DYNAMIC PROJECTION OF CLIMATE CHANGE SCENARIOS ON ABOVEGROUND CARBON STORAGE OF TROPICAL TREES IN WEST PAPUA, INDONESIA

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DYNAMIC PROJECTION OF CLIMATE CHANGE SCENARIOS ON ABOVEGROUND CARBON STORAGE OF TROPICAL TREES IN WEST PAPUA, INDONESIA. Through photosynthetic activities, tropical forest ecosystems capture and store the most significant carbon emissions in the form of biomass compared with other types of vegetation, and thus play a highly crucial part in dealing with climate change. However, such important role of tropical forest is very fragile from extreme changes in temperature and precipitation, because carbon storage in forest landscape is strongly related to those climate variables. This paper examines the impacts of future climate disturbances on aboveground carbon storage of three tropical tree species, namely *Myristic*a sp., *Palaquium* sp., and *Syzygium* sp. through "what if" scenarios evaluation using Structural Thinking and Experimental Learning Laboratory with Animation (STELLA). Results highlighted that when the dynamic simulation was running with five IPCC's climate change scenarios (Constant year 2000 concentrations, B1, A1T, A2, and A1F1) for 200 years simulation period, then moderate climate change scenarios occured, such as B1 and A1T, would have already caused significant statistical deviation to all of those tree species. At the worst level of A1F1, the 4°C temperature was coupled with 20% reduction in precipitation. *Palaquium* sp. showed the highest reduction of aboveground carbon storage with about 17.216% below its normal value. This finding implies the negative climate feedbacks should be considered seriously to ensure the accuracy of long term forest carbon accounting under future climate uncertainty.

Keywords: Climate change, aboveground carbon storage, West Papua, STELLA

PROYEKSI DINAMIS BERBAGAI SKENARIO PERUBAHAN IKLIM TERHADAP SIMPANAN KARBON DI ATAS PERMUKAAN TANAH PADA BERAGAM JENIS POHON TROPIS DI PAPUA BARAT, INDONESIA. Melalui fotosintesis, ekosistem hutan menangkap dan menyimpan emisi karbon dalam bentuk biomassa yang paling besar dibandingkan dengan jenis vegetasi lain, dan memainkan peran yang sangat penting dalam menangani perubahan iklim. Namun demikian, peran penting tersebut secara signifikan dapat terganggu oleh perubahan temperatur dan curah hujan yang ekstrem karena penyimpanan karbon di lanskap hutan sangat terkait dengan variabel iklim tersebut. Tulisan ini mempelajari dampak gangguan iklim di masa depan pada penyimpanan karbon di atas tanah pada tiga spesies pohon tropis, yaitu Myristica *sp.,* Palaquium *sp., dan* Syzygium *sp. melalui evaluasi skenario "bagaimana jika" berbasis STELLA. Hasil penelitian menunjukkan bahwa ketika simulasi dinamis dijalankan mengikuti lima skenario perubahan iklim oleh IPCC untuk periode simulasi 200 tahun, terlihat bahwa skenario moderat, seperti B1 dan A1T, telah menyebabkan simpangan yang signifikan untuk ketiga spesies pohon tropis tersebut. Pada skenario terburuk A1F1 (kenaikan suhu 4°C ditambah dengan pengurangan 20% curah hujan), pohon dari spesies* Palaquium *sp. memperlihatkan tingkat penurunan tertinggi pada simpanan karbon di atas tanah dengan sekitar 17,216% kurang dari nilai normalnya. Hal ini menunjukkan bahwa umpan balik negatif dari perubahan iklim harus diperhitungkan untuk memastikan keakuratan penghitungan karbon hutan jangka panjang di bawah ketidakpastian iklim di masa depan.*

Kata kunci: Perubahan iklim, simpanan karbon diatas tanah, Papua Barat, STELLA

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I. INTRODUCTION

It has been widely recognized that carbon dioxide (CO_2) constitutes for more than half of the total anthropogenic greenhouse gasses emissions. Through photosynthesis procedures, tropical forest ecosystems capture and store the most significant carbon emissions in the form of biomass compared with other types of vegetation, and thus it plays a highly crucial part in dealing with climate change. As reported by Sha et al. (2015), about 55% of annual net primary production of biomass across the globe is estimated to take place in the tropics. Nevertheless, some authors, such as Ricker, Gutiérrez-García, and Daly (2007); Dai et al. (2014); and Ma et al. (2014), have noted that such important role of tropical forest is very vulrnerable to extreme changes in temperature and precipitation since carbon storage in forest landscape is much related to those climate variables. Dai et al. (2014) also added how the changes in temperature and/or precipitation will drive carbon dynamics in forest ecosystem.

Nowadays, what is alarming is that the earth's mean temperature has already increased by 0.6°C over the last 100 years, and that further climate change may raise global temperature within the next century by another 4°C (Intergovernmental Panel on Climate Change [IPCC], 2007). Therefore, there is a need to assess how the carbon dynamics of tropical trees may react to climate change as the report has also suggested a negative impact of warming in tropical forests from decreased photosynthetic activity.

Previously, some researchers have carried out studies related to climate influence on carbon accumulation in forest ecosystems. Hunter (2015) assessed the influences of temperature and rainfall on carbon stocks across Northeastern part of New South Wales, Australia, while Limbu and Koirala (2017) examined the climate influence at different altitudinal gradients on both below and aboveground carbon storage. Recently, Ma et al. (2014) predicted the impacts of climate change on aboveground carbon storage rate in Northeastern China. Stinziano and Way, (2014) evaluated the effect of rising temperature on boreal forest. Meanwhile, climate sensitivity of Mediterranean landscape has been investigated by Touchan, Shishov, Meko, Nouiri, and Grachev (2012). Although all of those studies provide important information on the relation between changing climate variables and carbon storage, however, the dynamics of aboveground carbon storage of tropical trees in the eastern part of Indonesia under climate change scenarios are still unclear. Many other researchers had also examined how the carbon stock and biomass accumulation were assessed either using terrestrial or remotely sensed data (Jaya et al., 2012, Achmad, Jaya, Saleh, & Kuncahyo, 2013; Jaya, 2014).

According to Dominati, Patterson, and Mackay (2010), insufficient knowledge of carbon storage as ecosystem dynamic flow processes may result in the absence of a systematic and flexible method to manage and plan the ecosystem, so that temporal study and analysis of dynamic change of ecosystem service is necessary. Furthermore, Dean, Roxburgh, and Mackey (2003) and Oni, Dillon, Metcalfe, and Futter (2012) contend that dynamic flow modeling and its corresponding analyses are essential in providing a baseline and "what if" scenarios for evaluating effects related to climate disturbances. This paper examines the impacts of future climate disturbances on aboveground carbon storage of three tropical tree species, namely *Myristica* sp., *Palaquium* sp. and *Syzygium* sp. through "what if" scenarios evaluation using Structural Thinking and Experimental Learning Laboratory with Animation (STELLA).

II. MATERIAL AND METHOD

A. Study Site

As depicted in Figure 1, this study was conducted in a concession forest area managed by PT. Manokwari Mandiri Lestari in Teluk Bintuni Regency, West Papua (1057'50"-3011'26" S; 132044'59"-134014'49" E).

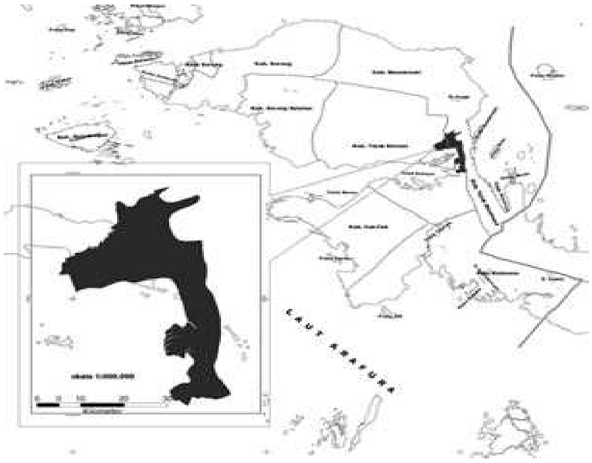


Figure 1. Research site map

This research area is mainly hilly and located about 500 meters above sea level with average humidity approximately 85%. There are three main soil types in the area, namely alluvial, gleysol and podzolic.

B. Model Conceptualization, Calibration and Projection

As shown in Figure 2, dynamic model structure for simulating relationship between local climate variables and carbon storage in this study was developed using STELLA 9.12, which is principally an object-oriented modeling and simulation software. Algorithm details of this dynamic model are shown in Appendix 1. Conceptually, in this study there are two step sectors in the whole process of carbon sequestration flow structure, which are carbon capture and carbon storage that can last for a long period. Carbon capture refers to the uptake of CO_2 from the atmosphere through photosynthetic mechanism and its conversion to biomass, whilst carbon storage refers to the preservation of carbon as biomass in the components of corresponding trees (Sha et al., 2015).

Firstly, in carbon capture sector, through photosynthesis, vegetation converts carbon from the atmosphere to carbohydrate and stores it in different tree organs. This process of carbon capture is related to the process of tree growth (Sha et al., 2015), and it is influenced by climatic factors, particularly temperature and precipitation rate (Theurillat & Guisan, 2001; Laubhann, Sterba, Reinds, & Vries, 2009; Allen et al., 2010). In this study, the value of tree growth as a function of time was adjusted based on the value of annual increment calculated by Wahyudi and Anwar (2013), in which *Palaquium* sp. was grouped into harvested commercial species, while both *Myristica* sp. and *Syzygium* sp. were grouped into other commercial un-harvested species, as depicted in Table 1. Although in their study, Wahyudi and Anwar (2013) have used the term Mean Annual Increment (MAI), however, according to several other studies such as Vanclay (1994), Avery and Harold (2002), and Pretzsch (2009), it seems that the term Periodic Annual Increment (PAI) is more relevant to represent the growth of tree species in natural forest because basically there is no age information for those natural tree species.

Obtained PAI data, as illustrated in Table 1, were then used to estimate the tree growth period (TGP) for each DBH class. For the beginning of the growth period, due to the unavailability of PAI data for DBH class less than 10 cm, the simulation at year 0 was set using initial DBH of 10 cm. From that point forward, TGP was calculated by dividing the interval of each DBH class (cm) with its corresponding PAI (cm/year) as depicted in Table 2.

Afterwards, biomass accumulation into the

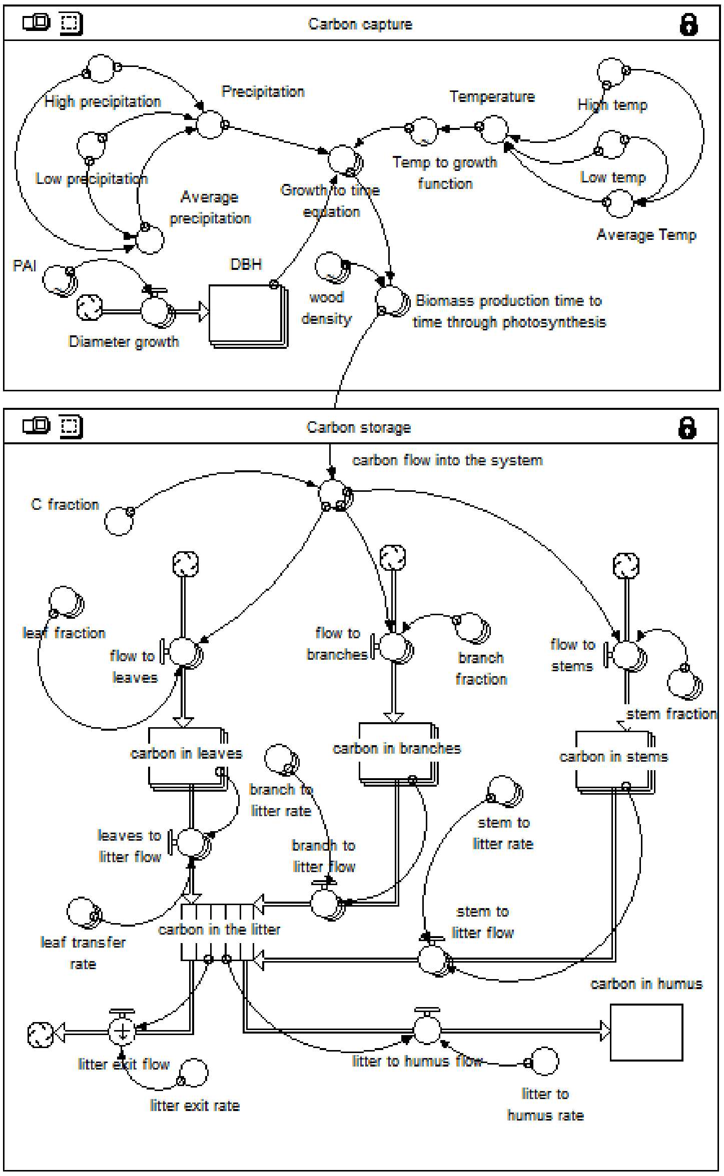


Figure 2. Model structure for simulating climate variables and carbon flows

system through photosynthetic activity was calibrated using locally developed allometric formula (Equation 1), which was specifically designed for mixed tree species in the research area by Maulana, Wibisono, and Utomo (2016).

$$Log(TAGB) = -0.267 + 2.23Log(DBH) + 0.649Log(WD) \quad ...(1)$$

where:

TAGB = total aboveground biomass (kg/tree)
DBH = diameter at breast height (cm)
WD = wood density or specific gravity (gr/cm^3)

In the meantime, in order to obtain values of wood density (WD) and biomass fractions allocated to leaves, branches and stems, harvest method was applied to 31 trees of *Myristica* sp., *Palaquium* sp. and *Syzygium* sp. Compared to wood density values from Soerianegara and Lemmens (1993), and Lemmens, Soerianegara, and Wong (1995), results of measurements in this study is shown in Figure 3. It illustrates a highly rational wood density for each species since it is mentioned that the range of wood density for *Myristica* sp., *Palaquium* sp., and *Syzygium* sp. are 0.40-0.65 gr/cm^3, 0.45-0.51 gr/cm^3, 0.56-0.83 gr/cm^3 respectively.

Moving on to the second sector of

Table 1. Tree growth

DBH Class (cm)	*Palaquium* sp.	*Myristica* sp.	*Syzygium* sp.
	PAI (cm/year)	PAI (cm/year)	PAI (cm/year)
10-19	0.2158	0.2108	0.2108
20-29	0.3408	0.3458	0.3458
30-39	0.4058	0.4208	0.4208
40-49	0.4108	0.4358	0.4358
50-59	0.3558	0.3908	0.3908
>60	0.2408	0.2858	0.2858

Source: Wahyudi and Anwar (2013)

Table 2. Calculation of Tree Growth Period (TGP) and its simulation time step

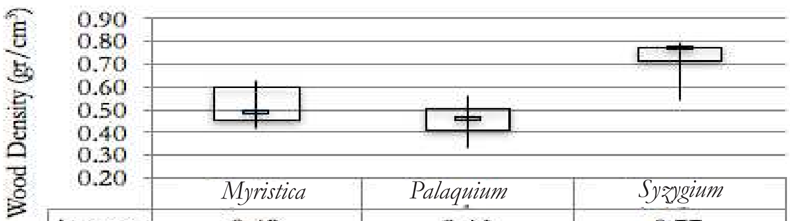
DBH class		10-19 cm	20-29 cm	30-39 cm	40-49 cm	50-59 cm	>60cm
TGP calculation		(19-10)/PAI	(29-20)/PAI	(39-30)/PAI	(49-40)/PAI	(59-50)/PAI	
Palaquium sp.	TGP	42 years	26 years	22 years	22 years	25 years	≥ year 142
	Time step	year 1 to 42	year 43 to 69	year 70 to 92	year 93 to 115	year 116 to 141	
Myristica sp.	TGP	43 years	26 years	21 years	21 years	23 years	≥ year 139
	Time step	year 1 to 43	year 44 to 70	year 71 to 92	year 93 to 114	year 115 to 138	
Syzygium sp.	TGP	43 years	26 years	21 years	21 years	23 years	≥ year 139

carbon storage, carbon influx is split in three directions, namely stems, branches and leaves. As depicted in Figure 4, result from destructive measurements to obtain biomass fraction for each species adapted from Maulana et al. (2016) have illustrated the major biomass storage in a tree, followed by branches and leaves. Meanwhile, carbon content in tree components was determined using biomass to carbon ratio value established by Hairiah and Rahayu (2007) that was 46%, so that carbon quantity in each component was defined by multiplying the dry weight of corresponding components by the percentage of carbon amount.

Calibration for carbon flow into the system and litter flow rate were conducted repeatedly until there was no significant difference between actual storage value approximation and dynamic modelling results based on the value of two samples t-test using MINITAB 14.0 software. In this study, actual carbon storage value approximation is defined as the value of total aboveground carbon stored in trees over time approached solely based on local allometric formula (Equation 1) using DBH adjusted by diameter growth periodic calculation and WD from field measurement. On the other hand, dynamic modeling carbon storage value is defined as the value of total aboveground carbon stored in tree over time calculated based on STELLA dynamic model structure as depicted in Figure 2.

Initial dynamic simulation was set based on climate time series data of perceived temperature and precipitation for the last decade (2005-2015) that were supplied by the National Climatic Data Center (NCDC) from its nearest climate station in Teluk Bintuni Regency, West Papua. The trends of these climate variables data are illustrated in Figure 5. According to these climatic trends, the annual range of temperature and precipitation in the research area were about 22.9°C to 31.5°C and 1042.7 mm/year to 3333.5 m/year respectively.

Subsequently, projections toward future probabilities of climate disturbances were



	Myristica	*Palaquium*	*Syzygium*
Average	0.49	0.46	0.77
Q1	0.45	0.41	0.72
Min	0.41	0.33	0.54
Max	0.63	0.56	0.80
Q3	0.60	0.50	0.78

Figure 3. Measured wood density

Table 3. Scenarios of future climate conditions at the end of 21st century (2090-2099)

Scenario	Temperature increase (°C)		Precipitation change
	Best estimate	Likely range	Average
Constant year 2000 concentrations	0.6	0.3-0.9	
B1	1.8	1.1-2.9	-20%
A1T	2.4	1.4-3.8	
A2	3.4	2.0-5.4	
A1FI	4.0	2.4-6.4	

Source: Intergovernmental Panel on Climate Change [IPCC] (2000)

conducted using scenarios described in Special Report on Emission Scenarios (SRES) by Intergovernmental Panel on Climate Change [IPCC] (2000). Details on climate scenarios involved in this study are depicted in Table 3. Overall, according to Intergovernmental Panel on Climate Change [IPCC] (2000), the first scenario (year 2000) is constant assumes that greenhouse gases concentration is held fixed at year 2000 levels. Hence, this scenario put the lowest projection of temperature increase at 0.6°C. The B2 scenario describes a world with less rapid economic and population development due to increasing attention to environmental sustainability. The A1T scenario illustrates a future world with rapid introduction of new technologies of non-fossil energy sources. The A2 scenario considers fragmented technological and economic development. Lastly, The A1FI scenario puts more emphasis on the intensive development of fossil fuel based industries, so that this scenario gets the highest estimate of temperature increase of 4°C. In the meantime, as suggested in Gardner and Urban (2003), in order to examine the impact of future climate disturbances on carbon storage of each species, results from dynamic simulations based on IPCC scenarios were then compared to results of their dynamic modelling of actual carbon storage harnessing their percentage value of deviation (Equation 2), while statistically examined based on paired t-test mechanism.

$$S = 100 * \left(\frac{\sum_{i=1}^{n} D_i - \sum_{i=1}^{n} B_i}{\sum_{i=1}^{n} B_i} \right) \qquad \text{.........................(2)}$$

where:

S = percentage value of deviation

B_i = dynamic modeling of actual carbon stored in tree-i

D_i = its projection based on IPCC scenario set in the dynamic model

n = number of observations

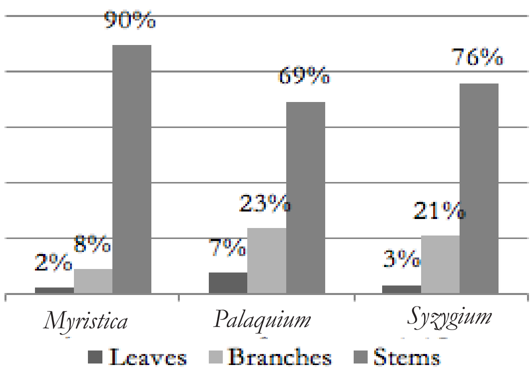


Figure 4. Observed biomass fraction (Source: adapted from Maulana et al., 2016)

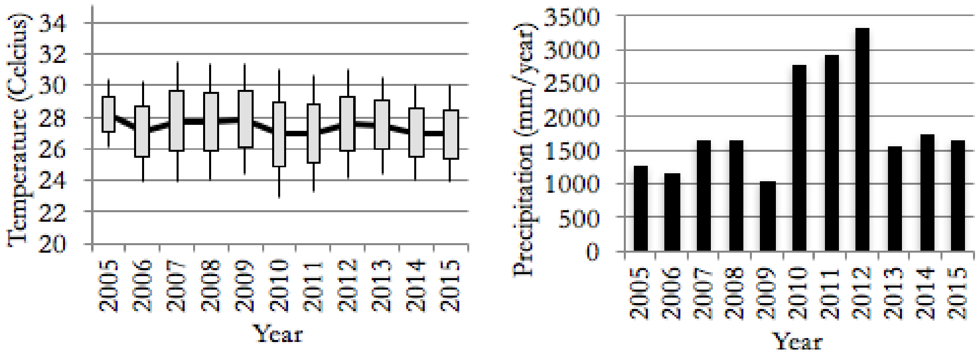


Figure 5. Baseline data for temperature and precipitation as observed by NCDC

III. RESULT AND DISCUSSION

A. Actual Approximation vs Dynamic Modeling of C Storage at Baseline Condition

To assess the accuracy and enhance projection confidence for future "what if" scenarios as described in Bugmann (2001) and Ford (2010), actual approximations of carbon storage for each species were initially evaluated against its corresponding dynamic modelling result set at baseline conditions. This evaluation is essential to show that there was no significant difference between actual carbon sequestered by the system and its dynamic estimation (Gardner & Urban, 2003; Ford, 2010).

In the previous study, the prototypes were also assessed by using some calculations for cost analysis. The result of the calculation for both prototypes is given in Table 4.

As depicted in Table 4, the result of t-test, shows that t-values are significantly below their t-table at 95% confidence interval; and P-values (P>0.05) also indicate weak evidence against the null hypothesis (H_0). This implies that H_0 (dynamic modelling is close to the actual approximation of carbon storage, expressing that for each species) are statistically accepted (Gardner & Urban, 2003). In addition, values of Pearson correlation test (r) between approximation and its corresponding dynamic modelling of actual storage for each species shows a very high and positive correlation. As illustrated in Figure 6, the overall trends of carbon storage for each species formed a common rough sigmoid shaped growth curve, showing that the carbon amount stored increases fast in their early age, while later this trend tends to gradually slow down due to the decrease in carbon capture.

Table 4. Statistical tests for actual approximation vs dynamic modeling of C storage

Species	Group comparison	t-test at 95% confidence interval						
		Mean	SE Mean	DF	t-table	t-value	p-value	r
Myristica sp.	Actual proxy	839	51	397	1.985	0.46	0.647	0.99
	Dynamic modeling	806	50					
Palaquium sp.	Actual proxy	754	45	397	1.985	0.47	0.639	0.99
	Dynamic modeling	725	44					
Syzygium sp.	Actual proxy	1019	60	397	1.985	0.48	0.634	0.99

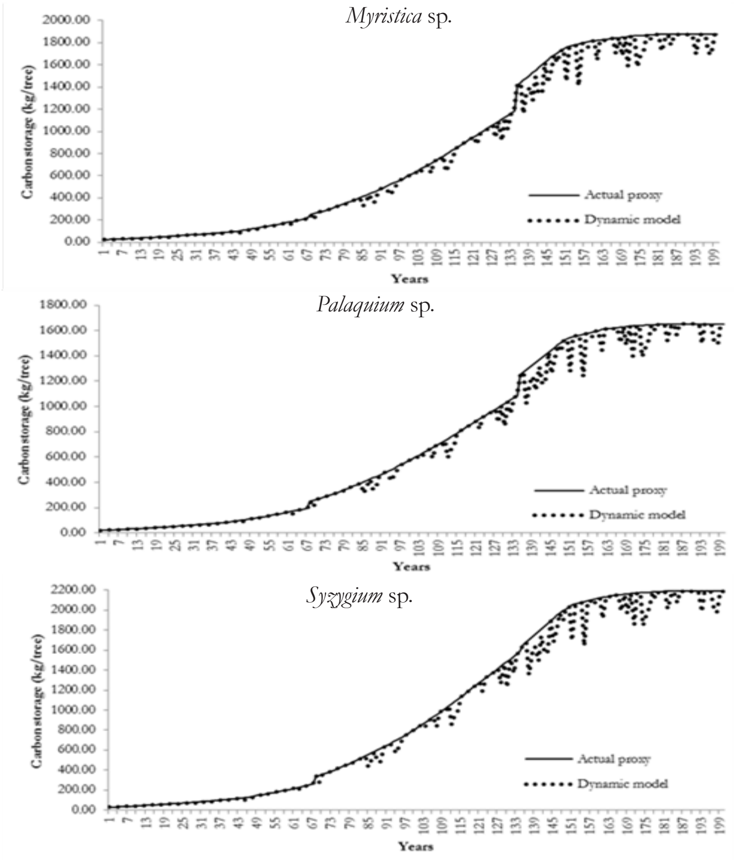


Figure 6. Actual approximation vs dynamic modeling of C storage at baseline condition

B. Dynamic Projections of Future C Storage Based on IPCC Scenarios

In general, as illustrated in Figure 7, 8 and 9, there were dynamic fluctuations of carbon storage for each species when climate parameters within the dynamic model were set following future scenarios as described in Intergovernmental Panel on Climate Change [IPCC] (2000). At first, the aboveground carbon storage for each tree species were relatively stable when the model was run based on the "constant year 2000 concentrations" scenario, where the assumption was a 0.6°C temperature increase and about 20% precipitation decrease. Nevertheless, from that point forward, the aboveground carbon stored in the system generally started to decrease when the climate parameters were adjusted to more extreme scenarios, namely B1, AIT, A2, and A1FI. This kind of fluctuation may occur since at warmer temperature and lower precipitation compared to normal condition, broadleaf trees tend to decrease their photosynthetic productivity while increase littering pace to sustain their metabolism equilibrium which eventually hamper their growth and reduce carbon storage capacity (Heimann & Reichstein, 2008; Omeja, Obua, Rwetsiba, & Chapman, 2012; Wang, Duan, & Zhang, 2012).

To sum up, the detailed projections of Intergovernmental Panel on Climate Change [IPCC] (2000) climate scenarios on carbon storage for each species from Figure 7, 8 and 9 are shown in Table 5. This table, apparently describes that future rise in temperature and decrease in precipitation rate will reduce carbon storage capacity for all species. Furthermore, climate change will cause the largest impact in scenario A1F1 where there is 4°C increase in temperature range coupled with 20% reduction in precipitation. At this scenario, aboveground carbon stored in the trees from species of *Myristica* sp., *Palaquium* sp., and *Syzygium* sp. will decrease approximately 17.213%, 17.216% and 16.062% respectively during 200 years of simulation period.

Figure 10 shows the projection of C storage, derived from Table 4. It is clearly shown that *Myristica* sp., *Palaquium* sp., and *Syzygium* sp. are becoming more vulnerable when climate scenario worsens. Moderate climate change scenarios, such as B1 and A1T, have already brought significant statistical deviation to all of those species. In addition to this, looking at

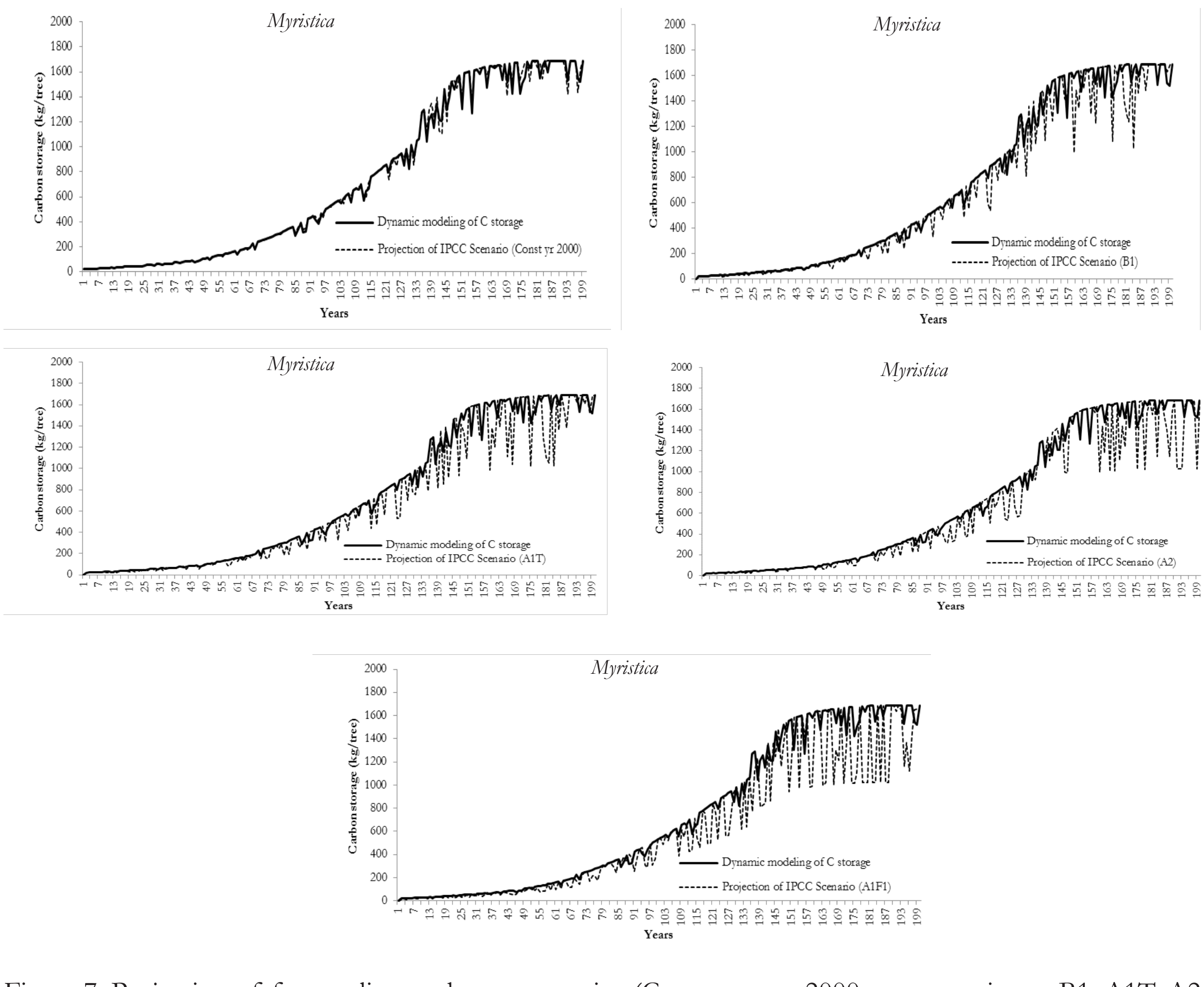


Figure 7. Projection of future climate change scenarios (Constant year 2000 concentrations, B1, A1T, A2, A1F1) on carbon storage of *Myristica* sp. for 200 years simulation period

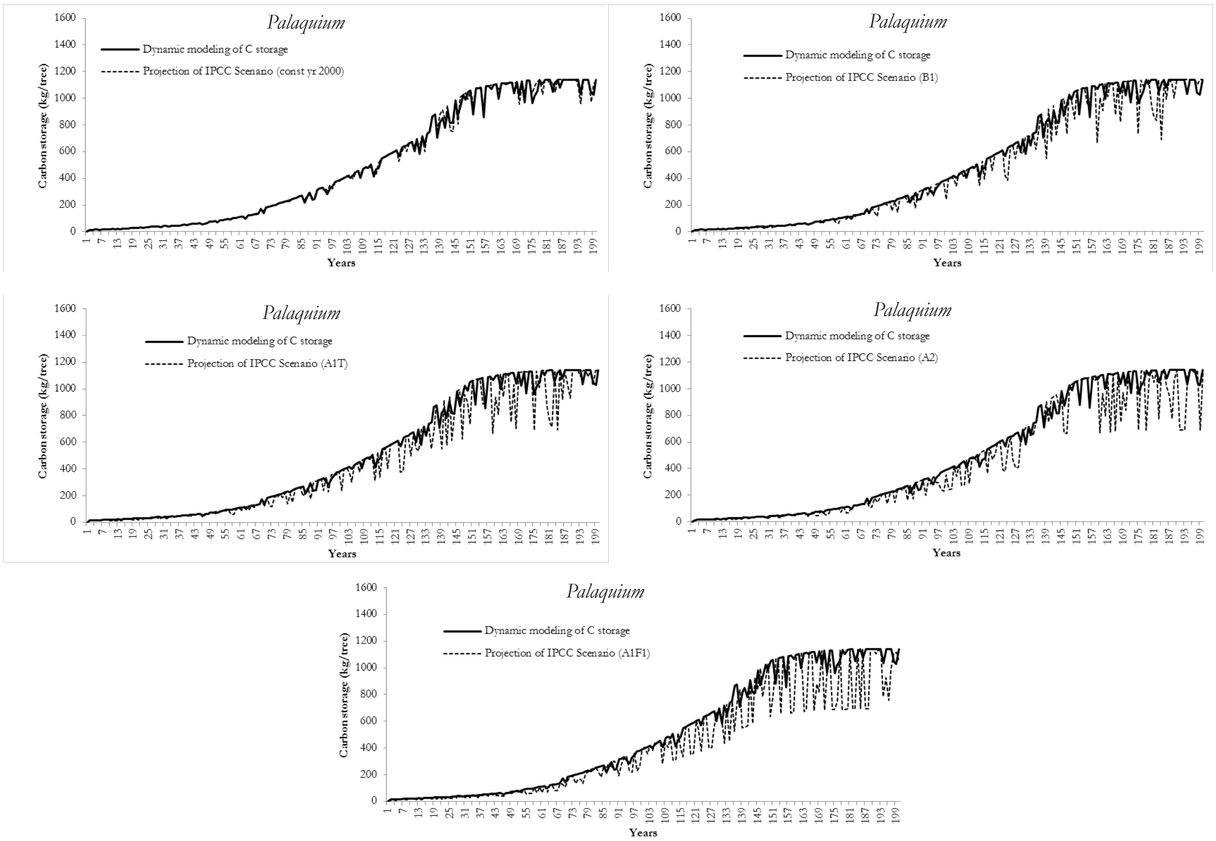


Figure 8. Projection of future climate change scenarios (Constant year 2000 concentrations, B1, A1T, A2, A1F1) on carbon storage of *Palaquium* sp. for 200 years simulation period

the more extreme climate scenario of A2 and A1F1, it seems that *Syzygium* sp. has the lowest decrease in carbon storage, while *Palaquium* sp. tends to produce the highest rate of decrease compared to the two other trees species. This finding is in agreement with several previous studies which have showed that the growth and productivity of many broadleaf trees with the lowest wood density value among their corresponding groups, is more vulnerable when temperature becomes warmer (Bennett et al., 2013; Coops & Waring, 2011; Subedi & Sharma, 2013; Hu, Su, Li, Li, & Ke, 2015). Taking into account of this notion, compared to *Myristica* sp. and *Syzygium* sp. (Table 5, Figure 3), *Palaquium* sp. has the lowest range of wood density with only 0.33 – 0.56 gr/cm^3 in contrast with *Syzygium* sp. that has the highest range of wood density with about 0.54 – 0.80 gr/cm^3.

This study noted that although the simulation findings may provide a feasible approach to analyze model dynamics, however, it should be kept in mind that the simulation aboveground carbon storage on various climate change scenarios are complex flow processes. The users may improve the accuracy of the dynamic model by appropriately considering the possible shortcomings, particularly in regard to tree growth calculation. Looking at the periodical annual increment of each tree species (Table 1), it seems that the growth rate are too slow and there is no obvious annual increment difference among them. The PAI for *Palaquium* sp. is only limited to 0.22 – 0.41 cm/year, while *Myristica* sp. and *Syzygium* sp. is about 0.21 – 0.43 cm/year. Those relatively small annual increments have also been reported by other studies, such as Santoso (2008), and Wahjono and Anwar (2008), who conducted measurements on permanent sample plots (PSPs) in 199

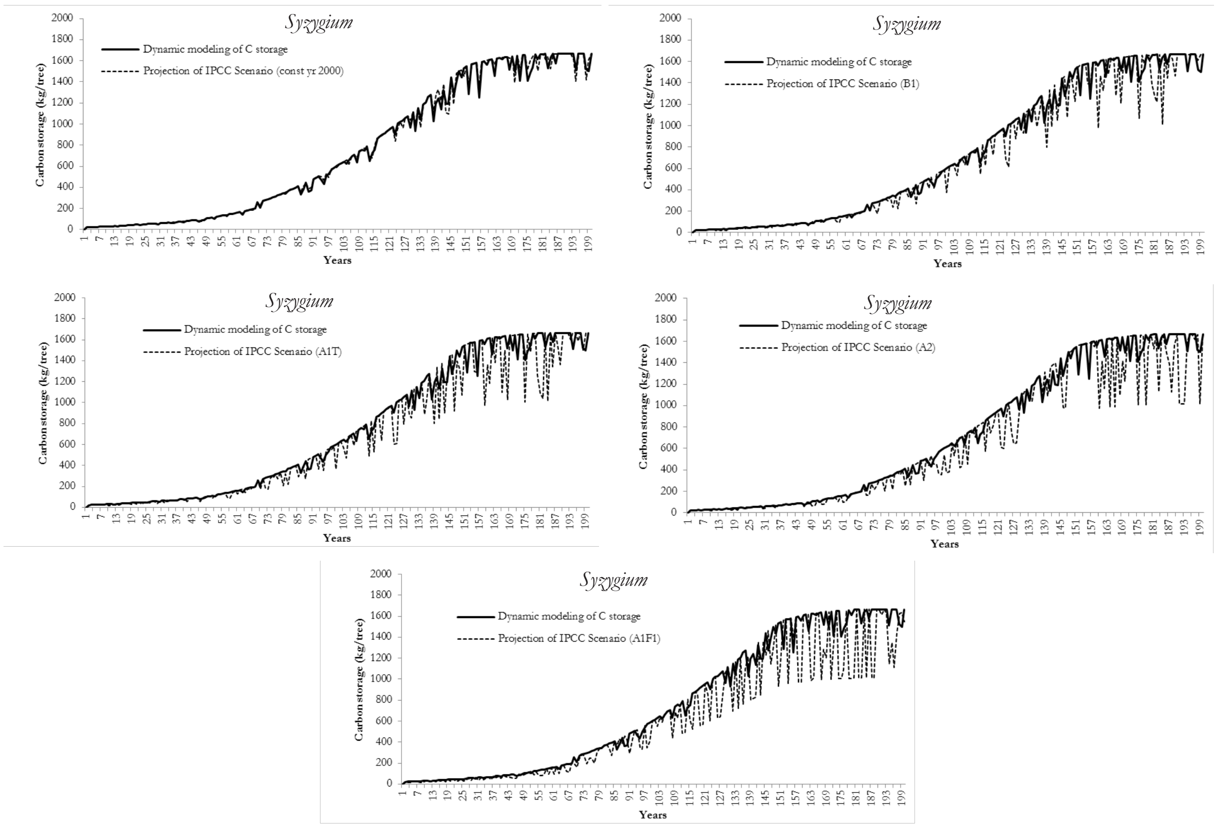


Figure 9. Projection of future climate change scenarios (Constant year 2000 concentrations, B1, A1T, A2, A1F1) on carbon storage of *Syzygium* sp. for 200 years simulation period

forest consessions across Indonesia. Although the use of tree growth data obtained from permanent sample plots (PSPs) of other studies, as mentioned in the methodology of this study, may inflict bias, however, this kind of approach should be considered as an acceptable alternative because detecting trends in tree growth over natural forest stands is not so simple (Bowman, Brienen, Gloor, Phillips, & Prior, 2013). In practice, measuring tree growth in PSPs of natural forest are indeed not only very time-consuming to conduct, but also highly logistically demanding since they are often located in remote species rich forets areas (Bowman et al., 2013; Weiskittel, Hann, Kershaw, & Vanclay, 2011).

IV. CONCLUSION

From the previous discussion, the following conclusions can be derived. When the dynamic simulation was run the five IPCC's climate change scenarios (Constant year 2000 concentrations, B1, A1T, A2, and A1F1) for a simulation period of 200 years, the aboveground carbon stored in tree species of *Myristica* sp., *Palaquium* sp., and *Syzygium* sp. will generally decrease. The moderate climate change scenarios, such as B1 and A1T, have already brought significant statistical deviation to all of those tree species. At the worst level of scenario A1F1 (4°C temperature increase coupled with 20% reduction in precipitation), the *Palaquium* sp. may suffer from the highest degree of reduction of aboveground carbon storage with about 17.216% below its normal value. The *Palaquium* sp. has the lowest range of wood density with only 0.33-0.56 gr/cm^3 compared to *Myristica* sp. and *Syzygium* sp. The study concludes that climate negative feedbacks should be considered to ensure the accuracy of long term forest carbon accounting under future climate uncertainties.

Table 5. C storage deviation based on IPCC SRES climate scenarios

Species		IPCC SRES Scenarios				
		Const yr 2000	B1	A1T	A2	A1F1
Myristica sp.	Deviation (S)	0.590%	-3.687%	-6.622%	-8.773%	-17.213%
	t-value at 95% CI	-1.70	3.25**	4.84***	5.04***	7.14***
	t-table (DF: 199; CI: 95%)	1.98	1.98	1.98	1.98	1.98
	p-value	0.090	0.001	<0.001	<0.001	<0.001
Palaquium sp.	Deviation (S)	0.589%	-3.687%	-6.622%	-8.777%	-17.216%
	t-value at 95% CI	-1.72	3.29**	4.90***	5.13***	7.23***
	t-table (DF: 199; CI: 95%)	1.98	1.98	1.98	1.98	1.98
	p-value	0.086	0.001	<0.001	<0.001	<0.001
Syzygium sp.	Deviation (S)	0.590%	-3.686%	-6.621%	-8.776%	-16.062%
	t-value at 95% CI	-1.71	3.32**	4.94***	5.17***	7.28***
	t-table (DF: 199; CI: 95%)	1.98	1.98	1.98	1.98	1.98
	p-value	0.089	0.001	<0.001	<0.001	<0.001

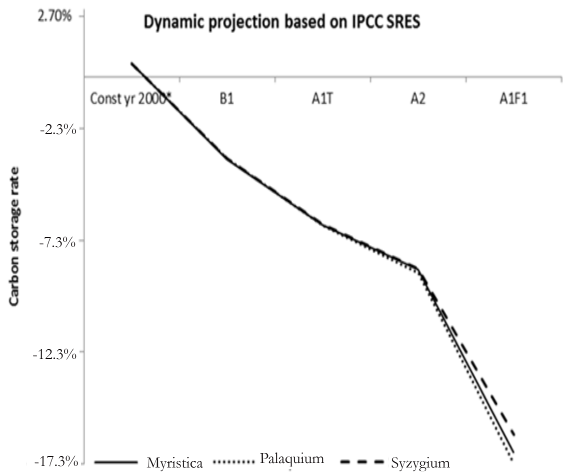


Figure 10. Trend of C storage deviation based on IPCC SRES climate scenarios

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