowerment through vocational education to increase the value of harvested goods, building a direct supply chain for the sales of the harvested goods, and assisting the establishment of local cooperatives that managed the community common capital that can be utilizes for the development of the community for generations.

Government has a minimum role here, they often only come once during the very first project in a new region for a general workshop but barely maintain the relationship for long-term empowerment and rely greatly upon the local organization that generally receives funds from the capital owner.

Planning

From a high-level perspective, the government holds the role of ultimate planner for carbon removal projects nationwide. Both government-led and private-led carbon removal projects will be synchronized to the national target to avoid conflict of interest in the field. The government, through the National Planning Agency, created a 5-year plan that derives into an annual action plan and project implementation. With MRV system integrates the result from the private-led activities.

The planning process for forest restoration, conservation and management generally covers the management of landownership, land utilization and how each restoration site can be sustained *ad infinitum*. Land ownership plan generally takes the majority of planning discussion, as they will define how the government and private sector can manage the restored ecosystem more sustainably. The option of social forestry also comes from the issue of landownership. To reduce the need of clearing land, the government devises a plan to integrate the community with the ecosystem itself. The management involved multiple stakeholders, mainly intermediary organizations, and private companies as capital owners.

The planning process also includes defining the infrastructure to support the sustenance of the restored ecosystem. This infrastructure planning generally involved increasing the outreach of the local community for the utilization of the harvested goods or their derivatives. The

economic infrastructure is also specially designed to answer each region's economic potential. On the eastern shore of Sumatera, the land is generally degraded due to the opening of the mining location or palm oil plantations. But the area is close to the tourism destination, hence the infrastructure for ecotourism is planned and built. The other forest ecosystem may be more suited for agroforestry, then the supply chain infrastructure is built to deliver the harvested goods faster to the primary market.

However, the planning process also comes with many challenges, government planning mechanisms are often not synchronized between ministries. In the case of coastal ecosystem restoration, the Ministry for Forestry and Environment often has a conflicted interest with the Ministry for Ocean and Fisheries. Which led to the abandonment of the project in certain locations altogether. The local organizations in Bali and Bangka Islands mention that this issue is common in their area for the government-led project. The project was later picked up by the local organizations, and both government agencies stepped back from the area. However, this issue of misaligned planning between ministries resurfaces on impact-claim of the project. Whether it should be attributed to the Ministry of Forestry and Environment or the Ministry of Ocean and Fisheries. Based on the current findings, the misalignment issue is persistent throughout the government-led environmental project. The government of Indonesia are working on the alignment and boundaries of each ministry in an inter-ministerial project.

Regulatory

The government holds an exclusive regulatory role. This regulatory role includes the setting of boundaries, rights, and responsibilities of all stakeholders. The national legislation generally deals with target settings and infrastructure. While the regulatory roles for implementation, are taken care of by the local government due to the decentralization system of legislation function where the central government only acts as the final supervisor, and not the implementor at the local level.

The local government has full rights and responsibilities to manage the implementation of forest management by themselves without any meaningful intervention by the national government. The consequences are diverse implementation in each region. This creates a diverse story from the local organizations. In a region where forest restoration is robust like Kalimantan and Sumatera, the local government generally engaged a lot with the implementation. However, some other regions faced a challenge with the misalignment of regulation between local government agencies.

Standard-Settings

As a continuation of the regulatory roles of the government, they also have a significant role as standard-setters. In Indonesia's forest restoration management, the government has set targets for forest restoration and conservation, peatland ecosystem restoration, and mangrove ecosystem restoration, as well as forest fire control in the fire-prone region. The government set the target of the restoration project as stated in Figure 4.4.

Besides that, they also set the standard of each forest management project that requires to have stakeholders that fulfil four main roles, namely rule and procedural function which holds by the local government, business function which is generally taken in cooperation between government and private companies, a mentoring function that relates to education and community building as explained in the previous section, and finally sustainability function that aim at optimization of environmental and economic benefit, generally fulfilled by the intermediary organizations.

The government also provides a standard for improvement benchmark of the forest restoration of at least 5% from the baselines with a verification process that is assured by third-party quality assurance agencies. This 5% annual growth standard is stated in the national 5-year plan and implemented by the relevant stakeholder in both government-led and private-company-led forest management projects. Currently, the implementation of this target is still far below the target. However, the government's recent massive effort in the REDD+ project to increase the MRV process could accelerate this benchmark improvement post-2025.

The government also provides standard settings for economic impact indicators for the success of the forest restoration project which covers two indicators. First is the increase of annual revenue of the Small-and-Medium Enterprises (SMEs) in the area, and the average increase of local community income that needs to be above the inflation rate.

Besides the government, financial institutions can also be an institution that holds the role of standard settings. Indonesia recently released the Green Taxonomy that dictated companies with high carbon intensity to disclose various environmental reports, including participation in carbon sequestration that yield benefit to the local community. This benefit includes the environmental benefit, the existence value of the ecosystem, and also the economic and financial benefit that increase the standard of living of the impacted local community.

Provider of Legitimacy

The government holds the ultimate power to legitimise the action of all stakeholders in Indonesia's forest restoration, conservation, and management. Each organization involved in the boundary of this thesis has a different experience with the government. CarbonEthics Foundation in Bangka Islands have a great relationship with the government, and their activity is recognized by the local government. However, the process of legitimisation takes place differently in northern Sumatra, where the government legitimized the program by the Leuser Communication Forum because they are failing in engaging the local community in a meaningful way.

Hence, there are two paths of legitimisation happening in the boundary of this thesis. *First*, is when the government actively engages with the intermediary organizations, and *second* when the government lets the local organizations do what they have failed to do. Substantively, the consequences are limited. But in terms of governance, the second pathway creates more room for the organizations to manage themselves however they see fit, while the first pathway creates more political dynamics in the process of engagement.

The process of legitimization is practically done when the government approved and symbolically commences the start of the project and hands it over to the local intermediary organizations. From that point, the government will generally leave it to the local organizations, and only be involved in the final reporting phase, or not involved at all.

From a meeting with the Ministry of Forestry and Environment, it is concluded that the government is currently looking for a better institutionalization process for all the currently running practices. The research is currently ongoing by the National Research Agency, involving several pilot projects in Sumatra, Kalimantan, and Java. The key findings were that the two models work. First is the state-led model where governments are actively involved from planning to implementation, or the society-led model, which most of the projects are under. However, the challenge of the second model is the roles and responsibilities of the stakeholders are still unclear and often create a blocker in the management process.

Facilitator/Enabler

The government, private companies, intermediary organizations, and the local community both serve as facilitators, in one way or another. The government generally facilitates high-level discussions between themselves and the industry association regarding the synchronization of efforts. Private companies facilitate the process of capital accumulation, target settings to greater sustainability goals, and sometimes also enable certain activities in a location that is considered a non-priority by the government. Distributing the effect of restoration across the region evenly by balancing themselves with what the government has already been doing.

The intermediary organizations could facilitate the government, private companies, and local community to devise a plan that yields an optimum benefit and facilitate the actual implementation and engagement with the local community. Meanwhile, the local community. Despite sometimes having limited educational capacity, enabling the process of restoration through providing knowledge that is relevant for the sustenance of the restored ecosystem.

Project Manager/Optimizer

The project management/optimizer function can be held by either government, private companies, or intermediary organizations, depending on the scenario of forest management stated in Chapter 4.1. The function includes optimization of impact between environmental and economic impact, preparation of the degraded land to be restored, engagement with the local community, actual implementation process, and reporting to the relevant capital owner.

For the government, the standard for project management optimization follows the four indicators previously mentioned in the standard-setting chapter. For the private company, it's about the optimization of environmental and economic benefits that fit the company goals in decarbonizations, and for the intermediary organizations, it's an optimum environmental and economic impact based on the best-available option scientific methods can offer. Therefore, it's about interest and power-play that determine how the project is being managed and to what degree they are being optimized. This is a complex process which involved multiple degrees of consideration, such as reputational factors, a minimum requirement for a license to operate, as well as monetary factors in it.

In addition to that, an interview with a government official also discovered a unique model of project management that involved multiple stakeholders' ownership of the project. Government can act exclusively as a high-level planner, while the rest of management is distributed across all stakeholders depending on their competitive advantage in the involvement of the project. But this model is highly unstable and acknowledged to create unnecessary bureaucratic blockers that often delay the project implementation or make a certain project to be cancelled due to the long waiting period for administrative registration of the project.

An additional challenge of multi-stakeholder project management is the lack of communication between the relevant stakeholders. Despite high-level communication between government, private companies and intermediary organizations being frequent, synchronization at the more grassroots level is almost non-existence and generally stops after the commencement of the project at the beginning of the project period. One of the reasons is that it's unnecessarily costly and time inefficient. Therefore, the implementation part of the project is often given to only a single stakeholder.

Supervisory

The supervisory function is held exclusively by the government. The government of Indonesia has a unified MRV mechanism that synchronizes all government-led and private-led forest

restoration, conservation, and management project in Indonesia. This supervisory function is also to make sure that there's no project that double-counted impact report and avoid the act of unsanctioned carbon offset by certain private players.

This function is held by the Ministry of Forestry and Environment, through the digital MRV system that combines the actual reporting from the project management entities with the satellite imagery data. These reports are then updated annually through the FLER report that is annually reported by the government of Indonesia to UNFCCC.

Post-Project Assurance

The third-party quality assurance provider is the main player to fulfil this role, they provide validation of the environmental project, quality assurance of the impact report, and become a source of credibility through the issuance of certain certificates that prove the environmental impact attributes of the project. These organizations like Bureau Veritas, Verra, and American Carbon Registry hold an important role that legitimizes the environmental project in the later stage. They have been seen as an impartial organization that provides an added value of credibility and verifiability of the company's environmental projects across the globe. Verra for example, is known for verifying carbon offset done by the company and making the process of a claim for a decarbonization achievement (i.e., by SBTi) easier.

The intermediary organizations are generally the stakeholder that provides the impact report, but these reports will only provide legitimation upon the approved accreditation from the carbon verification agencies. And the credibility of the capital owner claims over their sequestered carbon emissions will only be as good as the credibility of the carbon sequestration quality assurance organizations.

Value Dissemination

Private companies are generally the first to respond to government regulations because it could directly or indirectly affect their business. Hence, private companies often position themselves as government allies and try not to upset the government in any projects. From the interview with a technology company in Indonesia who have a lot of environmental projects. The advantage of going beyond the minimum requirements is not only that it's good for marketing, but it's also good for maintaining a bargaining position with government agencies against other companies in the same industry. For example, the palm oil and pulp and paper industry in Indonesia has a strong political dynamic. Currently, most of the industry players, such as Sinarmas Group and Indofood Group pouring their effort into helping government peatland restoration projects gain regulatory waivers or environmental licences to operate to expand their business operations, as a return for their considerably huge investment in the government's peatland restoration project.

The second role of value dissemination is to level the playing field at the industry level. Caterpillar is a leading company in terms of environmental impact compared to the other major players in the heavy equipment industry. This considerably huge environmental project investment has also pushed other players in the industry to do the same if not more. This is not an isolated case, as in the Indonesian tech industry, the industry player is competing to become number one in sustainability, often through the model of "carbon offset fund" to offset its user emissions from the purchase of their product.

5 Discussions

The following chapter will discuss the results explained in the previous section and analyse them more deeply using the theoretical framework outlined in Chapter 2. The dynamics of total economic valuation will be first discussed, then the field dynamics will be explored through the stakeholder analysis, based on the research boundary stated in the preceding chapters.

5.1 Total Economic Valuation of the Restored Ecosystem: Dynamics and Shortfall in Valuation

Considering a 20-year benefit period, the total economic valuation for the ecosystem restoration done by Caterpillar Foundation could be valued between USD 1.5 Billion at a 0% discount rate to USD 487 Billion at a -25% discount rate. Conservatively, with the same range of discount rate, but with a 10-year benefit period, the TEV range between USD 719 Million to USD 12.77 Billion. The final modelling generally will be affected by a single major factor, estimates of a benefit period. Based on the previous linear regression analysis done in Chapter 4.2.5., it is discovered that the discount rate effect on the total valuation is linear, where a negative rate yields a higher final valuation, and vice versa. However, when it comes to the estimates of the benefit period, after reaching certain tipping points, the value growth changes from linear growth to exponential growth.

Longer estimates of the benefit period will create bigger uncertainties, as the accuracy and validity of data decrease over time, as the distance between the actual and estimates data grew larger. From this analysis, it can also be inferred that the most optimum valuation should stop at 10-year estimates at the maximum. This is due to the valuation of year 11-onwards that falls farther from the linear regression slope. These uncertainties are the source of possible diminishing public trust toward the project, as a company will then have a possibility to overestimate its impact without actually being able to show the tangible picture of the benefit of their project (Rim & Dong, 2018; Yang & Stohl, 2020). Therefore, a 20-year valuation might not create legitimacy for the company that contributes to the project, as it will cast doubt on the whole project. As the research suggests, estimation from Year 11-onward falls farther from the linear regression slope, meaning it yields a bigger error possibility. Hence, the estimation shall be capped at 10 years, and a re-evaluation of benefits is conducted again on the framework of conservation instead of restoration.

In each element of the total economic valuation. The dynamics of valuation will be affected by various factors. Within the environmental dimension, carbon pricing will affect the total valuation for this dimension. Indonesia has a low carbon price for GHG emissions. Making external carbon pricing using the national carbon indicator undervalued the actual monetary value of each potentially sequestered carbon from the project if compared to mainstream figures used by private actors in other parts of the world like Europe or Northern America.

This problem will be persistent in other land-based biological carbon sequestration projects done in developing economies with carbon price way below the global average. One of the most ambitious projects by a European company, the Velux Group plans to sequester 5.6 Mn tons of its historical GHG emissions in Uganda and Myanmar. If the project is to be valued in economic terms, valuing this project using the national context of the project will render this project undervalued. Hence, the calculation for the environmental value of such a project shall take a different approach, such as using a global average of carbon price or internal carbon pricing that is project specific.

Furthermore, the valuation of the environmental side will also be affected by the dynamics of conservation of the area which is largely affected by the risk of land-use change. The biggest

risk for the Caterpillar project in Indonesia is land-use change as the land is generally owned by the government, and in other locations such as Semarang-Central Java and Buleleng-Bali, some area which previously being restored and conserved in the early 2000s, now has been changed into public infrastructure such as toll roads, and commercial area. Right now, the risk of greenwashing is minimum, however, once the risk is materialized, and land-use change is happening without any mitigation plan from Caterpillar Foundation and the intermediary institutions, the project will then frame as a greenwashing activity, as the benefit is no longer tangible, while the benefactor still claiming the credit for the project. Then, the project will see as an easy way out for a company to choose to escape its environmental responsibility (Torelli et al., 2020). The risk of land-use change in the area chosen by Caterpillar is varied. Aceh and Jambi have a minimum risk due to their remote location, however, Riau Islands have a considerably high risk of land-use change due to the increased popularity of the area as a tourism and aquaculture site. The choice of the area has considered this risk, and the choice of a combination of high and low-risk areas is a strategy decided by the intermediary institutions to keep the balance between long-term environmental benefits and possible corporate branding benefits. Riau Islands site has high public visibility that could boost Caterpillar's corporate branding to the public, while the other site's nature of remoteness makes it not feasible to be used for corporate branding purposes. Hence the environmental and economic benefits are on an optimum science-based level.

The economic benefit is generally affected by two factors in this study. *First,* the long-term effects of valuation are often uncertain due to unknown market dynamics, and *second,* the gap in knowledge in sustainable agroforestry practices. Failure to mitigate these two problems will render the economic valuation inaccurate and make the current valuation above the actual case. The case of overestimation is a major issue in global carbon sequestration projects. The forest restoration portfolio managed by Southpole in Zimbabwe faces this issue when after years of conservation, the estimates of benefit stated in the early years of the project fall far above the actual benefit provided. It resonates with research from Scanlan (2017) who emphasizes the possibility of overestimation in corporate environmental projects through reallocating risk and the outcome of the project itself. If the company is not willing to maintain its stewardship in the restored area which led to overclaim of benefit meanwhile the real on-field benefit is sharply diminished. The Caterpillar project can be a source of reputational risk for the company.

The existence value within the case study, is limited to disaster risk reduction, as it is most relevant for the study sites, valued through the contingent valuation model, is affected by how the sample perceived themselves, and how they perceived the role of the environment they live in relation to their livelihoods. The lower WTP seen in the findings above is greatly affected by the lower education background of the sample, however, the existence value can still be considered huge as the population size is huge with a considerably dense spread of the population.

In future research, it is important to understand the underlying context of the study and all cultural backgrounds which might affect the results of the study. This case has observed how community dynamics can affect the process of economic valuation. The level of understanding of the sample, as well as the methods of deployment, can be something that affects the results entirely and affects how biased the results are. Valuation bias assessment is excluded from this study due to limited data and sources, however, it is important to note that assessment of the level of bias from the study in a specific context like this will be important for future valuation.

5.2 Process Dynamics and Distribution of Stakeholder Roles

5.2.1 Local Wisdom as A Source of Local-Dependent Processes

The dynamics of project implementation can be grouped into two issues, local-dependent processes, and dynamics of responsibilities on the field. Indonesia consists of more than 17,000 islands, with each island consisting of at least one ethnic group with its own culture that affects all aspects of life. In all three project locations, despite being on the same islands (Sumatra and surrounding islands), the implementation process is not similar at all. Each location implements local wisdom into the planting process. This local wisdom includes the practice of preparing the lands, the seedling process, the distribution of roles among the member of society, and the practice to sustain the restored area based on the plan devised by the stakeholders involved in the projects.

This local wisdom also translated into law and education. In both Aceh and Jambi, the practice of clearing the lands by selected slash-and-burn is an acceptable practice protected by the law. Some modern context to the practice is also added to create a better environmental impact, such as how the burn phase needs to take place, and what window period for slash-and-burn to control the rate of forest fire and haze pollution. On the conservation side, the Indonesian government implementing the "Social Forestry System" which comes from an amalgamation of Indonesian forest community practices in managing the natural forest ecosystem. This social forestry system, as stated in Chapter 4.1., is the key to Indonesia's conservation efforts, to allow optimum utilization of the forest that still allows optimum sequestration and keeping the forest cover at an acceptable rate.

While the local community become a strong source of local wisdom, as a stakeholder, they lack the power to influence anything in the process of restoration, they have indirect power to influence the project through the use of their local knowledge, but the extent of this influence is limited to the implementation process, and lack of involvement of the local community in the planning stage, has made the local community looks like a passive receiver instead of an active stakeholder in the process. They are central to the survival of the restored area, but often their participation is still lacking, creating an imbalance in stakeholder power dynamics in the restoration project.

5.2.2 Dynamics of Stakeholder's Responsibility

Private Sectors

Beyond the local wisdom, the grassroots dynamics also cover the issue of stakeholder involvement in the process. The private sector has become a dominant initiator in the effort of forest restoration and conservation. Whether the goals are solely restoration and conservation or finding a verifiable and tradable carbon credit, the private sector has led most of the active projects throughout the country. Especially, after 2011 when the President of Indonesia declared each private and public company needs to disclose its sustainability reports based on acceptable standards to the relevant government agencies. More intense and strong effort is also shown by natural resources extraction and land-based industry such as metal mining, oil and gas, palm oil and pulp and paper. This industry's main "environmental" responsibility in their ESG report was forest/peatland rehabilitation and conservation.

Beyond the practice of compliance, private sector goals here have been recognized to increase the brand awareness of the public toward their environmental value. Caterpillar Global has a comprehensive integrated ESG report with a strong emphasis on the land-based carbon sequestration project, with a strong narrative to pitch their ESG value to the public. This is in

line with the previous research which explained that environmental projects are used by the private sector to improve their corporate branding and instilled positive energy in their public audience (Du, 2015; Scanlan, 2017; Xiao et al., 2022). However, for the case of Caterpillar, currently, there's no conclusive evidence that their environmental performance supports their corporate finance and capital market metrics as Xiao et. al., (2022) mentioned in their research.

The private sector can be considered a complete trifecta in the eye of stakeholder salience theory (Mitchell et al., 1997). They have enough power to initiate the process of restoration in the form of utilitarian power represented by the financial power to finance the project from start to end. Legitimacy is based on the public perspective, the responsibility of the company to the global community and its mature nature, and the urgency to do so under the legal pressure of national legislation and the global trend toward decarbonization. As a stakeholder, they are central in the case of restoration projects within the frame of the decarbonization journey of a company.

Government Agency

In contrast to the major role the business sector has in the implementation process of forest restoration and conservation, the government's role has been limited in the field. Their major role as regulators and supervisors of the projects remains strong through the implementation of integrated forest rehabilitation and conservation results. However, in the field, their role can only be seen in three activities: (1) *ceremonial role*, where the local government will be the one that commences the start of the restoration activity or institutionalize the conservation project funded by the private sector; (2) *introducing new regulation/forest management system,* where the government usually take part in disseminating the new regulation or system but shifts the responsibility of the implementation to a local organization. In the social forestry system that the government of Indonesia rolled out back in late 2019, the government role has been limited to informational and supervisory roles, while the implementation of the project has become the responsibility of local organizations, with the help of NGOs to ensure optimum results. Finally, (3) *government has a strong role in the MRV process*, which in most cases will have a government officer verify the ecosystem rehabilitation and conservation in the field and certify the project as "government-compliance" or "non-compliance". In the case of non-compliance, the main project donor will be warned, then prosecuted for greenwash practice upon repeated offence or illegal forest management activities, and their results won't be recorded as a creditable/tradable carbon offset by any third-party verificatory agency such as "Bureau Veritas" or "Verra".

Viewed through the lens of stakeholder salience theory, the government's power is rather normative or coercive at the same time. Normative in the sense that they have a symbolic influence as a regulator and supervisor of a restoration project, but also coercive as they have punitive power to adjudicate the mishap in the process of restoration. In the Caterpillar project, however, government agencies seem to have no urgencies to be involved and only stand whenever needed to show their normative power to legitimize the project. Their role is central, but their scope is rather limited to supervisory with limited involvement in the actual implementation process.

Intermediary Institutions

Meanwhile, the intermediary institution's role falls into a vague territory. They neither implement nor initiate any project independently. Their role, as the name stated, is limited to two activities: (1) intermediaries for the fund accumulation process, so a restoration project can take more than a single donor, increasing the scope and territory of the restored ecosystem, and (2) optimizing the restoration and conservation activities through a selection of trees species (which depends on local wisdom as well), the area of conservation, and selection of community development activity. In the end, their role can be seen as "Project Manager/Organizer" in which the sole purpose is to optimize the process of restoration and conservation to reach

optimum benefit based on the available resources. These roles make the intermediary institutions seen as the most legitimate stakeholders in managing the restoration project. They might lack power unlike the private sector; however, they can serve as the face of the legitimacy of the restoration project. Providing confidence in the project, and instilling trust in the public eye.

Intermediary institutions serve as a facilitator that reduces the risk of market failure in the restoration efforts. These economic pressures are the economic development processes in the restored area (Nurrochmat et al., 2020). The private sector often wanted to do restoration in areas with a high risk of land-use change, making the restoration efforts just cosmetic for their sustainability report. However, with the role of intermediary institutions such as environmental research institutes, this risk can be reduced or avoided by management of stakeholder expectations on the restoration project. In the case of Caterpillar Foundation, the initial landscape expectation was located in a high risk of land-use change due to the national development plan and demographic expansion. However, WRI Indonesia mitigate this by ensuring that Caterpillar could create higher environmental and economic benefits from the restoration by restoring areas with minimum land-use change risk, extending the possibility of the survivability of the restored area. The private sector is often misguided in choosing the restoration sites and species to be restored in the area, due to minimum knowledge and lack of collaboration with other stakeholders, which led to market failure as stated by previous research. But in the case of Caterpillar, this risk is mitigated through the strong role of intermediary institutions.

To summarize, the research has seen certain overlapping roles of the primary or secondary stakeholders in the restoration and conservation efforts, but Table 4-2. has delineated which role is exclusive to certain stakeholders, and which role is shared between stakeholders. The result also aligns with the initial assessment in Table 2-1. As all roles are seen in the stakeholder in this case study, additional stakeholders and additional role is discovered which enriches the literature for stakeholder roles in ecosystem restoration and conservation. To conclude, the researchers discovered that the process of restoration and conservation is dynamic, and so is the role of stakeholders. A single research methodology will render the research results unclear, hence mixed methodologies have helped the research to become more inclusive and integrative in the assessment process.

5.3 Making Sense of TEV and Stakeholder Responsibility for the Optimum Benefit of the Restoration Activity

Based on section 5.1. and 5.2., it is important to define several boundaries on how the TEV can be utilized to optimize the restoration project. As the previous research such as that by Noor et., al. (2020) and Sharma et., al. (2019) does not define how the valuation can be used by the respective stakeholders concerning their roles, this research provides several conclusions focused on the following points:

1. Project benefactor, as the source of capital, will be the major stakeholders that will observe and utilize the TEV the most. Their roles as capital owners, naturally demand some form of tangible return of investment to their spending on the project. However, the limitation on valuation needs to be acknowledged, and estimation needs to control to reduce or eliminate the possibility of overestimation. Should this occur, there is a significant risk of the project considered as greenwashing activity.
2. Government agencies care less about the monetary value of the project or the long-term economic benefit of the project but rather care more about the amount of carbons sequestered by the project in the long term. Hence, the importance of estimation is only

limited to this single facet of the environmental dimension of the restoration. This is due to the government goals indicator which complies with the UNFCCC target.

3. Intermediary institutions, as the project manager, considered the TEV from a combination of scientific and business perspectives. How the project yields optimum benefit for the project benefactor, but also optimum for the environment. The selection of tree species, location, and community has a huge effect on how intermediary institutions used the TEV simulation in making the estimates.
4. Local communities care less about the TEV itself; they are rather seeing the direct real financial benefit they could get instead of the intangible value. Hence, TEV might not be useful for this stakeholder with respect to their role as the one who receives the benefit. Because what speaks for them needs to be something tangible. Contingent value often perceives as important, but this sense of importance hardly materializes in comparison to the length of how tangible benefits can change their perspective on ecosystem restoration and conservation itself.

Therefore, to conclude, the TEV will have different usage for each stakeholder, with different limitations and reach. A holistic approach will be useful from the academic and business perspective; however, other stakeholders might not see the valuation as an important part of their daily operations. In the end, the important part is delineating the role of stakeholders to create an optimum yield of benefit from the project. Despite indirect usage of the TEV in the restoration project, it will remain important to materialize and showcase the project's benefit and effective implementation to all stakeholders.

6 Conclusions

6.1 Main Findings

The research begins with the quest of finding a total economic valuation of the restored ecosystem services done by Caterpillar Foundation in Indonesia, and the dynamics of stakeholders involved in the process. With limited research on the total economic valuation in the context of the Indonesian ecosystem and a lack of delineation of roles between stakeholders, this research brought these two issues into the light in this thesis.

The Caterpillar Foundation project in Indonesia encompasses ecosystem restoration in three areas in Sumatera and surrounding islands, with a total combined area of 100 hectares of the forest ecosystem and 25 hectares of mangrove ecosystem. The research discovered the environmental value of USD 29.47/ton CO2 sequestered (based on internal carbon pricing mechanisms), USD 92.7 Million of economic benefit for 20 years benefit period, and WTP of USD 110/person. While the number can be aggregated into a single TEV model, stating the conclusion this way enables a deeper dimensional understanding of the value of estimation as each dimension comes with a different factor affecting its final number.

Environmental dimension monetary values are strongly affected by the actual conservation effort in the later stage and the choice of carbon pricing mechanisms. The economic benefit that is affected by the market, societal and climate dynamics. While the existence value of the ecosystem is defined by how society perceives their relations with their natural environment. The higher their dependencies and higher their WTP will be. Aggregation is effective to showcase the business case for the project, but it yields less benefit for the academics in understanding the dynamics. As aggregation disregards the individual dynamics and cultural backgrounds/contexts that each dimension has, which indirectly affects other dimension results as well. For example, the high economic benefit from the harvested goods from the forests could affect the survival rate and sequestration rate of the trees, hence decreasing the environmental benefit of the ecosystem. This is a part of the study that is still unexplored and can be an opportunity for future research in this study.

Furthermore, in practice, ecosystem restoration and conservation are dynamic processes where each stakeholder perceives their role differently. The three primary stakeholders in all cases are the government, the private sector, and the local community. Then the secondary stakeholders are all intermediary institutions bridging and optimizing the communication and implementation. Each stakeholder has an overlapping role as well as exclusive roles within the project.

The primary stakeholders are often seen as having a competing interest in the project; however, this research concludes otherwise. In practice, a private entity has always led the initiative, with the support of intermediary organizations, such as environmental NGOs as project managers, and local organizations as daily operational entities. Meanwhile, the government often join the effort only in the beginning and the monitoring process at the end. The extent of government involvement in the Caterpillar project remains limited, but it's not closing the discourse that government might have a bigger role in another private-led restoration project in Indonesia.

Furthermore, it is also discovered that tertiary stakeholders, primarily financial institutions as well as third-party verificatory agencies have an increasing role in the process. Financial institutions recently take a more proactive approach through building the coalition for capital accumulation from their respective portfolio and clients, which could expand the scope and depth of land-based carbon biological carbon sequestration efforts. This rising importance of

the financial institution's role is yet to be unfolded. Such as the motivations and long-term intention in the field, the limit of their roles and practical involvement in the field, and the impact of the climate finance process on the practice of ecosystem restoration and conservation. Therefore, it serves as a great opportunity for future research.

6.2 Practical Implications and Recommendations

Based on the findings and discussion of this thesis, the following are the practical implications and recommendations:

1. For academics:
    a. valuing the environmental project in monetary value is possible, however, all factors affecting the dynamics of the restoration and conservation need to be considered to ensure a valid, transparent, 'more' accurate and defensible valuation.
    b. Making sense of stakeholder analysis in the restoration and conservation project is about mapping and delineating roles to provide a clear efficient role distribution among stakeholders.
2. For private companies:
    a. A claim of result uncertainty and estimation confidence of interval is a mandatory element in claiming the environmental and economic impact of a land-based biological carbon sequestration project.
    b. Carefully publishing the environmental, social and economic benefits of the ecosystem restoration and conservation they involve in to minimise the risk of possible greenwashing accusations.
    c. Involvement with the government is important to aligning the goals of the activity and ensuring smooth post-project MRV processes.
    d. Aligning with local government development agencies in planning the development of urban population and protected ecosystem zone to ensure land-use change risk is minimised.
3. For local and national government:
    a. It is important to understand each stakeholder's role in the project by clearly delineating each other's role, so no effort shall be wasted in the process of preparation, implementation, monitoring, and validation.
    b. The government currently lacks practical knowledge in the field. Further active participation with private-led projects is important to draw more insights for a better policy-making process.
    c. Educating the local community to understand the value of an ecosystem restoration and conservation project beyond its economic value is a determinant for the long-term sustenance of the restored ecosystem.
    d. Making sure the current land zonation for protected ecosystem zone, social forestry system, and national development agenda always considered the science-based process, to ensure sustainable land management processes.

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Appendix 1: CVM Base Questionnaire (English)

Contingent Valuation of Disaster Risk Reduction in Caterpillar Project

Demographic Questions:

1. What is your age?
    a. Below 18 years old
    b. 18-25 years old
    c. 26-35 years old
    d. 36-45 years old
    e. 46-55 years old
    f. Above 55 years old

2. What is your average income per month?
    a. Below IDR 1,000,000
    b. Between IDR 1,000,000- IDR 3,000,000
    c. Between IDR 3,000,001-IDR 5,000,000
    d. Between IDR 5,000,001- IDR 10,000,000
    e. Above 10,000,001

3. What gender do you identify yourself as?
    a. Male
    b. Female

4. What is your occupation?
    a. Farmer
    b. Fisherman
    c. Government Employee
    d. Traders
    e. Private company employee
    f. Other, please define.

Mangrove Ecosystem Knowledge

5. [Likert] How well do you think you know about mangroves?
6. [Likert] Do you know about mangrove ecosystem services?
7. [Likert] Do you know about mangrove function as agent that protect coastal region in your area?
8. [Likert] Do you know all the utilization of mangrove?
9. Do you know mangrove potential in your economy? Such as ecotourism?
10. [Likert] How often do you go to the mangrove-covered region?
11. [Likert] How important do you think mangrove ecosystem is?
12. [Likert] Do you think mangrove is part of your life?

13. [Likert] What is your willingness to protect mangrove?
14. Have you ever experience a natural disaster?
15. [MA] If yes, what kind of disaster?
    a. Flood
    b. Landslide
    c. Earthquake
16. [Likert] How often have you tried to try to reduce the disaster risk in your area?

Willingness to Pay for Disaster Risk Reduction

17. [SA] If your family faced a natural disaster, such as flood, how much do you think the house reparation will cost you?
    a. Below IDR 1,500,000
    b. Between IDR 1,500,001-IDR 3,000,000
    c. Between IDR 3,000,001-IDR 4,500,000
    d. Between IDR 4,500,001-IDR 6,000,000
    e. Between IDR 6,000,001-IDR 7,500,000
    f. More than that: please mention . . .

18. [Yes/No] If we can avoid any disaster from happening by paying a certain amount of money, are you willing to pay the following amount of money annually?

IDR 1,500,000

IDR 3,000,000

IDR 4,500,000

IDR 6,000,000

IDR 7,500,000

19. [Yes/No] If mangroves can reduce the disaster risk in your area, how much money you be willing to spend to protect mangroves?

IDR 1,500,000

IDR 3,000,000

IDR 4,500,000

IDR 6,000,000

IDR 7,500,000

Willingness to Accept Incentives

20. [Yes/No] Assuming government/other parties provide annual incentives for you to protect mangroves, how much money are you willing to accept to protect mangroves?

IDR 7,500,000/year

IDR 6,000,000/year

IDR 4,500,000/year

IDR 3,000,000/year

IDR 1,500,000/year

IDR 750,000/year

IDR 300,000/year

[Open Ended] How much money do you think mangrove ecosystem worth annually?

FGD Discussions

1. Why do we need to protect our environment? What benefit do we get from it?
2. What are our rights in relation to the ecosystem services provided by the natural ecosystem around us?
3. Who are the most important stakeholders who need to engage in ecosystem protection?
4. What do they need to provide to improve such a process?