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IMPACT OF MANAGEMENT POLICY ON DIRECT DRIVERS OF DEFORESTATION IN MALAYSIA

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Abstract: Deforestation is one of the incredible difficulties confronting mankind. The extraction of woods remains one of the main drivers of deforestation in Malaysia. Relatively, rising in timber values may lead to enlarge in the net advantages of clearing land. Thus, this study is written to assess the process and underlying causes of forest cover change in Malaysia from 1997 to 2016. After assessed the discusses it on the impact of direct drivers with different management scenarios on deforestation in Malaysia. The research design, data, and method also performed by using System Simulation Model. Model validation and sensitivity tests was carried out after the simulation model is implemented to check the correctness in line with the real system. The simulation analysis was carried out with three different simulation periods together with the impact of two main policies: (1) controlling threshold profit; (2) discounted rate. The result of the study indicates that the most suitable policy combination to manage the deforestation is scenario 2 (policy 2B) with the RM650 per/ha threshold profit coupled with interest rate r=4% within 50years period.

Keywords: Deforestation, direct driver, management policy, system Simulation model, Malaysia.

Introduction

Deforestation prescribes as learning virgin forests or considered shattering or elimination of trees and other vegetation for the purpose of cultivation, retailing, construction without replanting the trees and also fail to grant time for the forest to revitalize itself (Adeoye & Ayeni, 2011; Armenteras, *et al.,* 2017). Malaysia has about 20 million ha of forested area, which is roughly in the range of 62% of forest cover. Though, Malaysia had the world's most excessive rate of forest lost in the range between 2000- 2012 (Butler, 2013). It's about 14.4% of forest cover has been loss by the year of 2000 which is equivalent to 47,278 of square kilometres. Research by Keenan *et al. (*2015), supports that deforestation is a transformation woodland to a replacement undying non forested land-use for cultivation, cropping and for urban advancement purposes. Deforestation is essentially a worry for the creating nations of the tropics as it is contracting territories of the tropical woods causing loss of biodiversity and improving the glasshouse impact. The drivers of forest depletion differentiate between direct (proximate) drivers and indirect (underlying) drivers. Fundamental drivers are multiplex of social, monetary, political, social, statistic, and mechanical procedures that outcome in the immediate drivers causing deforestation. While the underlying drivers are demographic factors, economic factors, technological factors and cultural factors.

This deforestation is one of the provocations overlook by the forest sector in Malaysia. Hence, this analysis is proposed to detect the deforestation using direct drivers in which changes of forest due to some direct agents such as agriculture expansion, wood extraction and infrastructure expansion. A main purpose behind concentrating on these elements is that they appear awesome variety all through creating nations. various investigations recognize agriculture extension as the major proximate reason for tropical deforestation in Malaysia especially for commercial purposes. The expanding interest for agriculture items on the worldwide market has driven deforestation. Atmosphere and soils are the fundamental limitations to agriculture and there can also be extreme impacts in terms of infrastructure expansion such as roads easily which agricultural items can be delivered to market (Rosa et al., 2013). Furthermore, the recent study survey the process and causes of change in forest cover from 1970 to 2010 in Malaysia not only in agriculture expansion but also for wood extraction by exporting the timber production which relatively increase the GDP of nation (Miyamoto et al., 2014).

Research Background Problem statement and Objectives

Deforestation has lately been assigned as a substantial problem for creating nations and also been credited to different harming impacts bringing about expanding worldwide expenses (Indarto & Mutaqin, 2006). The consciousness with the deforestation issue in progressing nations appear nearly in 1970s (Allen & Barnes, 1985). Deforestation has been attributed to various damaging impacts resulting in increasing global costs (Uusivuori *et al.,* 2002). According to John et al. (2016), revealed that the major agents of deforestation were identified to fall into direct drivers. Direct drivers that mean here is the destruction of forest cover occurs due to human induced. Direct drivers of deforestation include conversion to agriculture, infrastructure expansion and wood extraction (Geist & Lambin, 2001). Those agents are playing a vital role in which by threatening the forest cover only for their personal use without considering about the consequences that might face by the other community. The extension of agriculture, mainly on commercial agriculture, is thought to be an essential factor in deforestation in numerous nations (Tole, 1998).

Deforestation is a multiplex activity that occur with the collaboration of proximate and underlying causes, which can be differ from one area to another area. Few studies clarify that agricultural expansion as the major cause of tropical deforestation, especially the making of commercial commodities such as rubber, palm oil, cattle, soybean and cocoa. According to the past research by Miyamoto *et al.,* (2014), clarify the expansion of agriculture giving a huge impact on deforestation. Empirical studies show that the prices of agricultural products and deforestation are effectively correspond with each other, which can be explained that there is a correlation between these quantities. The commercial export agriculture starts to enlarge in developing countries in order to develop worldwide market request. Eventually, the demand for agricultural products rise has driven for deforestation. In addition to agriculture, road construction, unsustainable commercial logging, and fuel-wood collection are proximate causes of deforestation.

"Forests are being destroyed at an alarming rate … by doing so we are destroying our own capacity to survive" (Spilsbury, 2009). This phrase clarify that our forest is becoming destructive quickly. Malaysia is one of the countries which is the most at risk from deforestation and caused serious problem and loss of habitat for flora and fauna. According to FAO (2015) indicates that during recent years the world's forest cover has declined from 4.1 billion ha to 4 billion ha, where there is a diminishing of 3.1 percent. Moreover, the global forest area changes between the year of 1990-2000 and 2010-2015 has break by 50 percent. Even though the government are acting on the sustainability of our forest cover. Though, there are still number of factors that claim to give a huge impact to our forest area for their personal purpose as well as for commercial purposes; and what make these issues distressing in today's era is the proximate effects. Proximate/direct drivers are characterized as human exercises that straightforwardly change the physical condition reflected in land cover. Moreover, the managing the forest area in Malaysia with the sustainable basic is the crucial need concerning with the current deforestation issue. The impact of the management policy to the forest management should be evaluated and the most proper combination of available management policy is needed to be researched and suggested for the sustainable forest management.

The aim of the study is to identify some underlying factors that contributed to deforestation and to measure the current rate of deforestation. Based on the problem statement above, the research question can be pointed out as follows: (1) What are the impact of direct drivers with different management scenarios on deforestation in Malaysia? (2) What is the rate of deforestation in Malaysia? Therefore, the objective of the research includes (1) To evaluate the impact of direct drivers with different management scenarios on deforestation in Malaysia and (2) To study the assessment on the rate of deforestation in Malaysia.

Research Methodology

Sources of Data

This study uses secondary data which refers to information obtained from existing sources. This secondary data is used to determine the rate of deforestation, the total forest area, the direct driver (wood extraction) and the economic gain from the deforestation in Malaysia. Data sources that need to be collected to know the existing relationship between the variables are the total forest area (m^3), the amount of wood extraction (m^3), and the total economic gain (RM). These data are derived from the internet, the Department of Statistics Malaysia (DOSM), World Bank Data (WBD) which covers several distinct collections and databases, past studies and other printed sources.

Conceptual Framework

The total forest area (ha) is affected by both the direct driver (logging volume, m^3) and the total agriculture land (ha). The direct driver (logging volume, m^3) are directly affected by the rate of logging, while the rate of logging is decided by the net profit ( ) and threshold profit (α). The rate of logging are affected by the net benefit where if the firm gets more profit, they will increase their logging activity and thus this may lead to increase in the rate of logging and cause the total forest area to decline. The net benefit that obtain by the firm are affected from the discounted value of logging and discounted cost of logging. The discounted value or also known as net present value The Net Present Value (NPV), also known Net Present Worth (NPW), of an investment is the present value of its revenues minus the present value of its costs. The discounted value of logging can be derived from the total value or total revenue divided by the $(1 + r)^t$ whereas the discounted cost of logging calculated by the total cost divided by the $(1 + r)^t$. The total value from the discounted value of logging can obtain by multiplying the value of logs with the price of log whereas the total cost from the discounted cost of logging by multiplying with the cost of logging and the unit cost for logging.

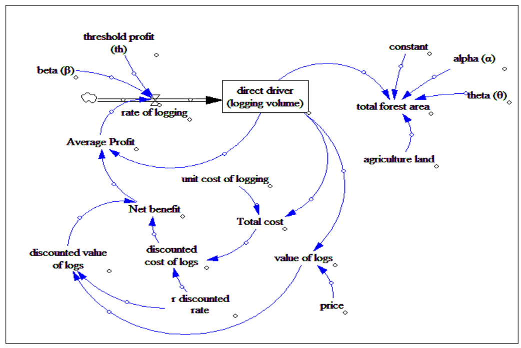


Figure 1: Causal diagram of the system simulation model

System Simulation Model

In this research, system simulation model is used for analysis purposes. This system dynamic simulation model (SD), is a study that represent the dynamics, cause-effect relationship as well as information feedbacks which changes occur in system over time (Wei et al., 2012). The system dynamic approach provided a framework for analysis of deforestation. It believed that this framework helps to lead the meaningful discussion between the variables. System dynamic approach focused on qualitative system that known as causal loop diagrams. According to Dudley (2002), causal loop diagram is an aid in visualizing how different variables in a system are interrelated with each other as well as powerful way to clarify and display the various model system.

Specification of the System Simulation Model

In order to identify the total forest area, the logging volume and total agriculture land are being used. This is because, based on the conceptual framework, the total forest area is directly affected by the logging volume and the total agriculture land. The logging volume data can be extract from the Department of Statistics Malaysia whereas the total agricultural land from the World Bank Data.

$$TFA\ (ha) = c + \alpha\ LogV\ (m^3) + \theta\ Total\ AgriL\ (ha) \quad (1)$$

Where: TFA (ha) is Total Forest Area, LogV (m^3) is Logging Volume per cubic metre, and Total AgriL (ha) is Total Agriculture Land

The direct driver logging from the previous formula is affected by the rate of logging. This rate of logging is decided by the net profit (π) and threshold profit (α) in which if the firm acquire net profit higher than the threshold profit, they will increase their logging activity and vice versa.

$$\Omega = \beta\ (TR\text{-}TC) \text{ or } \Omega = \beta\ (\pi - \alpha) \quad (2)$$

Where: Ω is rate of logging, π is Net Profit, and α is Threshold Profit, respectively.

Net profit is affected by the discount value of logging and discount cost of logging. It is important to review the Discounted Value or Net Present Value (NPV) concept as a tool in forest economics, which deals with the problems of choice in intertemporal production of forest. The discounted value of logging can be derived from the total value or total revenue divided by the $(1 + r)^t$ whereas the discounted cost of logging calculated by the total cost divided by the $(1 + r)^t$. The relation between the net present value and discount rate are negative. An increase in the discount rate will eventually decrease the net present value.

$$Net\ P = DicTR - DicTC \quad (3)$$

Where, Net P: Net Profit, DicTR is Discounted value of logging, and DicTCis Discounted cost of logging, respectively.

DicTR= (4)

Where, DicTR is Discounted Value of logging, TR is Total revenue, t{\displaystyle \,n\,} is number of periods, and {\displaystyle \,i\,}r is discount rate.

DicTC= (5)

Where, DicTC is Discounted Cost of logging, TC is Total cost, t{\displaystyle \,n\,} is number of periods, and {\displaystyle \,i\,}r is discount rate, respectively.

$$TR = LogQ \times p \quad (6)$$

Where, TR is Total Revenue, LogQ is Logging volume, and p is Price, respectively.

$$TC = LogQ \text{ x } c \quad (7)$$

Where, TC is Total Cost, LogQ is Logging volume, and c is unit cost of logging, respectively.

RD (%) = (8)

Where, RD is Rate of deforestation, TF historical is Total Forest Area Historical and TF estimated is Total Forest Area Estimated, respectively.

Model Validation Test

Validation deals with the assessment of the comparison between 'sufficiently accurate' computational results from the simulated data and the historical actual data from the system. In order, to compare the actual system and simulated system, Behaviour Reproduction Test are needed. "How well the model generated behaviour matches observed behaviour of the real system". The state of the forest over time can be simulated using the system simulation model (Vensim). In the initialization phase, the values of the parameters are assigned, and time is initialized as zero. In the execution phase, time is updated as T=T+dT, and state and rate variables are computed for time T. Model validation and sensitivity tests should be carries after initial computer model is constructed. Model validation is necessary to check the correctness in line with the real system. One of the major approaches for the model validation is done by comparing the simulated results with the historical results of the real system under the same condition.

Result and Discussion

Parameter Estimation

As shown in Table 1, the result of the panel linear regression model applied in this study. The multiple linear regression analysis method is used to obtain the form of relationship that exists between the dependent variable Y with the independent variables $X_{1,}$ and $X_{2.}$ This study uses two independent variables which is direct drivers (logging volume) and total agriculture land.

Table 1: Results for relationship of total forest area with direct drivers (logging volume) and total agriculture land also the rate of logging

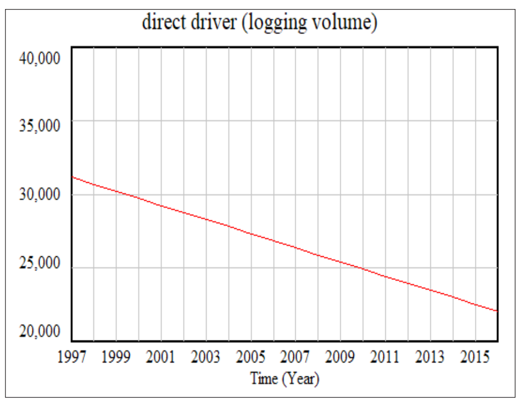
Variable	Dependent Variable	
	TFA	RATE OF LOGGING
Constant	17334.58	26170.46
LogV	0.043104	-
AgriLand	0.002157	-
Avg.Profit	-	-9.746006
Observation	20	20
R^2	0.513790	0.175004
Adjusted R^2	0.456589	0.129171

We could concur that the coefficient for the direct drivers (Logging Volume) and total agriculture land has a positive impact on Total forest area (TFA) and also statistically significant at the 5 percent level. According to the result, an increase 1% in logging volume would lead to increase 0.043 number of total forest area. Furthermore, the table shows that the coefficient of total agricultural land (Total AgriL) is positive and statistically significant at the 5 percent level. The result indicates that an increase in total agricultural land can lead to high in total forest area at 0.002 ha. Therefore, the number of disasters also increased dramatically. R^2 value indicates 51% variation in total forest area that can be explained by the variation in the independent variable. In order to find the rate of logging, the value of threshold profit is Ringgit 400/ m3 which has been obtain by choosing the lowest average profit within 20year time frame from 1997 to 2016. Threshold profit define as the specific level of income a person received at which once start to pay tax.

Model Validation Result

Model validation of simulation models are managed throughout the development of a simulation model with ultimate objective of constructing precise and reliable model. The role of the decision maker is to decide whether the models are eligible, and the result is considerable. Moreover, simulation models are approximate imitations of real-world systems and they never exactly imitate the real-world system. Due to that, a model ought to be confirmed and approved to the degree required for the model's planned reason. The historical and model simulated are compared and model is validated with the behaviour reproduction test and the results are shown in Figure 2-Figure 4.

Simulated



Historicala

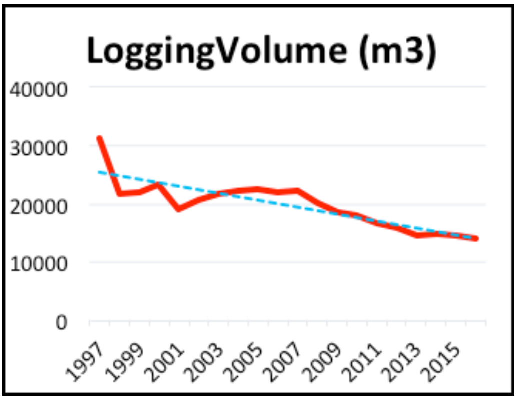
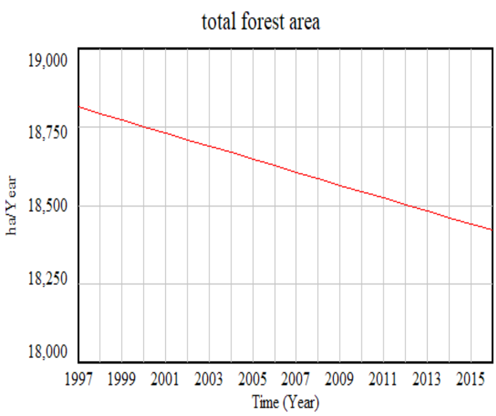


Figure 2: Comparison of logging volume (a) model simulated and (b) historical

a)



b)

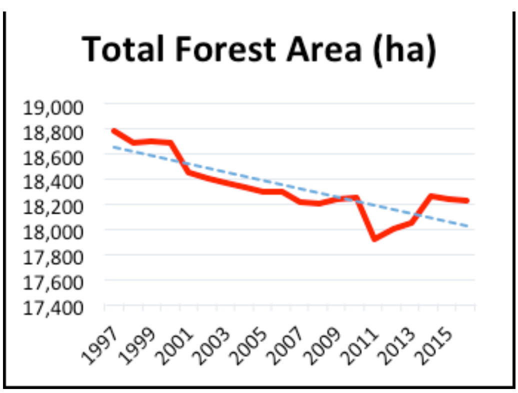
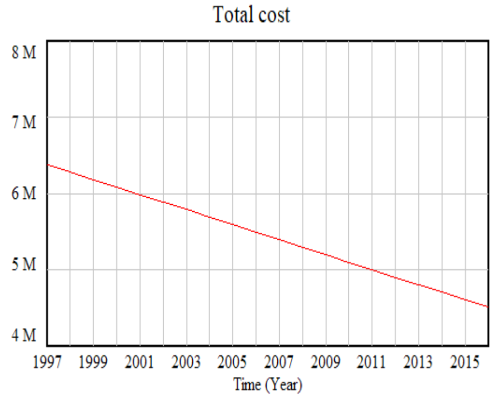


Figure 3: Comparison of total forest area (a) model simulated and (b) historical



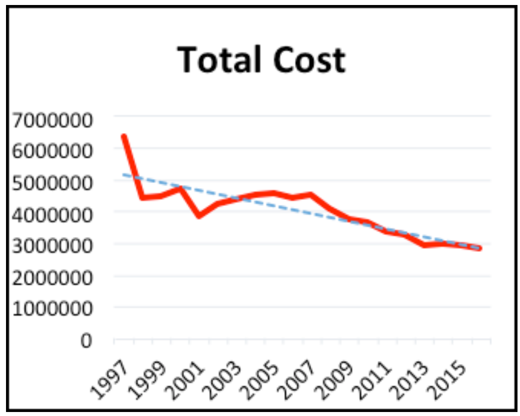


Figure 4: Comparison of total cost (a) model simulated and (b) historical

According to Sargent (2010), model validation usually carried out with certain segment procedure and analyses routinely. One of the segment is historical data validation in which if historical data exist (e.g., data collected on a system specifically for building and testing a model), part of the data is used to improve the model and the remaining data are used to determine whether the model behaves as the system does. This testing is conducted by driving the simulation model with either samples from distributions or traces. Furthermore, by changing simulation inputs and observing the resulting outputs, valuable insights may be obtained into which variable are most important and how variables interact. Based on the scenario shown above, by choosing the threshold profit at the level of 650, the simulated model shows the same trend as the historical model and this can indicate that the simulated condition emulates real world system. In other words, we can assume that current condition of de-forestation will show a clear picture on the future outcomes. The selection of threshold profit by the behaviour of the system model is shown in Figure 5 and 6.

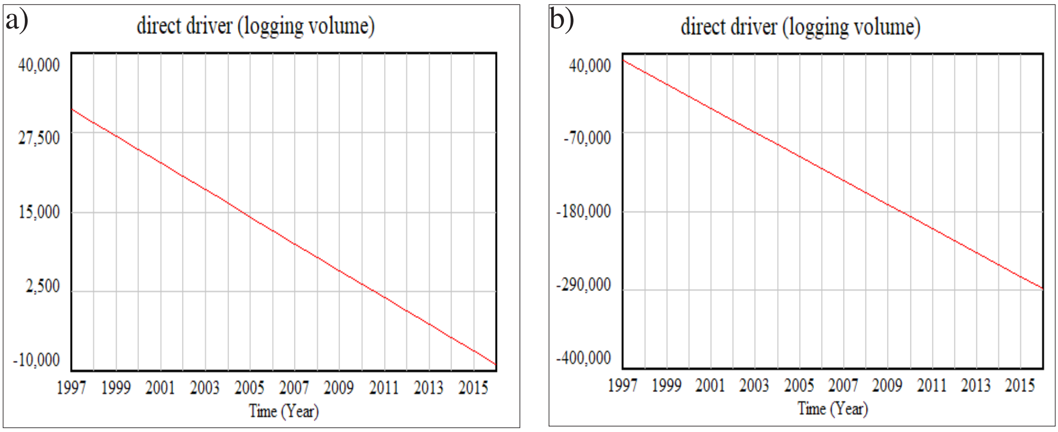


Figure 5: Logging volume from 1997-2015 with (a) threshold profit 400 RM/ha and (b) 650 RM/ha threshold profit

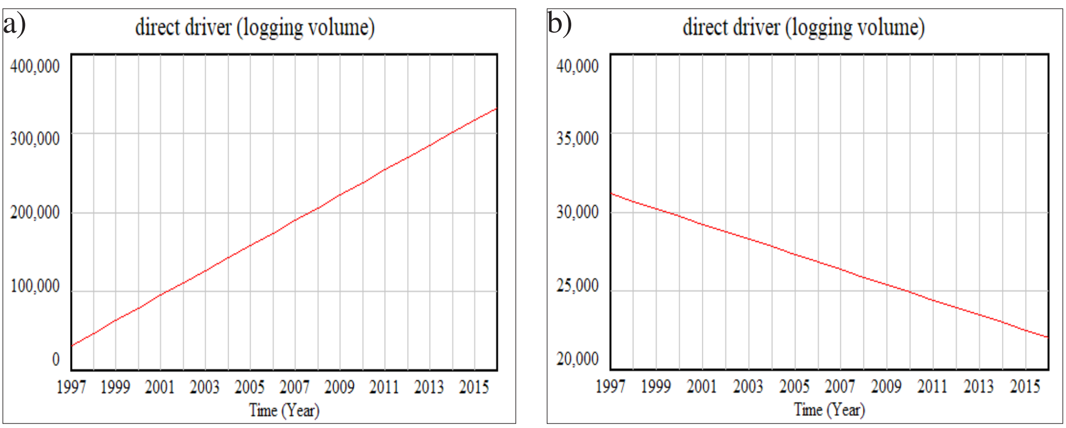


Figure 6: Logging volume from 1997-2015 with (a) threshold profit 675 RM/ha and (b) 900 RM/ha threshold profit

Figures above shows the condition of direct drivers (Logging Volume) with four different scale/value of threshold profit. The purpose of this validation test is the existence of differences between the historical and simulated data. According to the historical data, the logging volume are mean to be decrease from the year 1997 to 2016 whereas in simulated it shows vice versa. As a result, a model should be verified and validated to the degree needed for the models intended purpose. In that case, to fulfil the condition of validity test, three different level /value of threshold profit are shown in the figure above. Based on the figure above, in order to make the simulated model imitate the real-world system, the threshold profit at point RM 650 are chosen as the best value compare to the threshold profit at RM 400 because it shows a vice versa of the historical data. By choosing threshold profit at RM 675 and RM 900 also does not match with the historical data since the value is approaching in negative value. Overall, threshold profit at RM 650 indicate as the best imitation value of real-world system.

Statistical Accuracy Test Result

The numerical investigation on the proper of the simulation model was made using error measurement indices where often used in the assessment of forecasting (Okuda, et al., 2003). The summary of accuracy measures models is shown in Table 1.4. The numerical investigation of the suitable of the predictive model was analysed using error measurement indices such as Mean Absolute Deviation (MAD), and Mean Absolute Percent Error (MAPE) are used as measures of the accuracy of prediction of the model.

i. Mean Absolute Deviation

$$\text{MAD} = \frac{\sum_{t-1}^{n} |y_t - \bar{y}_t|}{n}$$

Mean Absolute Deviation (MAD) is utilized to evaluating forecasting methods by using sum of simple mistakes. MAD measures the accuracy of the prediction by averaging the alleged error (the absolute value of each error). MAD is useful when measuring prediction errors in the same unit as the original series. (Moreno, et al., 2013). Based on Table 2, MAD value is 1.005. From this, we can say that historical data set averages in a distance of 1.005 from the mean 18,616 ha. Since the MAD is "small", it implies that the mean of 18,616 is indicative of the other values within the data set. The MAD indicates how spread out our data is. A large MAD indicates a data set that is more spread out in relation to the mean where else a small MAD indicate data is less spread out and located closer to the mean.

ii. Mean Absolute Percentage Error

$$\mathbf{MAPE} = \frac{\sum_{t=1}^{n} \left| \frac{y_t - \hat{y}_t}{y_t} \right|}{n} * 100$$

According to Armstrong & Collopy (1992), The Mean Absolute Percentage Error (MAPE) is probably the most widely used forecasting accuracy measurement. MAPE has important, desirable features including reliability, unit-free measure, ease of interpretation, clarity of presentation, support of statistical evaluation, and the use of all the information concerning the error. However, several authors (Armstrong & Collopy, 1992; Kissinger et al., 2012) have questioned its validity, due to the characteristics of error distributions.

Table 2: Results of the statistical accuracy test

Statistical Accuracy Measure	Value	Unit
MAD	1.0055	Same as data
MAPE	1.5045	%

Note that, MAPE is calculated using the absolute error in each period divided by the observed values that are evident for that period. Then, averaging those fixed percentages. This approach is useful when the size or size of a prediction variable is significant in evaluating the accuracy of a prediction. MAPE indicates how much error in predicting compared with the real value.

Based on the result of statistical accuracy test in table 1.6, proved that the MAPE value is 1.5% shows that it is highly accurate with the forecasting value. This means that the error between simulated values and historical value are very little in the range between (<10%). From this, can be conclude that by using the simulated values we can estimate what would happen in the future with less error and find for early step to control deforestation. Moreover, by using visual technique, we can predict the behaviour between historical and simulated value.

Table 3: Interpretation of typical MAPE values

MAPE (%)	Interpretation
< 10	Highly accurate forecasting
10-20	Good Forecasting
20-50	Reasonable Forecasting
> 50	Inaccurate Forecasting

Source: Moreno *et al.,* 2013

Simulation Result

In this simulation result, we are going to run three scenarios. We have separated the scenarios into scenario 1, 2 and 3 with the different simulation period, which is 30years, 50years and 100years together with the policy analysis. The simulation result will be carried out with two policy impact. Policy 1 (P1) will be changes in threshold profit and policy 2 (P2) is the changes in interest rate. The details of the policy are mention in Table 4.

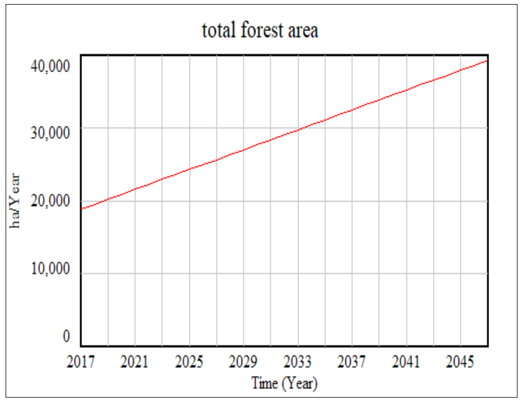
Table 4: List of simulation analysis scenarios

Policy 1: Changes in threshold profit	
Scenario 1 (P1A) Scenario 1 (P1B)	30 years simulation period with RM400 profit 30 years simulation period with RM650 profit
Scenario 2 (P1A) Scenario 2 (P1B)	50 years simulation period with RM400 profit 50 years simulation period with RM650 profit
Scenario 3 (P1A) Scenario 3 (P1B)	100 years simulation period with RM400 profit 100 tears simulation period with RM650 profit
Policy 2: Changes in interest rate	
Scenario 1 (P2A) Scenario 1 (P2B) Scenario 1 (P2C)	30 years simulation period with r=2% 30 years simulation period with r=4% 30 years simulation period with r=8%
Scenario 2 (P2A) Scenario 2 (P2B) Scenario 2 (P2C)	50 years simulation period with r=2% 50 years simulation period with r=4% 50 years simulation period with r=8%
Scenario 3 (P2A) Scenario 3 (P2B) Scenario 3 (P2C)	100 years simulation period with r=2% 100 years simulation period with r=4% 100 years simulation period with r=8%

Simulation result of Policy 1 (P1)

System simulation model can be either static or dynamic. Dynamic models consider changes with time, but static models represent relations between variables which do not involve time. In order to analyse the trend of variables for future purpose, dynamics model is mostly preferred because it describe the way in which a system changes over time (Rabbinge & De Wit, 1989).

Policy 1A



Policy 1B

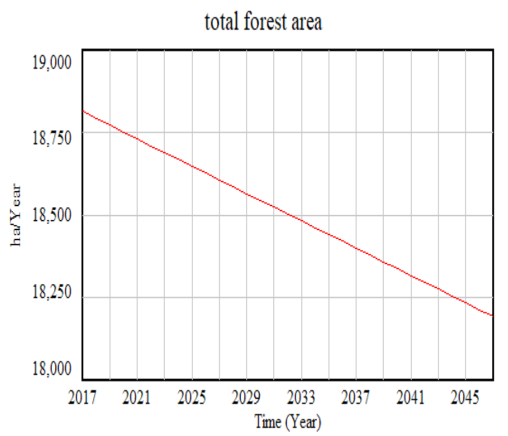
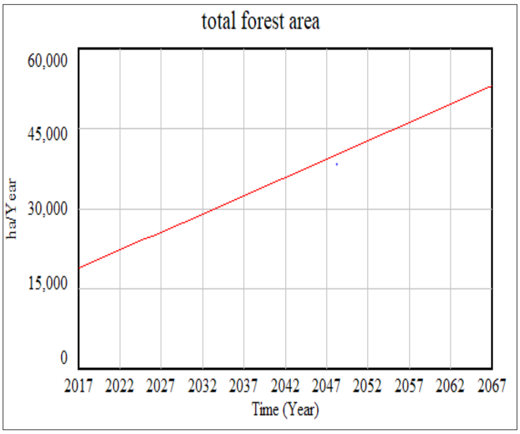


Figure 7: Simulation result of scenario 1 with policy 1A and policy 1B

Above scenario indicates the trend of the total forest area with two different threshold profit for the upcoming 30years. At the level of RM400 threshold profit, total forest area showed an increasing level in 30 years of time period. While upgrading the level of profit to RM650, the total forest area shows an opposite result by decreasing sharply over the future period.

Policy 1A



Policy 1B

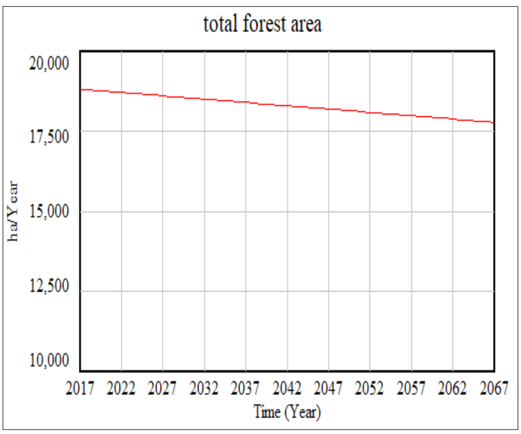
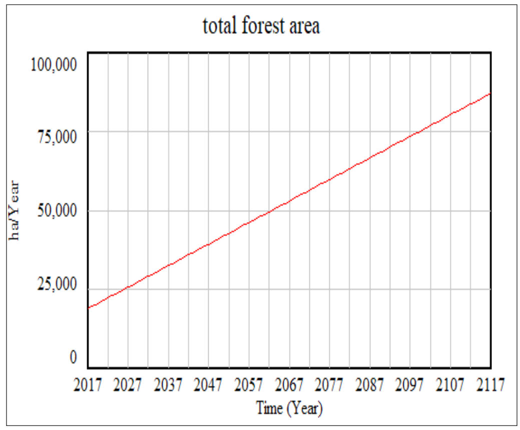


Figure 8: Simulation result of scenario 2 with policy 1A and policy 1B

In 50years, by using the same threshold profit which is RM 400 shows an increasing to the total forest area where as increase in profit to RM 650 induce the forest area to decrease but in slow manner also nearly to perfectly elastic. This means that, an increasing threshold profit does not show any changes in the forest area.

Policy 1A



Policy 1B

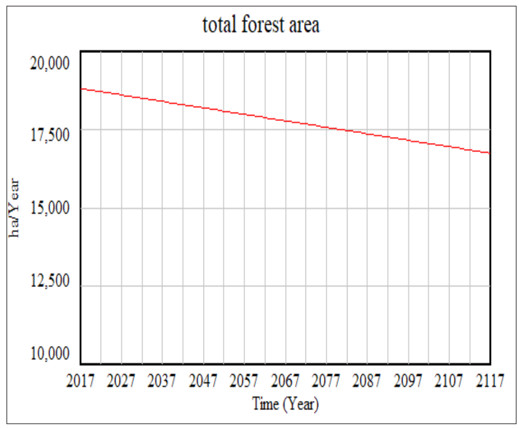


Figure 9: Simulation result of scenario 3 with policy 1A and policy 1B

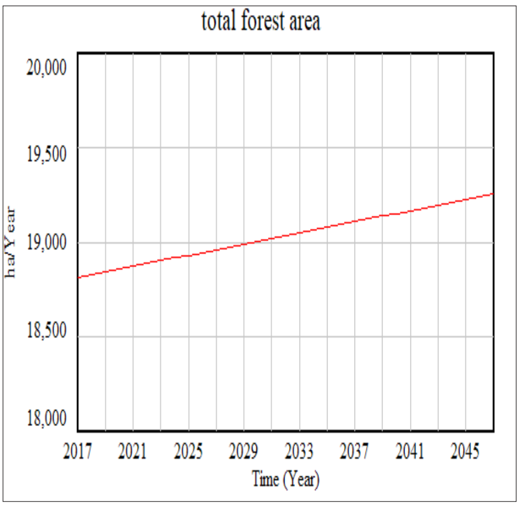
In 100 years, at the level of 400 threshold profit, cause the total forest area to increase rapidly. In other words, human disturbance towards the forest can be controllable and manageable. Once the threshold profit level increase from 400 to 650, total forest area declines as usual in slow motion in 100 years. Overall, the greater the profit earned, the greater the reduction in the conservation of forest.

Simulation result of Policy 2 (P2)

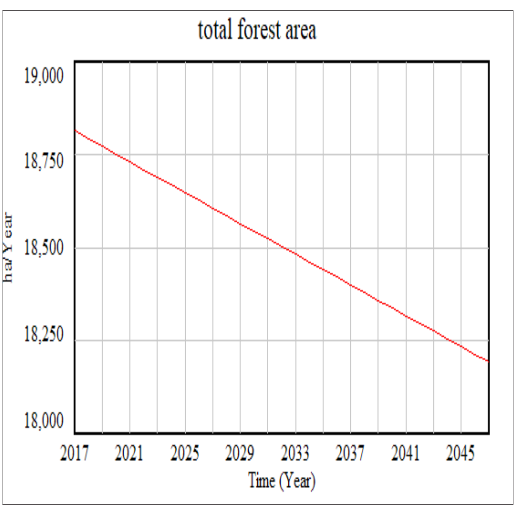
“Many economic factors have been blamed for destructive deforestation of the tropics” (Price, 1991). According to Angelsen and

Kaimowitz (1999), most of the farmers and loggers recommend that time favour and hazard avoidance are imperative in logical and observational models. High discount rates and risk aversion are both likely to reduce investment, but that investment could be either to clear the forest or to conserve it. Common wisdom implicit that higher in discount rate lead to decrease in sustainable forest. According to Hosonuma *et al* (2012), higher discount rate will encourage more deforestation and weaken sustainable forest management as well as diminish the needs of forest in future generation.

Policy 2A



Policy 2B



Policy 2C

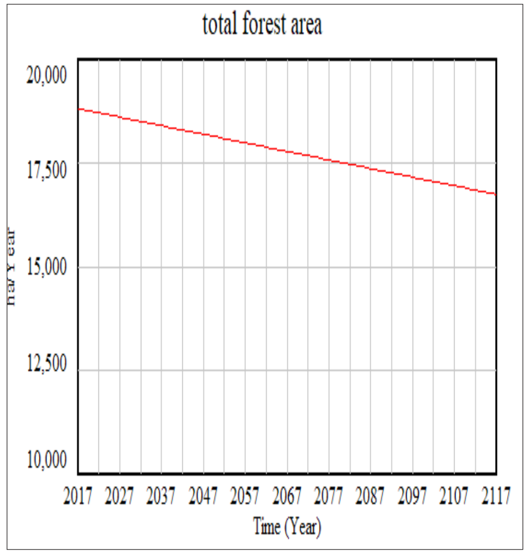
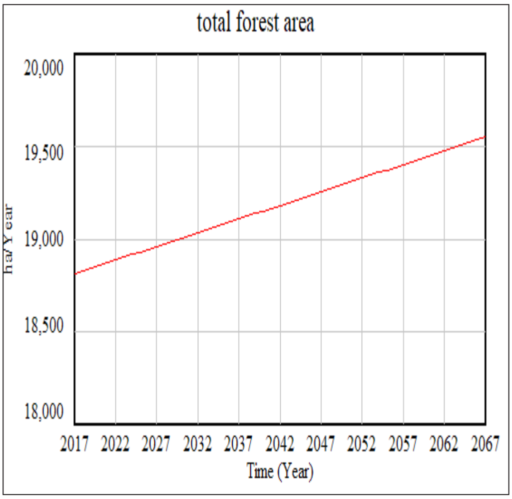


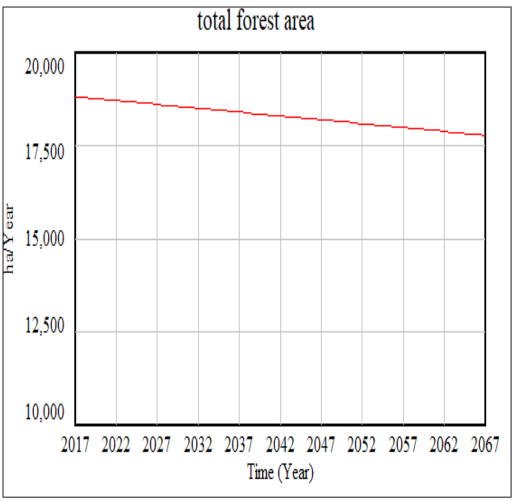
Figure 10: Simulation result of scenario 1 with policy 2A, policy 2B and policy 2C

By using the system simulation model, the condition of forest area in the upcoming future can be estimated according to the year period. Based on the graph in scenario 1 manifest the state of total forest area for the future days which is 30 years (2017-2047) indifference with discount rate at 2%, 4% and 8%. At the discount rate 4%, the total forest area will face a sharp decline in 30years time period. If the government plan to decrease the discount rate to 2% in 30years time, the total forest area face an increasing factor where else if the government increase the discount rate in future to 8%, total forest area will begin to decline in a slow manner. Thus, it clearly indicates that the lower the discount rate, the greater the total forest area. In other words, an increase in total forest area, the lower the deforestation rate in upcoming years.

Policy 2A



Policy 2B



Policy 2C

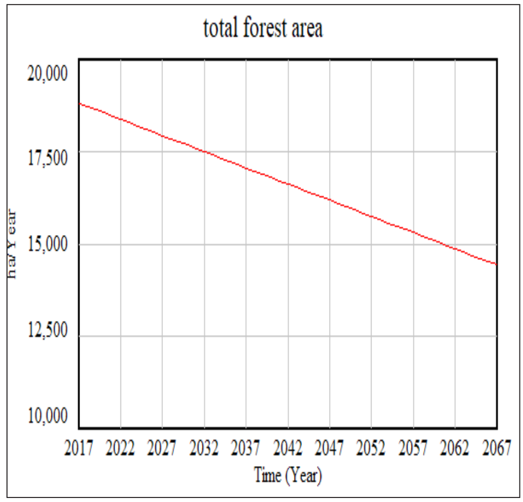
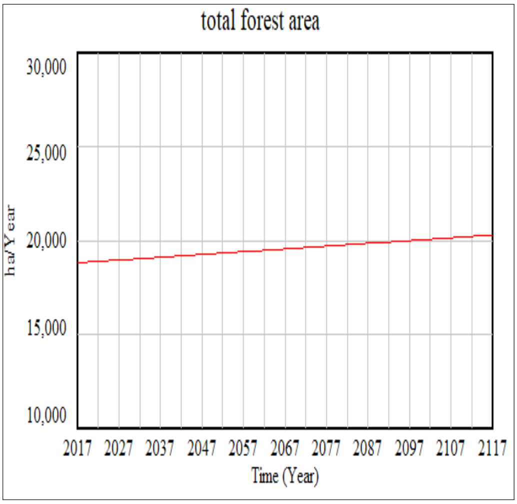


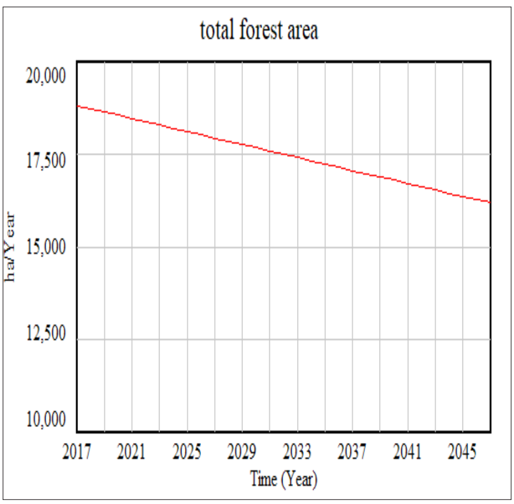
Figure 11: Simulation result of scenario 2 with policy 2A, policy 2B and policy 2C

Based on the graph in scenario 1 manifest the state of total forest area for the future days which is 30 years (2017-2067) indifference with discount rate at 2%, 4% and 8%. According to system simulation model, total forest area faces drastic changes based on the year mindful of different in the discount rate. When r at 2%, shows a positive change in total forest area where else an increase in the r from 2% to 4% indicate a negative change which means a higher discount rate lead to decrease in total forest area in a slow- moving. When the r increases to 8%, the total forest area continuously diminishes sharply.

Policy 2A



Policy 2B



Policy 2C

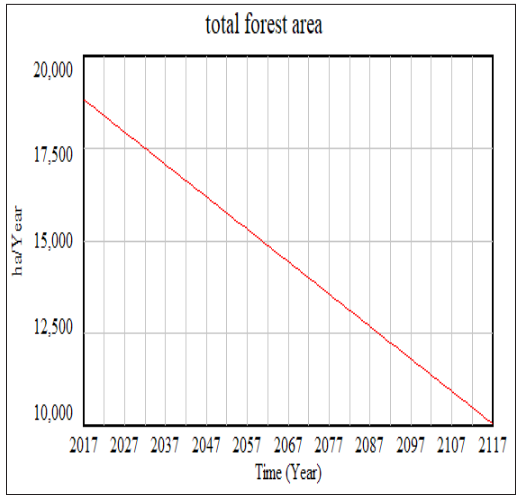


Figure 12: Simulation result of scenario 3 with policy 2A, policy 2B and policy 2C

By increasing the year from 50 to 100 years (2017-2117), causes the forest area to change excessively. When r at 2%, shows an increase in forest area which is nearly to perfectly elastic. This define that reducing the discount rate will not increase the total forest area. At 4% total forest area decline slowly whereas when the r at 8% shows steep decline. According to Bulte and Van Soest (1996), stated that higher discount rate demoralizes the forest to sustainable. Price discusses that by reducing the common rate of discount rate may really upgrade the problem for short term abuse of forests, because of the expanded estimation of reinvested incomes. An increase in the discount rate lead to more increasingly face negative effect on intergenerational value and sustainability (Bulte & Van Soest, 1996).

Rate of Deforestation

Based on the figure, we can study the assessment on the rate of deforestation by using two different parameters. By using the base run at 400 threshold profit, the rate of deforestation is becoming decline year by year. The average value of the rate of deforestation by using the base run is 42%. In case, we use the as modified parameter, which is 650 profit, it may cause the total forest area to experience a decline in the forest due to increase on the rate of deforestation. The average value of the rate of deforestation by using the modified parameter is 91%. Overall, we can conclude that increase in profit relatively urge humans to destroy our forest to earn profit regardless on the damage to our nature resources.

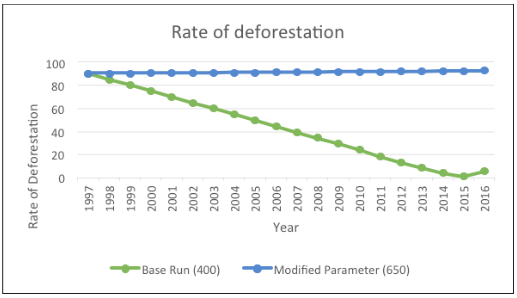


Figure 13: Rate of deforestation based on two different parameters

Summary of the results

The behavioural reproduction test answers the question on "How well the model generated behaviour matches observed behaviour of the real system?". From the graph above, the threshold profit at the level of 650, indicate that the simulated model shows the same trend as the historical model and signal that the simulated condition emulate real world system whereas the statistical accuracy test show the quantitative examination using error measurement indices in order to find the error between simulated and historical data. Based on the result, MAPE value is 1.5% shows that it is highly accurate with the forecasting value. This means that the error between simulated values and historical value are very little in the range between (<10%). The simulation results which to analyse the trend of variables for future purpose. This analysis trend of variable shows within two different state (e.g: changes in threshold profit and discount rate) and the simulation period (e.g: 30years, 50years and 100years). Based on the findings above, the most reliable policy that need to follow in order to control deforestation is by implementing the scenario 2 with policy 2B. The reason is at the level of RM 650 threshold profit, and 4% discount rate, the total forest area is facing only slide decline in 50years time period compare to policy 2C which shows a sharp decline on total forest area.

Conclusion

This system simulation model is the imitation of the operation of real-world process or system over time. By introducing the system stimulation modelling, we can speculate the consequences or the problem that might be face by our nation in upcoming years and also prevent or minimize the deforestation through some policy implications. Also, by using the modified parameter (650), we can conclude that rate of logging can be controlled and reduce in upcoming years.

Policy Implications

Based on the research conducted, this chapter will present some suggestions following the goals that want to achieve along with sustainable forest management in the future. The reason on giving this proposal is to guide that must be played by the authorities on the condition of forest on upcoming years. According to the findings, there are two policy analysis has been imposed for the purpose on to estimate forest condition in upcoming years together with different simulation time period (e.g: 30years, 50years and 100 years).

Based on the findings, the authorities need to be more alert on the second policy which is changes in the discount rate. According to Erwin and Daan (1996), imposing higher discount rate will encourage more deforestation and weaken sustainable forest management as well as diminish the needs of forest in future generation. To be precise, scenario 2 (policy 2B) is the most proper combination of policy to manage our forest area. Scenario 2 (policy 2B) is the maximum boundary to conserve our forest area where interest rate is not more than 4% and simulation period not more than 50 years.

The reason choosing this policy is because, in scenario 2 (policy 2C) shows a drastic fall on the total forest area compare to policy 2B where still maintain slight decline and this is why we have to set the boundary limit on policy 2B.

In other words, exceeding the interest rate to 8% (policy 2C) will cause the forest area to decline sharply. Based on the result findings, the study concludes that the most suitable policy combination for the management of total forest area with the aim of reducing deforestation and sustainable forest management will be scenario 2 (policy 2B). Therefore, our result findings that deforestation in Malaysia we should be manage with the RM650 per/ha threshold profit coupled with interest rate r=4% within 50years period. Lastly, in order to control the deforestation on upcoming years, we are recommended to use the research outcomes as for guidance.

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