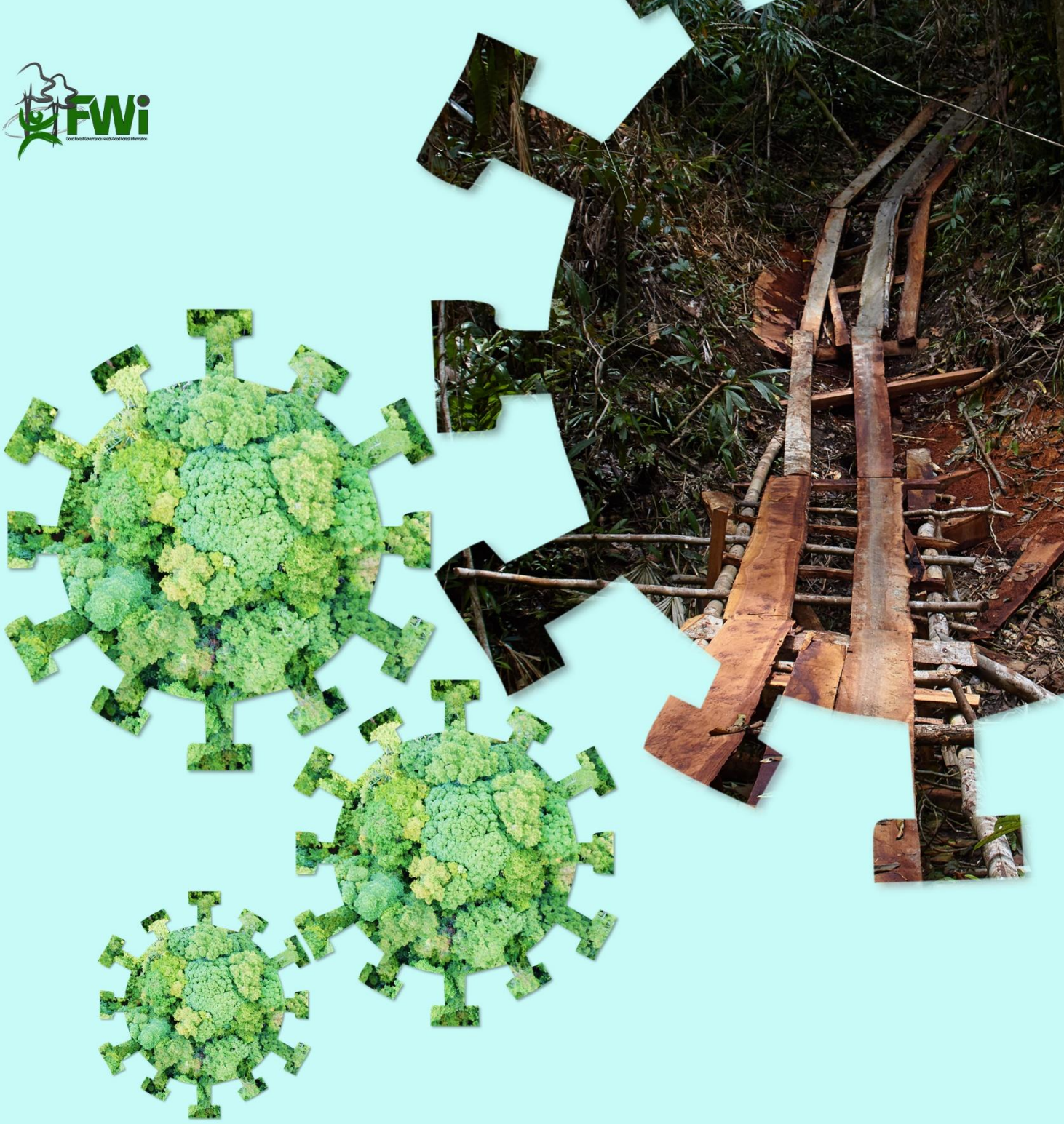


Potential Deforestation Post-Covid -19 pandemic in Indonesia

Forest Watch Indonesia

2020

Potential Deforestation Post-Covid -19 pandemic in Indonesia

Introduction

Indonesia is a tropical archipelago with relatively extensive forest area which covers 2% of the world's (Maryudi, 2016). This number may not look noteworthy, but as tropical forest, Indonesian forest is remarkable as it has rain throughout the year and often is called as world's lungs. About 40% of the world's oxygen was estimated to be produced from Indonesian forest. The forest was said to be world's carbon stock and any damage it suffers would affect global climate (Michael, 2001).

In the last two decades, Indonesian forest has been suffering massive deforestation. Data from Forest Watch Indonesia revealed that deforestation as expansive as 24 million ha has occurred in 2000-2017 with different rate in each period. One of the main triggers has been the government policies which allowed extensive investment which consequently resulted in the lack of people access, allocation politics, and land distribution, commodity shift, and also land conversion. Deforestation has affected various aspects of life such as, the disturbed ecological functions of forest, socioeconomics, and culture. Deforestation has also escalated disasters such as flood and landslide due to the forest disrupted ecological functions.

Moreover, in this Anthropocene era, biodiversity loss in natural forest has been taking place all over the world with significant biodiversity (Dirzo et al. 2014). Biodiversity loss may cause disrupted ecosystem functions, such as 1) pest control, 2) critical pollination, 3) nutrient cylce, 4) water quality, and human health. Biodiversity loss may affect human health in various ways such as, degradation of natural medicinal products, pest and disease controlling agent, food resource, and pathogen control. Zoonosis has threatened not only the global health but also global economy (Allen et al 2017).

The Covid-19 pandemic which was caused by severe acute respiratory syndrome (SARS) coronavirus 2 (SARS-CoV-2) has killed 740,276 people all over the world per August 12th 2020 and caused global health disaster. Similar to previous virus (SARS-CoV) which caused SARS disease in 2003, SARS-CoV-2 was also transmitted through bats and has similar symptoms. However, the new virus has much higher transmission rate and higher impact on elders and children.

In 2020, Indonesia, like other countries in the world, has suffered Covid-19 pandemic. The virus was first identified in Wuhan, China in late 2019. The coronavirus has remarkable high transmission between human which caused such aggressive spread of the virus. The virus is transmitted through droplets during cough and sneeze (Susilo et al. 2020). In March 2nd 2020, Joko Widodo as Indonesian president has announced the first case and per August 25h 2020, the case number has reached 155,000.

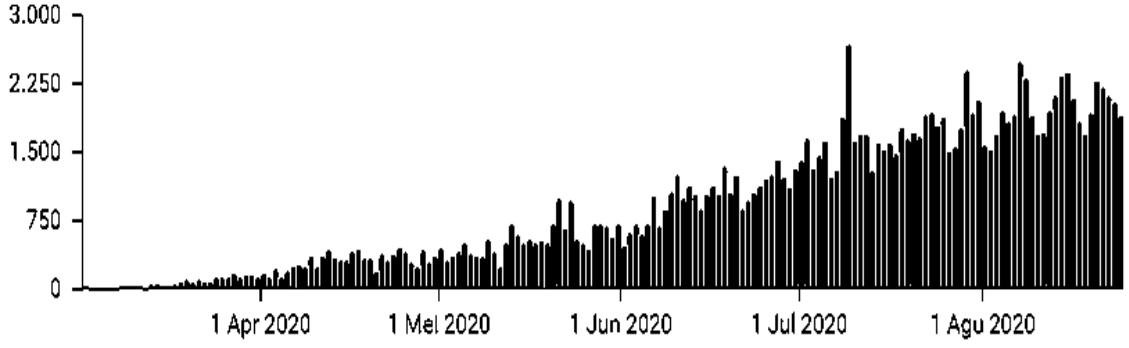
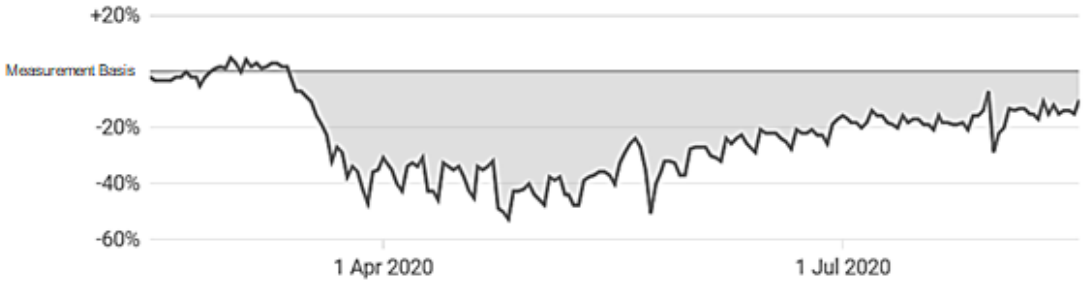


Figure 1: New cases of COVID-19 in Indonesia per August 25th 2020. Vertical axis represents people tested positive for the virus. Source: https://news.google.com/covid19/

For preventive measures, Indonesian government has released PP No. 21/2020 on Large-scale Social Distancing (*Pembatasan Sosial Berskala Besar, PSBB*). Social distancing included restricting school, workplace, religious, and other public activities which involves large crowds in private and/or public facilities in areas with high cases/transmissions. Up to this date, almost all provinces has practiced PSBB. With such restrictions, mobility in various sectors has suffered drastic drop and limitations which consequently affected the economy.



This data presents the trend in restaurants, cafes, shopping centers, attractions, museums, libraries, and movie theaters.

Figure 2 Mobility shift due to COVID-19. Vertical axis shows mobility shifts from the baseline condition. Source: Google COVID-19 Community Mobility Reports

One of the biggest impacts of PSBB was the decreasing economic growth. Minister of Finance, Sri Mulyani stated that PSBB has strike financial system and national economy. It is worth to note that economic growth In the first quarter has dropped to 2.97% from the last position last year which was 4.9%. Further contraction indicator (decreasing economic aggregate) was shown by national tax revenue of 2.5% in this year first quarter. Meanwhile the deficit has reached 852 trillion rupiahs or equal to 5.07% PDB.

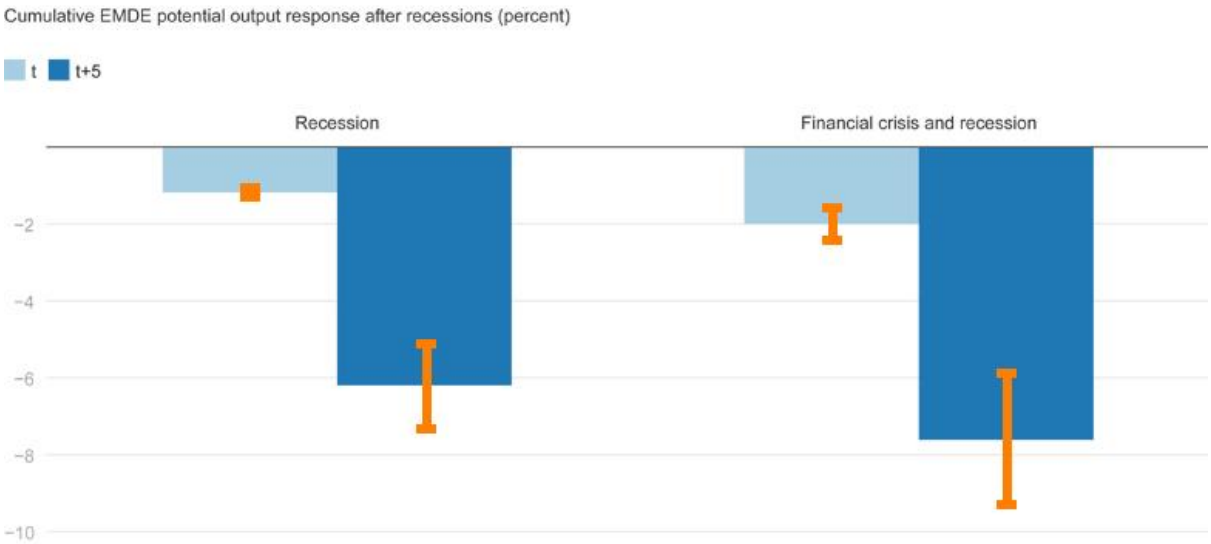


Figure 3. strong influence of economic recession due to the pandemic on potential output.

With the decline of economic growth and national deficit, revenue from forestry and energy sectors would have to be boosted to cover the financial lost. As previously happened in 1997-1998 monetary crisis when the economic growth was -13.8% and all economic sectors suffered negative growth except for agriculture, livestock, fishery, forestry, and energy (Susilo, 2002), which implied that these sectors survived despite the monetary crisis. Deforestation in the early reformation era (1996-2000) reached 2.83 million ha (KLHK, 2018) to boost the economy after crises trough illegal logging, palm oil and industrial plantation expansions, hundreds of HPH issuance, and other forestry problems which pushed the government through Minister of Forestry to issue new policies such as law No. 41/1999, The People's Consultative Assembly resolution (Tap MPR) on land and nature resources, wood/logging certificate, and other policies.

Policy to boost national income from forestry would threaten natural forest existence, from excessive logging to forest conversion. Land-base investment would likely to be accelerated to help recover the national economic growth and deficit. With all the problems that Indonesia is currently facing, from pandemic to economic decline, a thorough study is vital to analyze how the current policies affect deforestation after the pandemic to boost economic growth.

In this study, FWI analyzed the economic dynamics from forestry and logging in Indonesia in the perspective to help recover the economic growth and the continuity of national commitment on global emission. Spatial model based on CLUEs was used to observe the shift on land cover due to socioeconomic pressure and also the environment from 2000 to 2050. The aims of this study are:

1. To calculate the ration of contribution to economic growth and deforestation rate based on historical data.
2. To observe the relationship between land use shift or deforestation and economic growth contribution
3. To simulate future deforestation dynamics in Indonesia based on national contribution to climate change (NDC) based on the dynamic shift in land cover.

Methods

Data

This research needs the data from forestry and economy sector, in spatial form nor tabular for the statistical analysis and land cover change modeling using CLUEs. Herewith the detailed data information that used in this research.

Table 1 Data information that used in the research

Data	Source	Data Type	Year
GDI in forestry sector and logging	BPS	Tabular	2019 – 2020 (Quarterly)
National deforestation	KLHK	Tabular	2019 – 2020 (Quarterly)
Devegetation EWS (8-days)	IPB	Spatial	2019 – 2020
Natural forest cover	FWI	Spatial	2017
National economic growth target	RPJMN	Tabular	
Land cover	KLHK	Spatial	2000, 2011, 2015
Elevation	SRTM	Spatial	
Slope	SRTM	Spatial	

Road network	BIG	Spatial
Forest Area Function	KLHK	Spatial

Data Analysis

Ratio between economic benefit value and deforestation area

In this case, we try to make correlation between national GDI value from forestry sector and logging with the deforestation which happened in Indonesia in quarter range from 2019 to 2020. It is done to see the wood usage dynamics to national economic growth so we can obtain the simulation of national economic usage in the future based on the going deforestation information. Herewith the used equation

$$R = \frac{\sum_{i=1} \left(\frac{GDP}{DEF}\right)_i}{N}$$

R is the ratio average between the economic benefit value with deforestation area in Billion Rupiah per hectare unit, *GDP* is Gross Domestic Product from forestry sector and logging in Billion Rupiah unit, *DEF* is Indonesian Deforestation in hectare unit, and *i* is for index which represent quartal in research period. Related studies are using the *net present value* (NPV) definition to count the economic benefit from areal unit.

Land cover change simulation

Land cover change analysis is done to obtain the Indonesian deforestation dynamics based on the cellular automata modeling by considering every land covering elasticity, mentioned as CLUEs (*The Conversion of Land Use and its Effects*). CLUEs modeling is developed to simulate the land covering using quantitative relation between land covering/land usage and the driving factor, also combine it with the dynamic model from the competition of land covering types. This model can be used at national, local, nor continental level (Verburg 2010).

In this research, some driving factors in land covering that used in the model are: elevation, slope, nearest distance from road,a nd deforestation risk level based on the forest area function. Elevation and slope are the natural factors that affects the land covering change, especially in accessibility aspect. Those both topography factors also the natural barrier from the ecosystem type in study area. Previous study stated that the topography information (i. e. slope and elevation) is a factor that has strong affection to land changing. Besides that, the nearest distance from road network is the main factor which affects land usage change from anthropogenic activity. It represents human accessibility in ding land cover change, especially from the natural ecosystem (forest) to be built up land (man-made). The high accessibility (i.e. near from road) triggered changing opportunity for land usage type become relatively thigh. Some research also showed that road network has strong affection towards land changing, especially related with deforestation (Gaveau *et al.* 2009; Estrada *et al.* 2017; Condro *et al.* 2019; Vilela *et al.* 2020). Forest area function also used in the modeling for catching the general government's policy to do natural forest clearing in Indonesia. In this research, we try to classify the forest area function to become land deforestation in high level. Herewith the detailed information of Indonesian deforestation risk classification by Indonesian forest area function.

Table 2 Deforestation risk classification based on the forest area function

Forest Area Function	Deforestation Risk
Protected Forest	1
Nature Reserve Forest	2
Strict Nature Reserve	
Wildlife Reserve	
Nature Conservation Area	3
National Park	
Nature Recreation Park	
Grand Forest Park	
Game Reserve Park	
Production Forest	4
Limited Production Forest	
Converted Production Forest	
Other Areal Usage	5

Another important parameter in land cover change modeling using CLUEs is the changing allocation from each land cover category or the competition of land cover types which represented by elasticity conversion coefficient. In this case, we reclassified the 22 land cover classes from KLHK to be 4 classes; forest, agriculture, built up area, and the other, following the prior research which related to land cover history (Verburg 2010). Herewith the framework of land cover allocation procedure

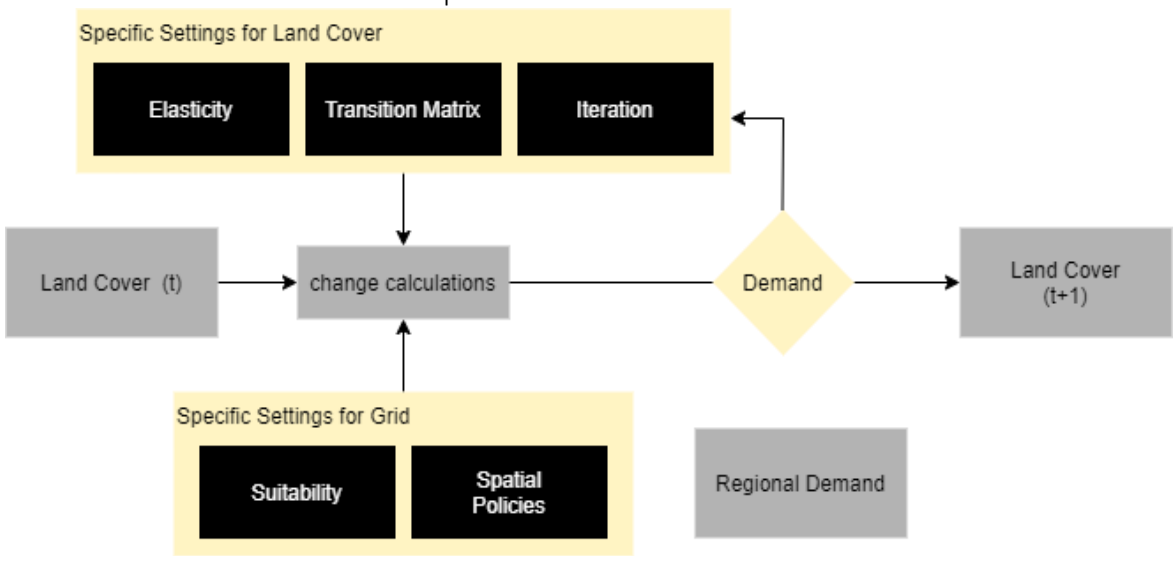


Figure 4 Framework of land cover allocation procedure in CLUEs model

Next, the wood extraction dynamics which represented by spatial deforestation from CLUEs simulation result, used as the baseline of this study. Herewith the used equation to determine the Indonesian deforestation.

$$DEF_{t+1-t} = FA_{t+1} - FA_t$$

With *DEF* is the rate of deforestation per year in *t* period so *t+1*, *FA* is the remaining forest area in period *t+1* and *t*.

Results and Discussion

How do the forestry and logging sectors contribute to national economic growth?

The forestry sector has an important role in the Indonesian economy, especially in the village community welfare. The economic contribution (share) of the forestry the Indonesian economy towards the whole output is 0.74% (Arifatul Ulya and Yunardy 2006). According to the data, the contribution of the foresty and logging sectors to the national GDP is IDR 14,328 billion to IDR 16,350 billion per quarter from 2019 – 2020. In 2008, foresty and logging sectors contributed to the GDP of IDR 63.218 billion. It means the realization of the wood extraction contributed around 61% inf the total target of the Environment and Forestry sector to the national GDP. Thus, logging is very important in the national economy, according to Strategic Planning of the Ministry of Environment and Foresty (KLHK). The quartal deforestation was obtained from the elaboration of natural forests' baseline data from Forest Watch Indonesia (FWI 2002) and early warning system of devegation from Institut Pertanian Bogor (IPB). Deforestation in Indonesia is varied between 33,350 ha to 186,074 ha per quartal in 2019-2020.

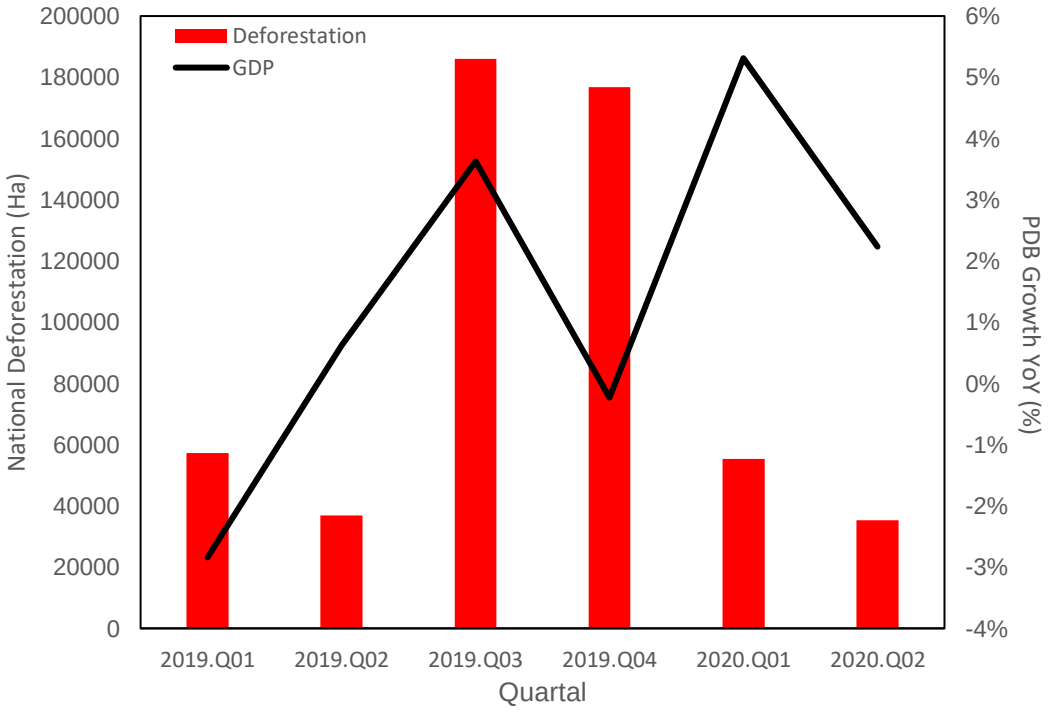


Figure 5: The Historical Deforestation and the GDP Quartal on the Foresty and Logging Sector in 2019-2020

According to the information on historical deforestation, the highest deforestation in 2009 is identified in the third quartile, which is in July, August, and September. Interestingly, the dynamic of GDP in the foresty and logging sectors has a high pattern similarity to the quarterly deforestation data. The Pearson correlation between deforestation and GDP shows a relatively moderate relationship (p = 0.477). It shows that deforestation in every quartal contributed to the national economic growth, so we calculate the ratio between deforestation

and GDP to review the contribution of logging to GDP based on deforestation information. More data needs to be collected so that it has a better representation to explain the relationship between deforestation and national economic growth and to improve the model performance. These dynamics are well represented in the majority of quarters, from Q2 2019 to Q1 2020.

If reviewed with a general variation in the dynamic of deforestation and GDP in 2019-2020, we can conclude that Indonesia can earn around IDR 266.6 million per hectare. This is very different from the estimated minimum NPV of tropical forests based according to the study by Pearce 2003, which was only about IDR 2.8 million per hectare (Pearce 2001). Therefore, the ratio will be used as a baseline in simulating the contribution of the forestry and logging sector to national economic growth.

How do the foresty take a role in saving the economic crisis and the dynamics of Indonesian deforestation?

Reflecting on Indonesia during the economic crisis in 1998, the rate of deforestation in Indonesia has increased dramatically, especially in Sumatera and Kalimantan region. Thus, the COVID-19 pandemic is also affected national economic conditions and potentially increase natural forest loss. As explained in the sub-chapter above, there is a strong relationship between deforestation and GDP in the forestry sector. Besides that, Indonesia has a target fulfilling the national economy to IDR 104 trillion from the Environmental and Forestry sector.

Based on the *business as usual* simulation, changes in land closure with the CLUEs approach in Indonesia, analyzes the potential impact on Indonesia's economic growth, and how the national efforts to realize Indonesia's commitment to reduce global emissions until 2050, CLUEs' model show a good performance on the Random Forest algorithm than the other algorithm, which is Generalized Linear Model (GLM) and Classification and Regression Trees (Rpart) according to the size of *the area under the ROC curve* or AUC. The value of AUC is ranged from 0 to 1, with 1 highest value.

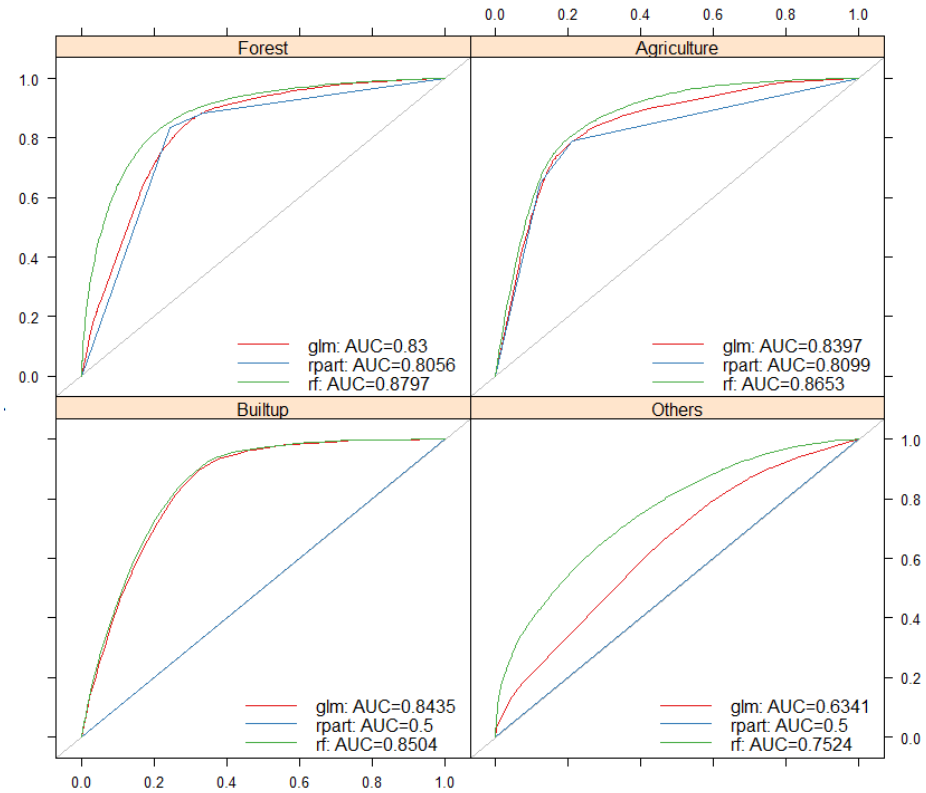


Figure 6: The Performance of CLUEs' Model on Every Land Closure Category. GLM: Generalized Linear Model, RPart: Classification and Regression Trees, and RF: Random Forest

Based on the AUC value, Random Forest surpassed the other two algorithms (i.e. CART dan GLM) in all land closure categories tested, with details as follows (AUC_{Forest} = 0.8797; $AUC_{Agriculture}$ = 0.8653; $AUC_{Buit\text{-}up\ areas}$ = 0.8504; dan AUC_{Others} = 0.7524). The land closure category has the highest value of model performance so that the dynamics of Indonesian deforestation can be well explained using the CLUEs model in the future. The results on the land closure simulation show an overestimate value than the FWI's natural forest reference in 2017 ($Hutan_{FWI}$ = 82.8 million ha dan $Hutan_{Simulasi}$ = 96.3 million ha). However, if compared with the information of the Ministry of the Environment and Foresty (KLHK) and Documentation Management Officer (PPID) in 2019 related to Indonesian forested land, the simulations show a good model performance ($Hutan_{KLHK}$ = 94.1 million ha or 50% form the land total and $Hutan_{Simulasi}$ = 95.3 million ha or 50% from the land total). This is greatly influenced by the databases used as the simulation input, which is the land closure data from the KLHK.

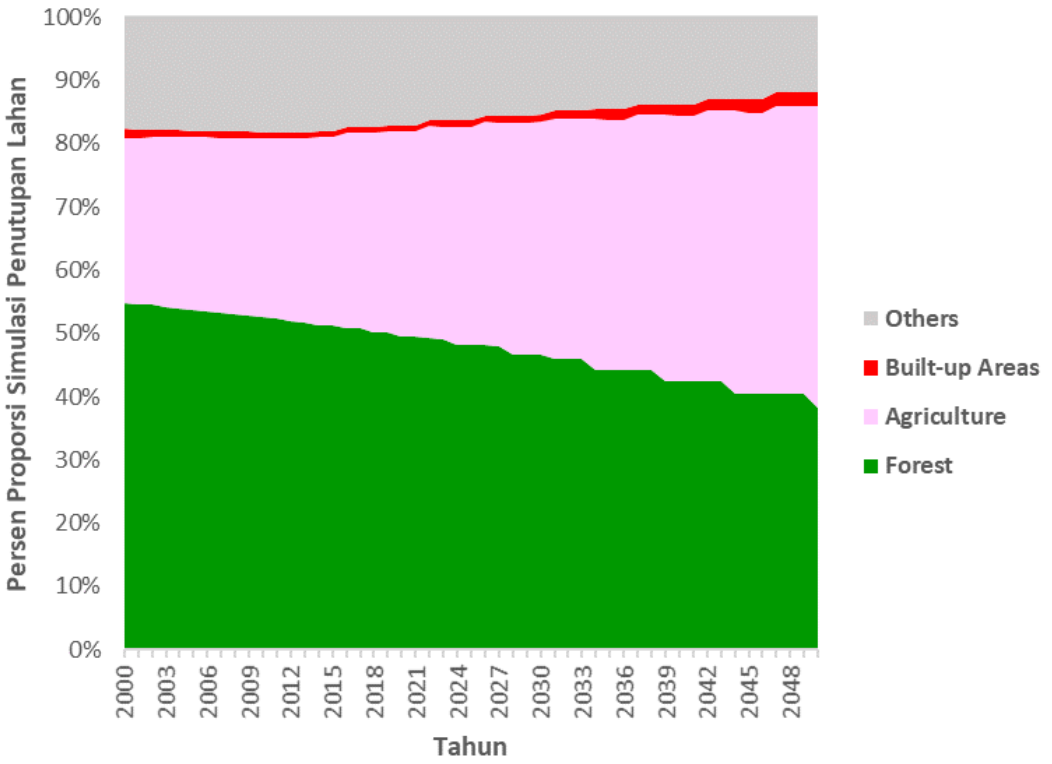
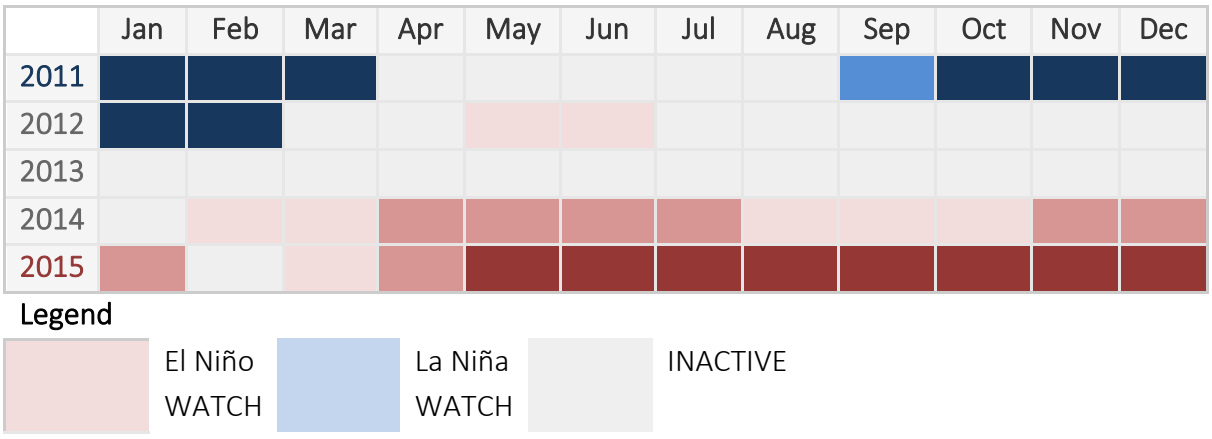


Figure 7: Simulation in the Changes of Land Closure in 2000-20150 According to Indonesia CLUEs models

Indonesia is recorded having about 55% forest closure in 2000 of total mainland. The simulation results showed a decrease in forest area from year to year gradually and an increase in the agricultural land area and established massively. Historical deforestation rate from 2000 to 2015 has a relatively high variation, from 302,500 ha/year to 1,062,500 ha/year with an average of 498,304 ha/year. The period of 2014 had the highest historical deforestation rate. This is associated with the oscillation phenomenon in the inter-seasonal Pacific, which is usually called ENSO (El Nino Southern Oscillation) that can increase the intensity of forest fire (Table 3).

Table 3 The History of El-Nino/La-Nina Climate Variability According to ENSO Outlook Bureau of Meteorological Organization Australia (BOM) in 2011-2015



In 2039-2042 there is a similarity between land use for agriculture and forest ecosystem that is 42% of the Indonesian land area. This simulation shows that the future of the Indonesian forests (in 2050) is very apprehensive. The remaining Indonesian forests in 2050 will be around 72.5 million ha or 38% of Indonesia's land area. Meanwhile, the area of agricultural land at that time reached 90.6 million ha, or 48% of Indonesia's land area. That point became an equilibrium point where the agricultural land area would be large than the natural forest area.

Box 1 Dynamics of Deforestation in Indonesian Province According to CLUEs Simulations

Specifically, to see the deforestation dynamics in Indonesia according to CLUEs simulation are shown in Figure 8. In figure 8 shows that eastern Indonesia, especially Papua and Maluku, has a great danger of deforestation. This research also can confirm that deforestation in Indonesia starts to shift in the eastern part of Indonesia due to the saturated support capability and forest resource capacity in the western region of Indonesia (Tsujino *et al*. 2016). The intensive attention related to development in the eastern area of Indonesia must be appropriately monitored because it can endanger the natural forests in eastern Indonesia, especially Papua. A previous study by FWI revealed that the current government regime had intensive infrastructure development in Papua based on the historical analysis of land closure change. Besides that, the interaction of indigenous people with Papua's forest is very intense. Thus, the natural forest conservation in Papua is equal to maintaining the indigenous people's welfare. Maluku (i.e., North Maluku and Maluku) also have a high potential loss of natural forests in 2050 (about 50% of forest will be lost), especially in the southeast of Halmahera, the coastal of Seram island, and the southern area of Aru islands. The potential deforestation on Kalimantan island is still relatively high because Kalimantan is a large area, and forest resources are relatively abundant. This can have a negative impact on the survival of biodiversity and environmental services in the world, especially in Indonesia (Dirzo *et al.*, 2014; Estrada *et al.*, 2018).

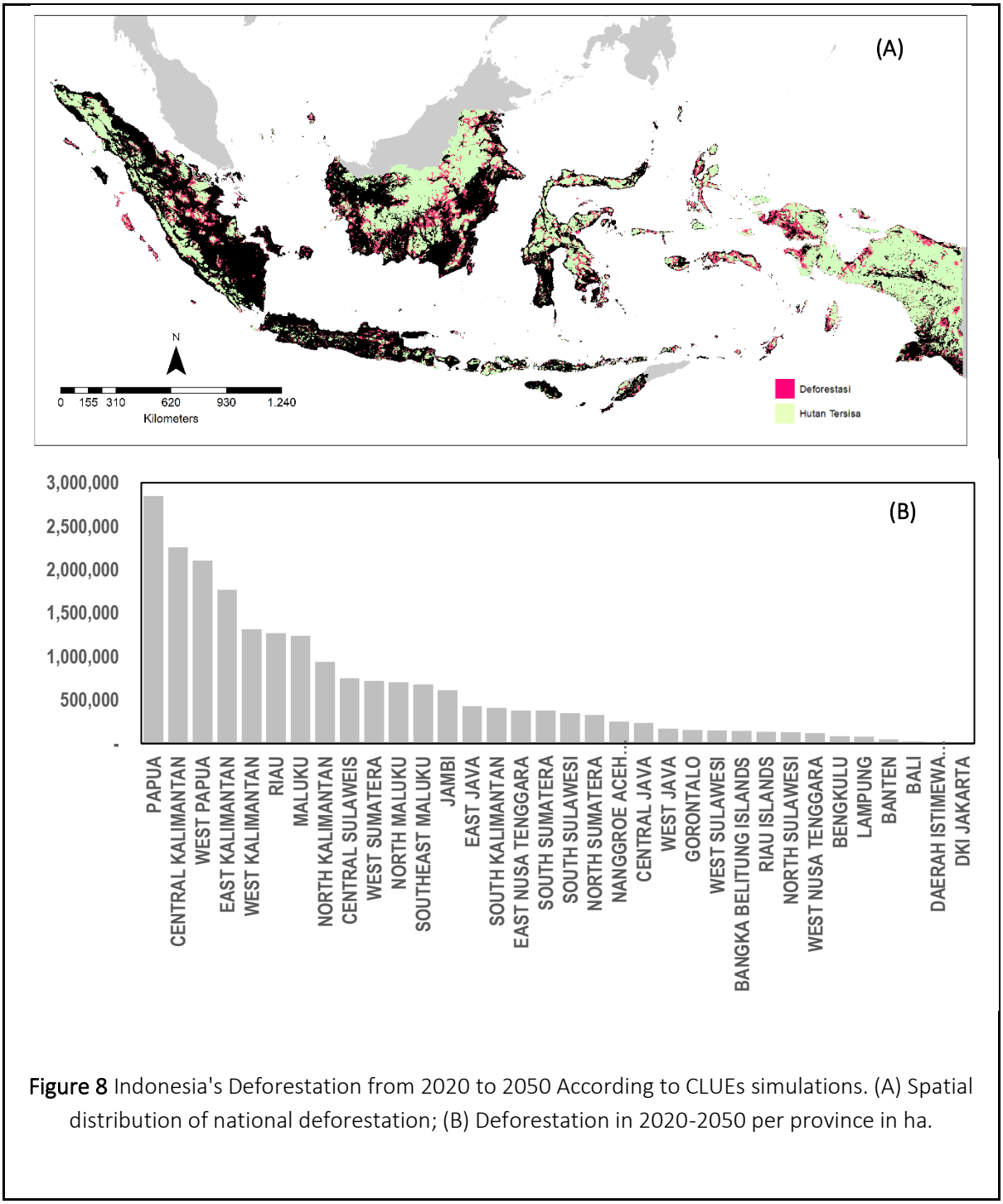


Figure 8 Indonesia's Deforestation from 2020 to 2050 According to CLUEs simulations. (A) Spatial distribution of national deforestation; (B) Deforestation in 2020-2050 per province in ha.

How will the contribution of the logging sector in the future (2020 - 2024) to the national economic target?

Based on the Strategic Planning of the Ministry of the Environment and Forestry (KLHK) in 2020-2024, the environmental and forestry sectors generally have a target in fulfilling the national GDP (Gross Domestic Product) from IDR 103 trillion to IDR 115 trillion. To achieve this target using historical analysis in the relationship between deforestation and contribution of the forestry sector, the forest area that should be deforested is 386,347 ha - 431,358 ha.

Meanwhile, the CLUEs simulation results show relatively high deforestation in 2020-2024, from 358,125 ha to 765,000 ha, and the highest deforestation was found in 2023 to 2024, reaching 765,000 ha/year. This means that there is a higher potential for deforestation when compared with the Strategic Plan target. Deforestation that occurred during these years had a relatively high contribution to the national GDP, which is IDR 95.48 trillion to IDR 203.95 trillion. The details in the contribution of forestry and logging sectors to national GDP can be seen in Table 4.

Table 4 Contribution of Forestry and Logging Sectors to National GDP and the Evaluation of Deforestation Related to National Economic Growth in the Future.

Years	Contribution of LHK Sectors on National GDP (Trillion Rupiahs)	The Deforestation Target to Reach the GDP Target (Ha)	Deforestation Simulation (Ha)	Estimation of Economic Benefits (Trillion Rupiahs)
2020	103	386.347	666.563	177,71
2021	106	397.599	521.875	139,13
2022	109	408.852	358.125	95,48
2023	112	420.105	765.000	203,95
2024	115	431.358	765.000	203,95

Based on the simulation results of BAU (Bussines as Usual), deforestation in Indonesia shows the contribution in obtaining economic benefits from IDR 177-204 trillion. It means that it exceeds the strategic planning target for the contribution of the forestry sector to the national GDP, also a larger deforested area. The greater value compared to the research results suggest that to achieve the target of economic growth, it is not necessary to excessively exploit natural resources, particularly forests, because forest ecosystems have high-value benefits in the economy and environmental services. Despite the impact of the COVID-19 pandemic caused an economic crisis, and the forestry sector also contributed significantly to national economic growth, it is also necessary to pay attention to the impact of deforestation in Indonesia.

What about Indonesia's commitment to reduce greenhouse gas emissions?

To reach the Sustainable Development Goals, especially SDG13 on Climate Action, Indonesia has been actively involved on a global scale as one of the countries that ratified the climate change convention through Law no. 6 of 1994 regarding the ratification of the UNFCCC (United Nations Framework Convention on Climate Change). After that, the Indonesian government has released Law no. 16 of 2016 regarding the Ratification of the Paris Agreement, which is elaborated with 9 priority actions of national development through the *Nawa Cita* for low carbon development and high climate resilience.[1].

[1] http://ditjenppi.menlhk.go.id/kcpi/index.php/tentang/amanat-perubahan-iklim/komitmen-indonesia

National Determined Contribution (NDC) is a commitment applied in Indonesia towards a low-emission and climate-resilient in the future. This is based on the Paris agreement on the network conventions of the United Nations regarding climate change. The contribution target applied by Indonesia is the decreasing emission of 29% on their efforts to 41% if there is an international cooperation of business as usual condition in 2030. There are two scenarios for mitigation commitment of climate change made outside the BAU that is CM 1 and CM 2. CM 1 does not have mitigation requirements so that resulting in an emission reduction of 29%. Therefore, CM2 must have mitigation requirements and be targeted to reduce the emission by 41%. These scenarios are established by the data of the baseline emission level in the Greenhouse Gas of 2010.

- The scenario of CM 1 or mitigation without requirement is conducted by Indonesia voluntarily without the help of other parties, and committed to reducing the emission by 29% in 2030. This scenario will be conducted through effective land use and spatial planning; sustainable forest management, including social forestry programs; restoring the function of degraded ecosystems including the wetland ecosystems; increase agricultural and fishery productivity; energy conservation, encouraging clean and renewable energy sources and improving waste management.
- The scenario of CM 2 that is more ambitious by the reducing emission of 41% has a dependency on international support in the transfer funding, the development of technology, and the increasing of capacity fairly with more complex fair and ambition.

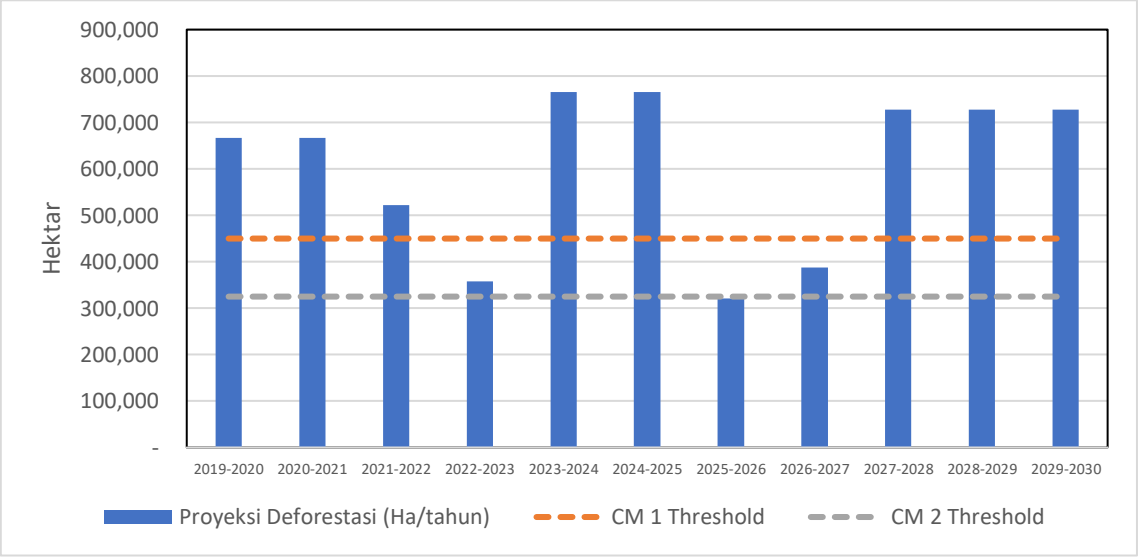


Figure 1 The balance of deforestation in Indonesia NDC scenario of CM 1 and CM 2 scenarios.

Based on the land closure data from the Ministry of the Environment and Forestry (KLHK), the remaining forest closure in Indonesia in 2018 was 88.53 million. This amount continued to decrease from 2013, which still left forest closure of KLHK through the Directorate

General of Climate Change (PPI). PPI target the decrease of deforestation to 450 thousand ha/year in 2013-2020 to fulfill the CM 1 agreement and 325 thousand ha/year for CM 2[2].

The simulation results of deforestation potential in Indonesia showed that in 2019-2030, there are only thirteen (2022-2023, 2025-2026, 2026-2027) annual deforestations under the threshold for the CM1 scenario. There is only 1-year annual deforestation fulfilling the CM2 scenario, which is in 2025-2026. This should be a warning for Indonesia not to overexploit the natural forest. Therefore, Indonesia's commitment to UNFCCC can be realized well. The simulation results show that the annual deforestation in Indonesia is still relatively high and has not reached the optimal target of NDC. Thus, the efforts to conserve the forest resources must be strengthened more.

On the other hand, if we see the target of Gross Domestic Product (GDP) in the forestry sector based on the strategic plan of KLHK in 2019-2024, the target of GDP made has considered the national contribution target in the emission reduction (NDC). It can be seen in Table 4, which estimates the forest area with potential deforestation to fulfill the GDP target in the forestry sectors that always under the deforestation threshold according to the CM1 scenario.

Conclusions

CLUEs simulation can be used as a good alarm and warning to explain the future of natural forests in Indonesia according to the historical changes and the policy applied in the study area. Based on AUC value, Random Forest surpass the two algorithms (i.e. CART and GLM) in the whole category of land closure tested, and the details are as follows: (AUC_{Forest} = 0.8797; $AUC_{Agriculture}$ = 0.8653; $AUC_{Buit\text{-}up\ areas}$ = 0.8504; dan AUC_{Others} = 0.7524). Some notes obtained from this study are:

1. The dynamics of Gross Domestic Product (GDP) in the forestry sector and logging have a high pattern similarity with the deforestation quarter data. The Pearson correlation between deforestation and GDP shows a relatively moderate relationship (p = 0.477). If reviewed based on the general variation of deforestation dynamics and PDB in 2019-2020, it can be concluded that Indonesia can obtain about 266.6 million Rupiahs per ha.
2. Deforestation in the period of 2020-2024 (Strategic Planning of KLHK) has a relatively high contribution to national GDP, which is about 95.48 trillion Rupiahs to 203.95 trillion Rupiahs. It indicates that massive deforestation still occurs in Indonesia. On the other hand, deforestation that will occur strongly can fulfill the target of the Environmental and Forestry (LHK) sectors on national GDP. Thus, excess exploitation will only drain the natural resources and decrease the ecosystem services in it.

[2] Study by Forest Watch Indonesia (2020) regarding NDC

3. The simulation results of deforestation show that in 2019-2030, there are only thirteen annual deforestations fulfilling the deforestation threshold for the CM1 scenario, and 1 year for the CM2 scenario that is in 2025-2026. It indicated that conservation efforts must be more intensified due to the relatively high deforestation in the simulation to fulfill the target determined.

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