The Impacts of Economic Growth on Environmental Conditions in Laos

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Abstract
This study aims to examine the relationship between economic growth and environmental degradation. The carbon dioxide emission (CO_2 emissions) per capita is used to be a proxy for environmental degradation, using time series data from the period between 1980 and 2010. To avoid the problems of non-stationary associated with time series analysis, the Dickey-Fuller unit roots is checked as to ascertain whether the variables are stationary, by transforming the dependent and independent variables in the first different operator form. This study is based on the hypothesis of the Environmental Kuznets Curve (EKC) that environmental degradation follows an inverted U-shaped trajectory in relation to economic growth. The result of this study confirms the invested correlation between economic growth and environmental degradation of EKC's hypothesis that at the early stage economic growth increases environmental degradation, then environmental degradation decreases after reaching a certain level of average income per capita. Moreover, other factors, such as trade openness, industrial extension, and becoming a full member of ASEAN, also cause an increase in environmental degradation. In order to reach the sustainable development goal, strong environmental and natural resource protection policies are suggested for the current and future development of Laos.

Keywords: GDP per capita, trade openness, environmental degradation and sustainability.

I. INTRODUCTION

The impact of sustained growth on the environment has been widely discussed in the economic literature. Several studies have investigated the relationship between environmental pollution and per capita income, mostly by using the framework of Kuznets curve, which was introduced by Kuznets (1955), known as the inverted-U-shaped curve. This hypothesis, which suggests a U-shaped relationship between two variables, implies a non-linear relationship that is applicable in many countries. The key indicators used to capture the changes in environmental conditions have been developed and used in many countries. A high rate of economic growth has been a primary and permanent goal of government and society, particularly in developing countries. The increase in economic growth is related to an increase in the production and consumption of goods and services; consequently, this may lead to an increase in the multiplied goods of the people and income per capita consumption. Technological development has been considered as having the potential to diminish or exacerbate the effects of economic growth; however, this depends on the net result regarding increased or decreased per capita natural resource consumption.

To encourage a high rate of growth, different economies' mechanisms have involved development based on each individual country's characteristics and the potential natural resources that are available. The growth may produce negative impacts on the environment through many aspects, such as environmental condition (pollution), overexploitation of natural resources, degradation and loss of wildlife habitat, and climate change. These are the key issues that many countries have been facing; in particular, the decline in environmental quality is considered to be a serious issue for the living condition of the population from the current as well as the long-term perspective.

To achieve extreme development, the economic condition should not be measured by the GDP growth alone. Instead, the sustainability of natural resources and environmental condition must be considered to be one key factor that can be used to prove that the benefit of growth is distributed throughout the population and environment. Consequently, the strength of the country's economy must be incorporated into the condition to achieve economic growth. On the other hand, if the national development goal is focused only on income growth and fails to consider its impacts on the natural resources and environmental condition, this would confirm that the envisaged development guidelines and processes are inadequate for the long-term development perspective of the country. For this reason, to achieve successfully the goals of the various economic development plans, a country's government needs to consider both the development potential to increase the living condition of the population and the sustainability that would ensure lasting benefits for the country's future generations.

This paper highlights the situation of Laos, and aims to investigate the relationship between economic growth and the pressure on nature from the environmental sustainability perspective. Considering at the environmental condition, it seems that there are many aspects are included in environmental condition, such as water pollution, Carbone Dioxide emissions (CO_2 emissions), soil erosion, solid waste, and deforestation. However, since we have

limited time and data available of other aspects, this study is considered only the CO_2emissions per capita to be a proxy for environmental degradation. By definition, the increase of the CO_2emissions mainly causes from burning oil, coal, and natural gas for energy use. Furthermore, CO_2emissions also enters the atmosphere from burning wood and waste material land from some industrial process such as cement production, garment manufacturing, alcohol factories, Tabaco companies, etc. The increase in number of economic activities is assumed to increase the proportion of environmental damage this study would discuss some hints about how to accomplish the balance of the growth and maintain a good condition of environment.

As already mentioned in relation to the environmental issue of Laos, which is only a minor contributor to climate change at global and regional levels, the degradation in the environmental system, particularly the rapid decline of natural resources caused by factors such as deforestation, may cause a negative impact on the living condition of the population from the current and the long-term perspective. This is due to the high rate of growth in recent years relying on natural resources to support the export volume and also to increase the domestic productivity. In general, the economic reform in Laos is successful in terms of boosting growth; however, it is greatly dependent on natural resources. The high rate of growth is a promising prospect for the country to disembark from the list of LDCs and it is questionable whether the high rate of sustained growth during the last two decades has produced negative impacts on the natural resources and environmental condition of the country. The expected outcome of this study may provide a good suggestion for policy makers to consider the most appropriate method to achieve a high level of growth and simultaneously to maintain the sustainability of the natural system and a good environmental condition.

This paper consists of five sections including the introductory section. The next section contains a literature review. In section 3, the methodology and data use is discussed, including the econometric models. The empirical results are detailed in section 4. The last section summarizes the outcome and makes some recommendations for future development.

II. LITERATURE REVIEW

Referring to the neoclassical economic theory, sustainability can be identified in terms of the maximization of well-being of a population over time, while the economy is considered to be a major source of the improvement in the living condition of a country and its population (Lawrence, 2011). From this poin t of view, the progress of growth occurs through the growing gconsumption of the country of both goods and services; therefore, the governments of many countries have emphasized the achievement of a high rate of growth. The measurement of the growth of sustainable development (e.g. GDP growth) has been considered as a major objective of development. The growth theory has relied on the hypothesis of economic efficiency and dynamics optimality.

Grossman and Krueger (1991) state that the impact of economic growth on environmental quality is categorized through three different channels: (1) the scale effect, (2) the composition effect, and (3) the technique effect. By definition, the scale effect happens as pollution increases with the size of the economy, the explanation being that even if the structure of the economy and technology does not change, it is assumed that an increase in the scale of economic activity leads to an increase in pollution and environmental degradation, while the composition effect refers to the change in production structure of an economy from agriculture-based to industry and service. In the first stage of the development process, pollution increases as the economic structure changes from agriculture to resource-intensive heavy industries. The last effect is the technique effect, which captures improvements in the technique of production and adaption of cleaner technologies and hence a reduction in pollution.

Several studies have considered the impact of growth on environmental conditions. One of the most effective studies is that of Smyth and his colleagues (2008), who conducted an analysis of the relationship between growth and environmental issues in China, finding that together with the high rate of economic growth, it also produces a high rate of pollution. Many cities in China are now suffering from a high level of pollution and natural disasters, as well as a traffic congestion problem. Those problems are becoming a major challenge for the future development of China. Some studies have confirmed that the pursuit of higher growth dominates the environmental aspects. However, environmental and social harm can limit long-run growth; therefore, the key factors of social, economic and environmental systems are codetermined. Thus, in order to obtain the objective of sustainable development, an expansion of the scope of analysis is required to encompass wider system dynamics (Munasinghe, 2001).

Other studies have demonstrated a negative relation between the abundant endowment of natural resources and economic growth in that countries that have abundant natural resources tend to have lower growth than others (Ascher, 1999; Birdsall et al., 2001; Gylfason, 2001; Sachs and Warner, 1995). However, these studies employed cross-sectional data from across countries, with which it is hard to classify the process of different natural resources' scarcity, which is expected to affect economic growth according to different patterns. In terms of economic growth, the increase in GDP that arises from converting energy and natural resources into capital and

consumption goods leads to a decrease in environmental quality. In this condition, the worsening of the environment eventually leads to a decline in the average income of the population (Day and Grafton, 2001).

The relationship between economic growth and environmental degradation has been recognized and approved by numerous studies, such as the study of Opschoor (2001), who explores the negative relationship between economic growth and environmental sustainability, while proposing institutional and moral reforms to promote sustainable development. The study by Norgaard (2001) indicates some basic limitations of rapid sustained growth, discusses some mythologies concerning economic growth, and finally outlines an agenda based on ecological economics to move beyond growth and globalization.

The growth of economic activities, in terms of production and consumption, requires larger inputs of energy and material that generate a greater quantity of waste by-products (Georgescu-Roegen, 1986). This is confirmed by Grossman and Krueger (1995), who state that to achieve a high level of growth a country needs more inputs to enlarge its outputs, leading to an increase in the waste and emissions generated through the production of economic activities. The increased allocation of natural resources, accumulation of waste, and concentration of pollutants directly impacts on the degradation of environmental quality, leading to a decrease in the human living quality, despite the rising income (Daly, 1991). In addition, the paper argues that the cause of resource degradation may eventually put economic activity itself at risk; therefore, to maintain the environment and even economic activity itself, the growth must cease and the world must establish a transition to a steady-state economy.

Panayotou (1993) points out that when the production of an economy shifts from mainly agriculture to industry, the pollution intensity increases, and then at higher levels of development, structural change towards information-intensive industries and services, coupled with increased environmental awareness, enforcement of environmental regulations, better technology and higher environmental expenditures would ultimately lead to a leveling off and gradual decline in environmental degradation. Beckerman (1992) reports a strong relationship between the income growth and the adoption of environmental protection measures, which indicates in the long term that the improvement of the environmental quality of a country can only occur when it has become rich.

Since the beginning of the 1990s, several empirical studies have examined the relationship between economic growth and environmental degradation, by using the environmental Kuznets curve (EKC). The studies by Grossman and Krueger (1995), Selden and Song (1994), and Shafik and Bandyopadhyay (1992) hypothesize that the relationship between economic growth and environment quality, whether positive or negative, is not fixed along a country's development path; certainly, the correlation would change the direction from positive to negative when a country reaches a level of income at which people require and are able to afford more efficient construction and tools for a cleaner environment.

Stern (2004) states that the environmental Kuznets curve is a hypothesized relationship among various indicators of environmental degradation and income per capita, during the early stages of economic growth, degradation and pollution increase, but beyond some level of income per capita the trend reverses, so what the high income level economic growth leads to environmental improvement. This indicates that the environmental impact indicator is an inverted U-shaped function of income per capita. Normally, the logarithm of the indicator is modeled as a quadratic function of the logarithm of income.

The EKC hypothesis is fundamentally a within-country story; however, cross-country study assumes that all cross-section countries react identically, regardless of their differences in income, geographical condition, culture, and history (Dijkgraaf and Vollebergh, 1998). Recently, some studies have started to analyze single country to examine the EKC hypothesis: for example, the studies of Cole (2003), Lekakis (2000), and Stern and Common (2001). In fact, the environmental degradation factor is not only caused by the impact of income per capita growth; it is also affected by other factors of economic development (Akpan et al., 2011).

Considering the case of Laos, it seems that there are limited studies have carried out the Environmental Kuznets Curve (EKC) to examine the impacts of economic growth on environmental condition in Laos. The previous study conducted by Kyophilavong (2011) uses a Computable General Equilibrium (CGE) method to analyze the impact of trade liberalization on CO2 emissions and a micro-simulation to assess the impacts of trade liberalization. His study proves that trade liberalization provides positive impact on growth, and it also decreases CO2 emissions but it increases the proportion of resource depletion because the demand for products increases. One more study conducted by Dasgupta et al. (2005), have examined the regional poverty-environment nexus in Cambodia, Laos, and Vietnam. This study focuses on spatial relations between poverty populations and environmental problems at provincial and district level. The result of this study shows that where the pattern of regional settlement by poor households is strongly associated with each of five environmental problems, including: deforestation, fragile soils, indoor air pollution, contaminated water, and outdoor pollution.

This study is different from other previous studies in Laos, because, it intends to put several factors together, using time series data analysis to test whether an EKC exists. Given this state of affairs, this paper systematically examines the relationship between economic growth and environmental quality. The study is based on the

experience of previous studies and the concept of EKC, known as the inverted-U correlation between environmental degradation and economic growth, together with an analysis of the impact of other factors, such as population density, trade openness, and other independent variables, rather than considering income per capita growth and the environment alone.

III. RESEARCH METHODOLOGY

This section presents the methodology which is employed in this analysis. It includes the data sources and characteristics of the variables, followed by the model specifications based on the EKC's hypothesis, which is used to analyze the impacts of economic growth on social and environmental condition.

3.1. Source and data collection methodology

The data are mainly from international and national organizations, such as the World Development Indicator, the openness degree is from the Penn World Table or PENN database, and Laos Economic and Consumption Survey (LECS[1]) from the Department of National Statistics in Laos. Additionally, data were collected from survey and case studies carried out by local and international organizations, including the economic annual reports of Laos. The nature of the data is annual time series for all key factors including dependent and explanatory variables.

Time series variables are often non-stationary at levels and an econometrics analysis with these variables results in spurious correlations, that is, a seemingly significant effect though the variables are actually unrelated in a statistical sense. To avoid spurious relations among economic variables, time series analysis should not use the original series but recommended to be transformed. It can be possible to eliminate non stationarity by using difference[2]. A variable is said to be integrated of order d, (I (d)), if it can be transformed to a stationary stochastic process by differencing d times.

In order to test whether variables are stationary and establish order of integration, we employed Augmented Dickey Fuller (ADF) tests. The null hypothesis of unit roots test is non-stationarity, and if the value of the test statistic is smaller than the critical value of significant, we reject the null hypothesis. As shown below in table 1, the results of the ADF tests suggest that variables are not stationary at their first level, but at their first differences. Thus, our proceeding analysis uses the first differences of variables. A variable process is said to be stationary if its mean and variance are constant over time.

Table 1: The results of Augmented Dickey-Fuller (ADF) unit roots test

		ADF test	
At level	**Lag**	**t-statistics**	**Critical Value**
LnED	1	-2.196	-3.233
LnGDPP	1	-2.89	-3.20
LnOPEN	1	-2.123	-3.233
LnPOPD	3	-2.817	-3.235
LnIND	6	-2.698	-3.240
At first difference	**Lag**	**t-statistics**	**Critical Value**
dLnED	1	-3.402**	-3.235
dLnGDPP	1	-3.471***	-2.655
dLnOPEN	4	-3.953***	-3.750
dLnPOPD	1	-4.465***	-3.233
dlnIND	6	3.270*	-3.240

Note: Asterisks (***), (**), and (*) indicates the significant level at 1%, 5%, and 10 %, respectively, where "d" refers to the first order difference.

This analysis aims to examine the impact of economic growth on environmental quality, based on the economic performance from the period between 1980 and 2010, particularly after the introduction of the new economic system and becoming a member of ASEAN in 1997. The impact analysis will link to the current situation as well as the long-term perspective of the economic development. The study combines both descriptive and empirical methods; in this case, the simple regression (OLS) is performed. The data contained the key variables of CO_2, used as a proxy the environmental degradation (ED), GDPP, OPEN, and POPD, and other additional variables would be included in this study.

[1] The Laos Economic Consumption Survey or LECS is conducted every 5 years; the first survey was in 1992–93, the second in 1997–98, the third in 2002–2003, and the fourth in 2007–2008.

[2] The first difference of variables is generated according to the following equation:

$$dY_t = Y_t - Y_{t-1}$$

Table 2: Definition and descriptive statistics of the variables, 1980-2010

		Before being a member of ASEAN				After Being a member of ASEAN			
Variable	Obs	Mean	Std.Dev	Min	Max	Mean	Std.Dev	Min	Max
LnED	30	3.297	0.767	2.086	4.176	4.307	0.123	4.135	4.461
LnGDPP	31	5.66	0.35	5.05	6.27	6.13	0.48	5.53	6.84
LnOPEN	31	3.297	0.767	2.086	4.177	4.307	0.127	4.135	4.461
lnPOPD	31	2.83	0.14	2.61	3.05	3.17	0.06	3.07	3.26
LnIND	32	18.48	0.414	17.77	19.22	20.00	0.49	19.30	20.84

Source: Author's analysis

Table 2 is a summary the descriptive statistics, which is divided into two periods for the analysis: one before 1997 when it did not hold a full membership, and the second one after 1997 beyond which it holds a full membership of ASEAN. Regarding the membership of ASEAN, it shows a positive relationship between ASEAN and the economic growth of Laos. However, it is questionable whether joining ASEAN produced a negative impact on the environmental condition, and thus this factor is included in this study. Looking at the mean value of CO2 emission per capita after being a full member of ASEAN is higher than other, which is 3.297 and 4.307, respectively. It is noticeable that being a member of ASEAN is increased the number of productivity, which is assumed to produce negative impacts on environmental conditions.

3.2. Model specification

The approach consists of estimating reduced-form models of the relationship between environmental degradation and per capita income. There are different indicators have been employed in empirical literature on EKC, based on the basic models of the EKC include an indicator of environmental degradation (such as per capita C02 emissions, S02, etc.) as a function of the levels and squares of per capita income. Since there is limited data of other indicators, therefore, CO2 is used as a proxy environmental condition; it is measured by the proportion between annual carbon dioxide emissions and population. The GDP per capita is used to be an explanatory variable, and is assumed to have a negative correlation with environmental quality based on the volume of carbon dioxide emissions.

The impacts of economic growth on environmental conditions is fundamentally based on the standard framework EKC, as the study of Stern (2004), who employs the method of EKC with the simple quadratic functions of the levels income, by using a logarithmic dependent and independent variables. Both the dependent variable and the independent variable(s) are log-transformed variables, based on the basic interpretation of coefficients in a regression analysis is that a one unit change in the independent variable results in the respective regression coefficient change in the expected value of the dependent variable, while all other independent variables are held constant. The first equation of standard EKC regression can be simplified as:

$$\mathrm{dLnED_t} = \beta_0 + +\beta_1 \mathrm{dLnGDPP_t} + \beta_2 \mathrm{dLnGDPPSQ_t} + \beta_3 \mathrm{D_t} + \in \qquad (1)$$

Where $\mathrm{ED_t}$ denotes environmental degradation based on $\mathrm{CO_2/population}$ and is an endogenous variable that represents better environmental quality if it is a lower level. $\mathrm{GDPP_t}$ and $\mathrm{GDPPSQ_t}$ represent the income per capita and squared income per capita variables, while "d" is the first difference operator; and $\in$ is used to present the error term in year t. $\mathrm{D_t}$ represents a dummy variable (D = 0 is before 1997, and D = 1 is from 1997), which is used to examine the impact of joining ASEAN on the environmental condition. In order to prove the hypothesis of Kuznets, the value of β_1 is expected to be positive and the value of β_2 is expected to be negative, while the value of β_3 is assumed to be positive or negative.

To avoid the problem suffering from omitted variables bias, in addition of more explanatory variables, such as openness to trade and population density (POPD) are assumed to bear effect on environmental condition and those indicators are also included in this study. Therefore, the next model specification refers to the study by Kleeman and Abdulai (2011), which was also developed from the EKC by considering international trade to be one of the key factors influencing natural resource degradation. The next equation can be modified as:

$$\mathrm{dLnED_t} = \beta_0 + \beta_1 \mathrm{dLnGDPP_t} + \beta_2 \mathrm{dLnGDPPSQ_t} + \beta_3 \mathrm{dLnOPEN_t} + \beta_4 \mathrm{dLnPOPD_t} + \in \qquad (2)$$

Where $\mathrm{OPEN_t}$ denotes the trade openness degree; $\mathrm{POPD_t}$ represents the population density. These two variables are assumed to have a positive correlation with environmental degradation.

Moreover, the economic reform as opening the country and holding a full membership of ASEAN, which leads to maintain high rate of growth, it relates with the increase in productivity through the manufacturing expansion and growing of industrial establishment. Therefore, the changing of national income from manufacturing and industrial factor is included in this analysis; the next equation can be simplified below:

$$\mathrm{dLnED_t} = \beta_0 + \beta_1 \mathrm{dLnGDPP_t} + \beta_2 \mathrm{dLnGDPPSQ_t} + \beta_3 \mathrm{dLnOPEN_t} + \beta_4 \mathrm{dLnIND_t} + \in \qquad (3)$$

Where IND denotes the income share from industrial sector, which is used a proxy for industrial enlargement, the coefficient value of industrial factor is assumed to be positive, this implies that an increase in number of manufacturing and industries leads to increase the level of environmental degradation.

The maximum point or turning point (τ) of the EKC function measured by the first derivative test, which is used to determine whether a given critical point of a function is a local maximum, a local minimum, or neither. Making the first derivative equal zero, the turning point is achieved at the coefficient on GDPP over twice the absolute value of the coefficient on the square of GDPP.

$$(\tau) = \left|\frac{\beta_1}{2\beta_2}\right| \qquad (4)$$

Since our equations are using the first different operator form and log-transformed variables,in order to calculate the maximum of turning point we employ the original values of dependent (ED) and independent variables (GDPP, and GDPPSQ), while keeping other variables are constant.

IV. RESULTS AND DISCUSSION

The impact of economic growth on environmental quality is an empirical problem and it varies according to circumstances, such as individual countries' development view, degree of economic development and trade openness. This paper deals with explanatory variables, such as GDP per capita, openness, and other variables relating to the environment conditions. In order to investigate the relationship between economic growth and environmental degradation, we based our study on the hypothesis of EKC, the estimation results are detailed in table 3.

Table 3: The relationship between economic growth and environment

	Dependent variable ($dLnED_t$)		
Explanatory variable	**(1)**	**(2)**	**(3)**
Intercept(c)	-0.069* (0.026)	-1.995** (0.962)	-3.994** (1.579)
dLnGDPP	1.125*** (0.325)	1.061*** (0.269)	1.276*** (0.286)
dLnGDPPSQ	-0.073* (0.009)	-0.077** (0.0082)	-0.152* (0.091)
dLnOPEN		0.003 (0.069)	0.033 (0.046)
dLnPOPD		0.724* (0.309)	
dlnIND			0.206** (0.087)
Dummy (1997)	0.486*** (0.048)	0.273*** (0.071)	0.224*** (0.077)
R-square	0.964	0.979	0.981
Adj R-square	0.960	0.974	0.977
Heteroskedasticity*: Prob > chi2	0.10	0.13	0.10

Note: All the regressions are estimated using the OLS method, with *, **, and *** denoting statistical significance at the 10%, 5%, and 1%, respectively. The values in the parentheses (…) are the standard errors of the estimates.

Table 3 summarizes the results of the regressions included in this study. In regressions 1, 2 and 3, the results show that the estimated coefficient of the GDP is positive and that the GDPSQ has a negative sign and those are statistically significant. These results confirm that economic growth has the expected Kuznets effect on the environmental circumstances in Laos. It would imply that at the early stage of economic growth, environmental pollution cannot be avoided, but when reaching a higher level, the environmental condition will gradually improve as the level of development and living conditions improve. This study indicates that the computed turning point is approximately equal to US$ 1691.14 (annex1).

In considering the estimated coefficient values of dummy, the results show the positive and statistically significant between dummy and environmental degradation. This finding indicates that joining ASEAN may produce indirect effects on environmental degradation.

The high level of economic competition among ASEAN nations encourages Laos to improve its economic performance, including increasing investment, trade cooperation, and improving productivity related manufacturing and industrialized extension. These factors are related the environmental quality and natural resource circumstances; for example, the huge investments in this country are mainly related to hydropower generation, which is assumed to produce a very strong effect on the environmental system, while it is questionable how the mineral exploration can be sustained in the future. The export products are mainly wood, raw material, and electricity; together with those factors, the rapid increase in the number of vehicles is also considered to be a factor that produces air pollution through gasoline consumption in Laos.

In additional, we assume that there are also other indicators may influence the environmental conditions; therefore, equations 2 and 3, we examined the impacts of trade openness, population density and industrialized expansion on environmental degradation. The results show that the estimated coefficient of OPEN in both regressions are positive but statistically insignificant; however, the positive side correlation, this may indicate that trade openness produces a negative impact on environmental quality, because trade openness is associated with export promotion, which leads to increased productivity in order to obtain a high level of growth and an improved living standard of the population, factors that are assumed to increase the level of air pollution. The estimated coefficient of POPD (regression 2) is positive and statistically significant, this result indicates that population growth contributes to environmental degradation. In brief, this paper indicates that population is an important determinant of environmental degradation through the use natural resources and production wests and is associated with environmental stresses like loss of biodiversity, air and water pollution and increased pressure on arable land.

Moreover, the increase in economic progress aims to obtain a high level of growth, by increasing the volume of productivities and natural resource allocation, leads to an increase in the volume of air pollution and damaged environmental conditions. Regression 3, we examined the impact of industrial extension (IND) by employing its income share in GDP, which is used as a proxy for the development and extension of factories, manufactures, and industries. The result shows that the estimated coefficient value of IND is positive and statistically significant; this confirms that the increase in number of industries is considered to increase the proportion of environmental degradation. Most industries in Laos are related to the natural resource allocation such as, mining (copper, tin, gold, and gypsum); timber, electric power, agricultural processing, rubber, construction, garments, cement, brewery factories, etc.

It is noticeable that the results of those three equations confirm the environmental Kuznets' hypothesis that at the first stage economic growth increases the level of environmental degradation, and then environmental degradation decreases after reaching a certain level of average income per capita. Although the increase in the level of trade openness, industrial extension, and being a member of ASEAN show positive impacts on environmental degradation, if the natural and environmental policies are clearly explained and practiced among trade partners and ASEAN members, the environmental condition of Laos would maintain a good condition for a long time. To conclude this paper we can say that growth is important for the economic development of many countries, if high rate of growth produces a smaller impact on the environmental condition, because this is the only factor to ensure the achievement of sustainable development.

V. CONCLUSIONS AND POLICY IMPLICATIONS

This paper examines the relationship between economic growth and environmental degradation, which is a component of sustainable development. The expected outcome is to master the role of sustainability in the national development priorities, based on growth with equity and the conservation of the resource base. Therefore, this paper provides a very good strategy that can contribute to the sustainable economic development of Laos. In order to generate the most appropriate model, we reviewed relevant theoretical and empirical studies that had been conducted by social scientists, based on the hypothesis of the environmental Kuznets curve (EKC).

This study confirms the inverted-U relationship between economic growth and environmental condition of the environmental Kuznets hypothesis. At the early stage, economic growth increases environmental degradation, then environmental degradation decreases after reaching a certain level of average income per capita. Laos has experienced a high rate of growth since 1990. It is questionable whether the growth causes negative impacts on the environmental condition. To achieve the income per capita at the changing point, it would take a great deal of time, as well as the exploitation of a large amount of natural resources.

Becoming a full member of ASEAN shows a negative impact on the environmental condition, indicating that the high economic competition amongst the members may be pushing Laos to improve its economic performance and also to develop trade cooperation amongst members. Moreover, this study indicates that trade openness also

produces a negative impact on environmental quality. The increase in trade openness leads to increased economic activity through investment and productivity, which aims to increase the volume of exports. The rapid increase in the number of factories/industries and also vehicles lead to an increase to a high level of pollution, since the coefficient value of industrial factors is positive with environmental degradation. Moreover, the economic development of Laos is mainly dependent on natural resources, such as wood, mineral resources, and raw material products. The huge investments are mostly related to environmental issues, especially hydropower investment, which produces a serious problem for the natural system.

Even those factors such as economic growth, trade openness, industrialized extension, and ASEAN membership confirm their negative impacts on the environmental condition. A good government policy is required to ensure current and long-term development. In order to obtain sustainable development, one suggestion is to reconsider the national potential advantage that would contribute to social economic development, particularly the tourism sustainability concept, since Laos is a land of discovery containing historical sites (ancient temples, Buddhist history, etc.), wonderful views of natural resources (caves, waterfalls, islands, etc.), and the traditional lifestyle of Laos (clothes, traditional festivals/beliefs, etc.). These things are the main potential resources that are available in Laos.

A good policy for managing natural resources is essential, especially if Laos wants the growth to continue in the long term. Moreover, the major mining and hydroelectric projects are required to have acceptable environmental impact studies from environmental specialists. In the case of the slash and burn agriculture traditionally practised in remote areas, the Government should put in place a policy to resettle residents in locations where agriculture is sustainable, which would also suggest extending the concept of community participation in development progress. This development concept is assumed to improve the capacity and awareness of local people, which would contribute to their community development and ensure the sustainability of natural resources.

The next suggestion is that to ensure sustainability, an urgent need exists to look beyond the EKC by adjusting courageous policy measures for environmental conservation in Laos irrespective of the country's level of income. The last suggestion relates to ASEAN: since resource scarcity and depletion are a major cause of concern for this region, it is being subjected to severe environmental stress due to rapid industrialization and population growth, and the associated problems of urbanization, pollution, and deforestation. It is necessary to foster strong cooperation among the members to develop a concrete policy for environmental protection, which is based on the characteristics of each member.

REFERENCES

Akpan, U, F. and Chuku, A., (2011) Economic Growth and Environmental Degradation in Nigeria: Beyond the Environmental Kuznets Curve. A Revised Paper Presented at the 4th Annual NAEE/IAEE International Conference, held at Sheraton Hotels and Towers , Abuja, Nigeria, April 2011.

Ascher, W., (1999) Why Governments Waste Natural Resources: Policy Failures in Developing Countries. John Hopkins University Press, Baltimore.

Beckerman, W., (1992) Economic Development and the Environment: Conflict of Complementarity?. Policy Research Working Paper Series 961, the World Bank.

Birdsall, N., Pinckney, T. and Sabot, R., (2001) Natural Resources, Human Capital, and Growth in Resource Abundance and Economic Growth, Oxford University Press, Oxford, pp. 57–75.

Cole, M.A., (2003), "Development, Trade, and the Environment: How Robust is the Environmental Kuznets Curve?", *Environment and Development Economics*, Vol. 8, pp. 557–580.

Daly, H.E., (1991) Steady-State Economics, 2nd Edition. Freeman & Co., San Francesco; Island Press, Washington, D.C.

Dasgupta, S., Deichmann, U., Meisner, C., and Wheeler, D.,(2005) Where is the Poverty-Environment Nexus? Evidence from Cambodia, Laos, and Vietnam. *World Development*, Vol.33, No.4, pp.617-638, doi:10.1016/j.worlddev.2004.10.003

Day, K. and Grafton, R.Q. (2001) Economic Growth and Environmental Degradation in Canada. *Review of Economic Performance and Social Progress*, available online at: http://ideas.repec.org/h/sls/repsls/v1y2001kdfqg.html.

Dijkgraaf, E. and Vollegergh, H.R.J. (1998) Environmental Kuznets Revisited: Time Series versus Panel Estimation: The CO2 Case. Erasmus University Rotterdam, OC/EB, Research Memorandum 9806.

Georgescu-Roegen, N., (1986). The Entropy Law and the Economic Process. *Eastern Economic Journal*, Vol. 7, No. 1, pp. 3–25.

Grossman, G.M. and Krueger, A.B., (1991) Environmental Impacts of the North American Free Trade Agreement. NBER Working Paper, 3914.

Grossman, G.M. and Kreuger, A.B., (1995). Economic Growth and the Environment. *Quarterly Journal of Economics*, Vol. 110, No. 2, pp. 353–377.

Gylfason, T., (2001). Natural Resources, Education, and Economic Development. *European Economic Review*, Vol. 45, pp. 847–859.

Kleeman, L. and Abdulai, A., (2011). The Impact of Trade and Economic Growth on the Environment: Revising the Cross-Country Evidence. *Journal of International Development*, available online at: Wiley Online Library, DIO: 10.1002/jid.1789.

Kuznets.S., (1955). Economic growth and inequality. *American Economic Review*, Vol. 49, No.1, pp. 1-28

Kyophilavong, P., (2011) Trade liberalization, pollulation, and poverty: Evidence from Laos. Research Report published by the Economy and Environment Program for Southeast Asia (EEPSEA),NO.2011-RR11, online: www.eepsea.org

Lawrence, C. (2011) Economic Growth and Human Wellbeing. School of Sociology, University of Western Australia.

Lekakis, J.N., (2000) Environment and Development in a Southern European Country: Which Environmental Kuznets Curves?. *Journal of Environmental Planning and Management*, Vol. 43, No. 1, pp. 139–153.

Munasinghe, M., (2001) Sustainable Development and Climate Change: Applying the Sustainomics Transdisciplinary Meta-framework. *International Journal of Global Environmental Issues*, Vol. 1, No. 1, pp. 13–55.

Norgaard, R.B., (2001) Restructuring Development and Growth for Greater Sustainability. Available online at: http://www.eoearth.org/article/Restructuring_development_and_growth_for_greater_sustainability.

Opschoor, H., (2001) Environmental Economics and Policy Making in Developing Countries. Edward Elgar, Chelthenham, UK; Northampton, MA, USA.

Panayotou, T., (1993) Empirical Tests and Policy Analysis of Development. ILO Technology and Employment Programme Working Paper, WP238.

Phimphanthavong, H., (2012) Economic Reform and Regional Development of Laos. *Modern Economy*, Vol. 3, pp. 179–186, doi:10.4236/me.2012.32025, available online at http://www.SciRP.org/journal/me.

Sachs, J.D. and Warner, A.M., (1995) Natural Resource Abundance and Economic Growth. Development Discussion Paper No. 517, Harvard Institute of International Development.

Selden, T.M. and Song, D. (1994) Environmental Quality and Development: Is there a Kuznets Curve for Air Pollution Emissions?. *Journal of Environmental Economics and Management*, Vol. 27, pp. 147–162.

Shafik, N. and Bandyopadhyay, S. (1992). Economic Growth and Environmental Resources. *Journal of Environmental Economics and Management*, Vol. 4, pp. 1-24.

Smyth, R., Nielsen, I., Zhai, Q., Liu, T., Liu, Y., Tang, C.Y., Wang, Z., Wang, Z., and Zhang, J., (2008) Environmental Surroundings and Personal Well-Being in Urban China. Monash Department of Economics Discussion Paper 32/08.

Stern, D.I. and Common, M.S., (2001) Is there an Environmental Kuznets Curve and for Sulphur?. *Journal of Environmental Economics and Management*, Vol. 41, No. 2, pp. 162–178.

Stern, D. I.,(2004) Environmental Kuznets Curve. *Encyclopedia of Energy*, Vo.2, pp.517-525.

ANNEX 1

Estimated long-run coefficients between economic growth and environmental conditions

Explanatory variable	ED_t
Intercept(c)	-11.23 (2.328)
$GDPP_t$ (β_1)	0.3122** (0.121)
$GDPP_t^2$ (β_2)	-0.0000923* (0.000011)
Dummy	109.3358*** (10.514)
R-square	0.9493
Adj R-square	0.9434
Heteroskedasticity*: Prob > chi2	0.0092
Turning point (τ)	1691.41 $

Note: The turning point is measured by: $\tau = \left|\frac{\beta_1}{2\beta_2}\right| = \left|\frac{0.3122}{2*0.0000923}\right| = 1691.41$ $