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THE RELATIONSHIP BETWEEN AIR QUALITY AND POLITICAL DEVELOPMENT: THE CASE OF NEPAL

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ABSTRACT

Economic development activities are often taken as the key source of environmental degradation, but recently the realization is that evaluating the state of environment in a country cannot be detached from its political development. There are studies accounting the relationship between political development and environmental performance. Those studies have put forward a political EKC hypothesis. This study aims to test the political EKC hypothesis for three different indicators of air pollution: carbon dioxide (CO_2), sulphur oxide (SO_x) and particulate matter (PM_{10}) using time series data for a single country, Nepal. The study specifies an econometric model and the data are analysed using maximum likelihood regression technique. The study posits two important findings. The empirical evidence for the political EKC hypothesis for CO_2 and SO_x does not exist for Nepal, however, CO_2 and SO_x emissions have positive linear relationship with the level of democracy. Second, the level of democracy as measured by the Polity index does not appear as a dominant factor in explaining degradation of air quality. Factors like population and income keep more explanatory power compared to democracy in accounting degradation of air quality.

Keywords: Democracy, Economic development, Environmental degradation, Environmental Kuznets Curve (EKC), Political development

INTRODUCTION

Environmental degradation has emerged as the major problem in different parts of the world. Most of the environmental studies show that economic development activities are the key source

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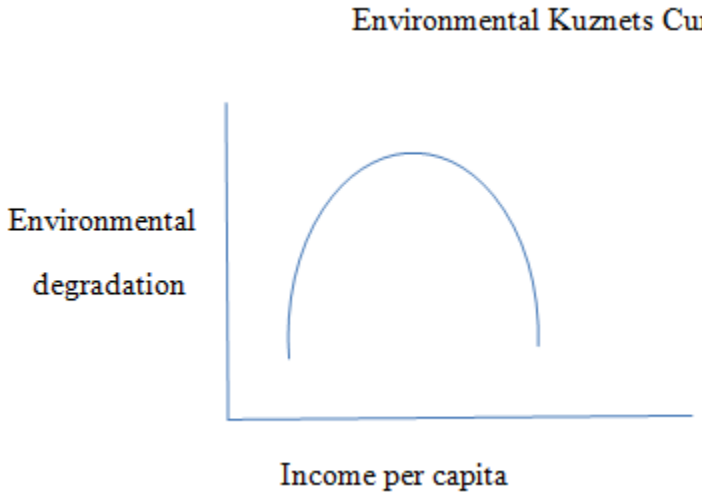
of environmental degradation. These studies have found the relationship between environmental degradation and economic growth not as a linear one, but as an inverted U-shaped, which is popularly known as Environmental Kuznets Curve (EKC). The EKC explains that economic growth is accompanied by deterioration in environmental quality at low income levels and an improvement in environmental quality at high income levels (Barrett and Graddy, 2000).



There are several studies that test the EKC relationship between economic growth and different indicators of environmental quality. However, the relationship is found evident only for some indicators of environmental quality (but not all). In recent years, scholars have started to see the effects of political system (level of democracy) on environmental performance of a country. The question is being raised what effect the democracy may have on environment. Some emerging findings are that the state of political system of a country influences the state of many other facets in the society, including the environment. Buitenzorgy and Mol (2011) uses deforestation rates as a proxy for environmental degradation and studies the effects of political system on deforestation rates. Their result suggests that countries in the process of democratization (young democracies) are more vulnerable to environmental degradation. It is, therefore, sensed that political stability helps planning, drawing programs and implementing policies for environmental preservation.

Literature in political science and environmental studies comes with the debate among scholars regarding the effect of the political development, measured as the level of democracy, on the state of environment. Some scholars claim that democracy has no significant effect on environmental quality, whereas others argue that there is significant relationship between democracy and environmental quality. Empirical evidences so far have been limited and conflicting, and there are still inconclusive and unsettled answers in the literature about the

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relationship between democracy and environment. Pellegrini and Gerlagh (2006) reported the limited power of democracy to explain environmental policy stringency. Grafton and Knowles (2004) found insignificant effect of the political system on total suspended particulate matter (TSP) concentration and four other environmental indicators. Similarly, Roberts and Parks (2007) found that the level of democracy had almost no impact on carbon dioxide emissions.

However, there is comparatively large group of researchers who believe in existence of significant relationship between the level of democracy and environmental performance, no matter the relationship is positive or negative. Payne (1995), in his theoretical evidence, supports the case for the positive effect of democracy on environment. He argues that people in democratic countries enjoy freedom of press, freedom of speech, freedom of association and freedom of vote. This helps them become able to express their views on environmental issues, which in turn influences policy-making on environmental sector. Gleditsch and Sverdrup (2002), from their study on a sample of 108 countries, reports that increase in the level of democracy (represented by Polity III index) lowers carbon dioxide emissions per capita. Farzin and Bond (2005) associate higher Polity scores with lower levels of carbon dioxide, volatile organic compounds, nitrogen oxides and sulphur dioxide emissions. Some scholars have contrasting views too. They believe that democracy has negative effects on the environment. Hardin (1968) raises the issue of unchecked natural resource exploitation and environmental mismanagement from the independent citizens of democratic country, each of which acting in their individual self-interest (Li and Reuveny, 2006).

Recently, Buitenzorgy and Mol (2011) introduced a modification of the EKC hypothesis, termed as 'political' EKC hypothesis. This 'political' EKC hypothesis implies that countries classified as young democracies experience highest incidence of environmental degradation, while autocracies and mature democracies experience less or environmental quality may be better there. Buitenzorgy and Mol (2011) found the empirical evidence for an EKC relationship between deforestation and democracy. The finding from Buitenzorgy and Mol keeps high importance in the case of Nepal in understanding the state of environment. Nepal is going through severe degradation of environment in the last twenty years. During the same time, political instability remains a major problem affecting all other areas of development. At this situation, economic growth alone cannot be taken as the major cause of such degradation. Political instability must better explain such environmental degradation.

Using available data sets on three major air pollutants: carbon dioxide (CO_2), sulphur oxides (SO_x) and particulate matter (PM_{10}) concentration and the level of democracy (measured by Polity Index), this study aims at investigating the relationship between democracy and air pollutants, and comparing the explanatory power of democracy versus other control variables in

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explaining degradation of air quality. The study, therefore, helps to reveal the relationship between political system and environmental performance of the country, Nepal.

DATA DESCRIPTION AND METHODOLOGY

For the collection of data, first we contacted Government of Nepal, National Planning Commission Secretariat, Central Bureau of Statistics, Kathmandu, Nepal. We got very few publications on 'Environment Statistics of Nepal' from there, which we found not enough to generate necessary data for the research. Then we went to the World Bank's website for the 'World Development Indicators' from where we retrieved most of the data used in the research.

The data and methods used in the empirical analysis are discussed below. The descriptive statistics of the data is given in Table 1.

Table 1: Definition and descriptive statistics of the variables, 1960-2010

Variables	Description	Unit	Year	Obs.	Mean	Std. Dev.	Min	Max
CO2	CO_2 emissions	metric tons/capita	1960-2008	49	0.056	0.042	0.008	0.138
Sox	SO_x emissions	thousand metric tons	1960-2000	41	7.422	5.391	0.998	17.9
PM10	PM10 concentration	micrograms/m3	1990-2009	20	48.599	12.109	29.504	67.286
DEMO	Democracy level (polity index)	Index	1960-2010	51	-2.745	6.399	-10	6
POP	Population density	people/km2	1961-2010	50	127.218	42.764	69.354	208.995
INDUSTRY	Value added to GDP (manufacturing)	%	1965-2010	46	15.188	4.522	8.176	22.916
YPCAP	GDP per capita	current US$	1960-2010	51	171.921	106.858	47.266	534.528
YGROWTH	Annual percentage change in real GDP per capita	%	1961-2010	50	1.366	2.716	-5.248	7.114

Dependent Variables

To account the environmental performance, the three key indicators of air pollution used in the study are: carbon dioxide (CO_2) emissions, emissions of sulphur oxides (SO_X) and particulate matter (PM_{10}) concentration.

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The data on CO_2 emissions and PM_{10} concentration was collected from the World Development Indicators (The World Bank, 2012). The data on SO_X emissions were obtained from Stern (2005).

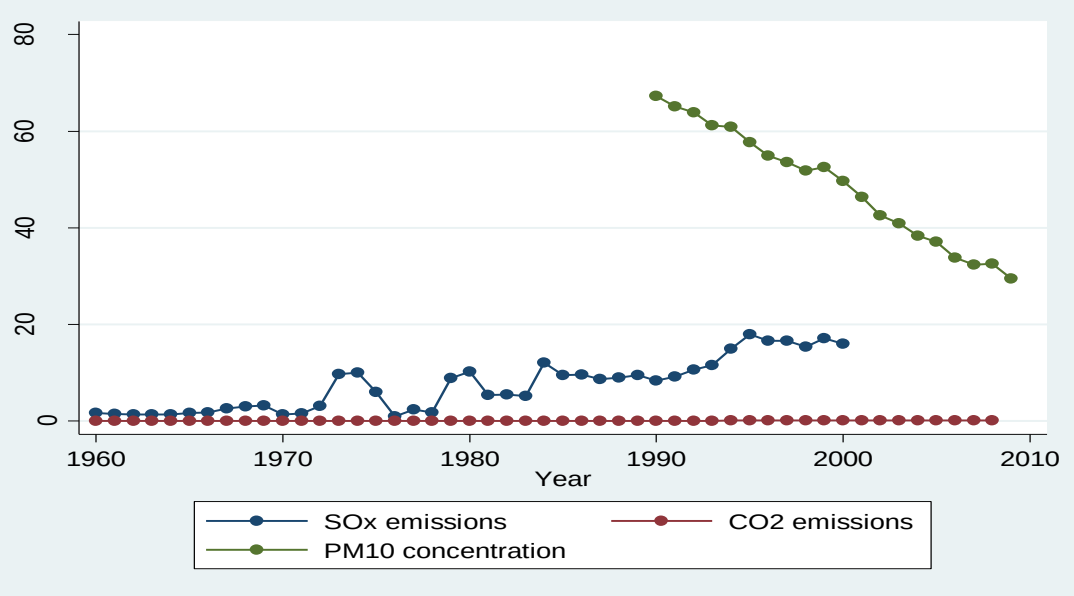

Fig 1: Emission trends of three different pollutants during 1960-2010.

Independent Variables

Level of Democracy

The main independent variable is the level of democracy. We chose Polity IV index as the proxy of democracy level from among other democracy indices like Freedom House Index and Vanhanen Index. This index includes a specific range that is associated to the semi-democratic regime. Polity index is a combined index of democracy and autocracy based on the Polity project. The polity score is computed by subtracting the Autocracy score from the Democracy score, and the resulting combined polity scale ranges from +10 (strongly democratic) to -10 (strongly autocratic). The three regimes of polity score are designed as 'autocracies' (-10 to -6), 'anocracies' (-5 to +5) and 'democracies' (+6 to +10). Anocracies describe those countries that reveal mix of democratic and autocratic characters and practices (Marshall, Jaggers and Gurr, 2011).

Control Variables

Economic Activity

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The level of output per capita (GDP per capita) and its squared term is used in the statistical model, which includes the concept of economic Environmental Kuznets Curve. The data on the economic output were taken from the World Development Indicators (The World Bank, 2012). The data are in the current US$.

Population Density

It is the total population of an area divided by its land size. The effect of population density on air pollution may vary across different air pollutants. The data on this variable were gathered from the World Development Indicators (The World Bank, 2012).

Industry

The development of industrial activities in any jurisdiction plays a vital role in causing air pollution. The industry indicator used in the study represents percentage of value added to GDP from manufacturing. The data were gathered from the World Development Indicators (The World Bank, 2012).

Empirical Model

The available time series data were used for all described variables. The data sample used in the model is of Nepal for the periods as reported in Table 1. For the analysis of data, the following econometric model was specified:

$$e_t = \beta_0 + \beta_1 DEMO_t + \beta_2 DEMO_t^2 + \beta_3 Y_t + \beta_4 Y_t^2 + \beta_5 POPDEN_t + \beta_6 INDUSTRY_t + \varepsilon$$

In the model, e_t denotes the quantity of a pollutant in year *t*, β_0 is the intercept, $DEMO_t$ denotes the Polity index in year *t*, Y_t denotes per capita GDP in year *t* (in current US$), $POPDEN_t$ denotes population density in year *t*, $INDUSTRY_t$ denotes the proportion of value added to GDP (%) from manufacturing. Any unobserved factors that influence the response variable are captured in the term ε. The data were analysed using maximum likelihood regression in STATA.

RESULTS AND DISCUSSION

The results of regression analyses based on the designed statistical model are presented in the tables 2, 3 and 4. In the analysis, five different models are used with different control variables for each response variable. This was done to see and compare the explanatory power of different control variables in explaining degradation of air quality.

When the model includes only the democracy level (polity index) variable, the linear terms for CO_2 and SO_x emissions appear positively significant (Figs. 2 and 3), while the variable fails to

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explain the PM_{10} concentration as the results remain insignificant. However, models 2 and 3 results show that with the inclusion of other control variables, democracy loses its significance in explaining CO_2 and SO_x emission phenomena, while the results for PM_{10} appear opposite, i.e., both linear and quadratic terms for the variable remain positively significant. Except the model 1, all other models for SO_x emission do not perform well. Models 4 and 5 exclude democracy variable and include income and income square. From the results, it is evident that linear and quadratic coefficients of the income variable fail to explain SOx emission. For PM_{10}, both linear and quadratic terms appear significant giving U-shaped curve, which suggests that increase in the level of income decreases the level of PM_{10} up to a certain point and then increases with the increase.

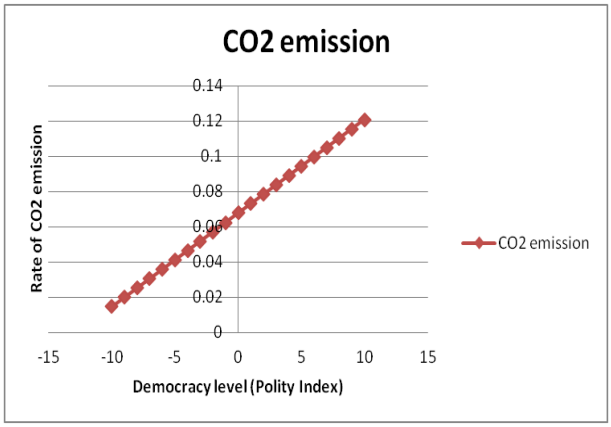

Fig. 2

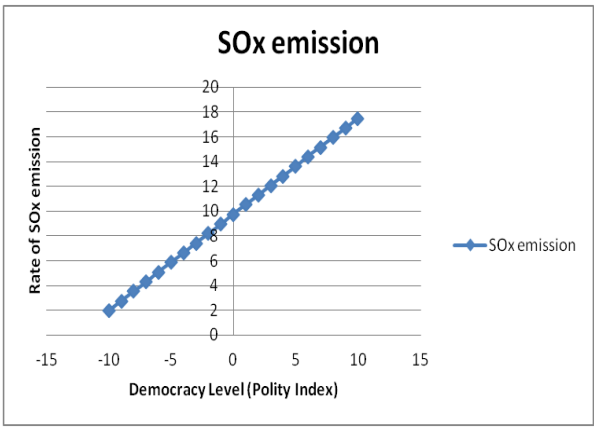

Fig. 3

Figures: Line plots of carbon dioxide and sulphur oxides emissions against level of democracy

Maximum likelihood regression results using Polity Index for democracy

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Table 2: For Carbon dioxide (CO_2)

Independent Variables	Model 1 N=49	Model 2 N=44	Model 3 N=44	Model 4 N=44	Model 5 N=49
Constant	0.068	-0.104	-0.088	-0.080	-0.031
	(0.000)***	(0.000)***	(0.009)**	(0.000)***	(0.082)*
Democracy	0.0053	0.00023	0.00071		
	(0.000)***	(0.749)	(0.257)		
Democracy-sq	0.000091	0.00033	0.00018		
	(0.748)	(0.020)**	(0.329)		
Population density		0.00085	0.0015	0.0016	
		(0.000)***	(0.000)***	(0.000)***	
Industry-value added to GDP		0.00279	0.00145	0.0019	
		(0.001)**	(0.148)	(0.020)**	
Income			-0.00054	-0.00077	0.00069
			(0.137)	(0.001)**	(0.000)***
Income-sq			----	---	-0.00000067
					(0.058)*
Wald chi2	*17.44*	*240.07*	*311.82*	*354.18*	*57.78*
Prob>chi2	*(0.0002)***	*(0.0000)***	*(0.0000)***	*(0.0000)***	*(0.0000)***

Table 3: For Sulphur oxides (SO_x)

Independent Variables	Model 1 N=41	Model 2 N=36	Model 3 N=36	Model 4 N=36	Model 5 N=41
Constant	9.764	-17.060	-16.984	-11.311	1.514
	(0.000)***	(0.094)*	(0.236)	(0.328)	(0.779)
Democracy	0.776	-0.273	-0.277		
	(0.000)***	(0.499)	(0.533)		
Democracy-sq	0.011	0.0054	0.00236		
	(0.709)	(0.840)	(0.949)		
Population density		0.177	0.190	0.191	
		(0.060)*	(0.291)	(0.255)	
Industry-value added to GDP		0.265	0.243	0.061	
		(0.482)	(0.556)	(0.886)	

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Income			-0.0102	-0.025	-0.0067
			(0.923)	(0.758)	(0.931)
Income-sq			0.0000133	----	0.000332
			(0.976)		(0.207)
Wald chi2	*39.80*	*69.89*	*71.35*	*72.96*	*65.92*
Prob>chi2	*(0.0000)***	*(0.0000)***	*(0.0000)***	*(0.0000)***	*(0.0000)***

Table 4: For Particulate matter (PM_{10})

Independent Variables	**Model 1 N=20**	**Model 2 N=20**	**Model 3 N=20**	**Model 4 N=20**	**Model 5 N=20**
Constant	105.248	133.102	137.140	140.103	150.628
	(0.000)***	(0.000)***	(0.000)***	(0.000)***	(0.000)***
Democracy	-0.014	0.110	0.0192		
	(0.986)	(0.017)**	(0.651)		
Democracy-sq	-1.823	0.234	0.355		
	(0.000)***	(0.001)**	(0.000)***		
Population		-0.565	-0.628	-0.496	
density		(0.000)***	(0.000)***	(0.000)***	
Industry-value		0.170	0.354	0.098	
added to GDP		(0.159)	(0.002)**	(0.477)	
Income			-0.016	-0.065	-0.631
			(0.683)	(0.387)	(0.000)***
Income-sq			0.0000506	0.0000966	0.00082
			(0.349)	(0.344)	(0.000)***
Wald chi2	*38.94*	*5371.42*	*6274.16*	*1412.38*	*108.09*
Prob>chi2	*(0.0000)***	*(0.0000)***	*(0.0000)***	*(0.0000)***	*(0.0000)***

Values in the first and second rows of each independent variables are normal coefficients and p-values (in parenthesis) respectively. *, **, *** denote level of statistical significance at 10, 5 and 1 % respectively.

The overall result shows that increase in the level of democracy increases CO_2 and SO_x emissions. However, there is no empirical evidence for the political EKC hypothesis in Nepal. This might be because Nepal has not attained the mature democracy yet, and is still in the phase of young democracy. This suggests that the level of democracy lies within the range of young democracy for Nepal, which in the political EKC is represented by the first half of the curve

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before reaching to the turning point (i.e. mature democracy). When democracy variable together with other control variables like income, population density and industry (manufacturing) are included in the model, democracy loses its significance while variables like population density and industry remain significant. This proves that democracy is not a dominant factor to explain the emission phenomena in Nepal. There are other factors which have comparatively more explanatory power than democracy. The finding with income variable is quite significant for CO_2 emission, which seems to satisfy the economic EKC hypothesis. This means that economic growth increases the emission up to a certain point, after which emission rate decreases with increase in income. The results for PM_{10} concentration fluctuate throughout the models, so the study finds difficulty in predicting the precise relationship between PM_{10} and the control variables. This might be due to limitation in data availability (only 20 observations) for PM_{10}.

CONCLUSION

This study contributes the knowledge in understanding the relationship between political development and environmental performance in Nepal at the time when the issue has hit the ground on global context. The study posits two important findings. First, there is no empirical evidence for the political EKC hypothesis for air pollutants like CO_2 and SO_x. However, the study finds that CO_2 and SO_x emissions have positive linear relationship with the level of democracy. This might be due to the fact that Nepal is still in the phase of young democracy, and the level of democracy, therefore, lies within the range of young democracy, which in the political EKC is represented by the first half of the curve before reaching to the turning point (i.e. mature democracy). Second, the level of democracy as measured by the Polity index does not appear as a dominant factor in explaining degradation of air quality. Other factors like population and income have more explaining power than democracy in accounting degradation of air quality in the case of Nepal.

Unlike previous studies, this is a single country study and it reveals that political EKC may not hold true for all countries. Despite difficulties in data availability, the study takes three indicators of air pollution and looks them separately. From the study, it is evident that for a country like Nepal where high population growth is a major concern, environmental problems are going parallel with it. Population density being significant most of the time in the results indicates high population density brings high degradation of air quality. The study, therefore, also warns about the bad consequences of rapid population growth in near future if necessary controlling measures are not taken in time.

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REFERENCES

Arrow K, Bolin B, Costanza R, Dasgupta P, Folke C, Holling CS, Jansson BO, Levin S, Maler KG, Perrings C, Pimental D. Economic growth, carrying capacity and the environment. *Science.*1996; 268: 520-21.

Baek J, Cho Y, Koo WW. The environmental consequences of globalization: A country-specific time-series analysis. *Ecological Economics.* 2009; 68: 2255-2264.

Barrett S, Graddy K. Freedom, growth, and the environment. *Environ. Dev. Econ.* 2000; 5 (4):433-456.

Bernauer T, Koubi V. Effects of political institutions on air quality. *Ecological Economics.* 2009; 68 (5): 1355-1365.

Buitenzorgy M, Mol APJ. Does democracy lead to better environment? Deforestation and democratic transition peak. *Environ. Resource Econ.* 2011; 48: 59-70.

Congleton RD. Political institutions and pollution control. *Rev. Econ. Stat.* 1992; 74: 412-421.

Endres W. *Applied Econometric Time Series.* JohnWiley & Sons, Inc., Courier Kendallville. 2010.

Eriksson C, Presson J. Economic growth, inequality, democratization, and the environment. *Environ. Resource Econ.* 2003; 25 (1): 1-16.

Farzin YH, Bond CA. Democracy and environmental quality. *J. Dev. Econ.* 2006; 81 (1): 213-235.

ISSN: 2455-8834

Volume:02, Issue:09 "September 2017"

Gleditsch NP, Sverdrup BO. Democracy and the environment, in Page EA, Redclift M (Eds). *Human Security and the Environment: International Comparisons.* Edward Elgar, Cheltenham. 2002; 45-70.

Government of Nepal. Environment Statistics of Nepal. National Planning Commission Secretariat, Central Bureau of Statistics, Kathmandu, Nepal. 2006.

Grafton RQ, Knowles S. Social capital and national environmental performance: a cross-sectional analysis. *J. Environ. Dev.* 2004; 13 (4): 336-370.

Grossman GM, Krueger AB. Economic growth and the environment. *Quart. J. Econ.* 1995; 110 (2): 353-357.

His Majesty's Government. Handbook of Environment Statictics. National Planning Commission Secretariat, Central Bureau of Statistics, Kathmandu, Nepal. 2003.

Li Q, Reuveny R. Democracy and environmental degradation. *Int. Stud. Quart.* 2006; 50: 935-956.

Marshaall MG, Jaggers K, Gurr T. Polity IV project: political regime characteristics and transitions, 1800-2010. Centre for Systemic Peace. 2011. Available from URL: http://www.systemicpeace.org/polity/olity4.htm. Cited 15 March 2012.

Midlarsky M. Democracy and the environment: an empirical assessment. *J. Peace Res.* 1998; 35 (3): 341-361.

Pas-ong S, Lebel L. Political transformation and the environment in Southeast Asia. *Environment*. 2000; 42 (8): 8-19.

Pellegrini L, Gerlagh R. Corruption, democracy, and environmental policy: an empirical contribution to the debate. *J. Environ. Dev.* 2006; 15 (3): 332-354.

Roberts JT, Grimes PE. Carbon intensity and economic development 1962-91: a brief exploration of the Environmental Kuznets Curve. *World Dev.* 1997; 25 (2): 191-198.

Saboori B, Sulaiman JB, Mohd S. An Empirical Analysis of the Environmental Kuznets Curve for CO2 Emissions in Indonesia: The Role of Energy Consumption and Foreign Trade. *International Journal of Economics and Finance.* 2012; 4 (2): 243-251.

Stern DI. Global sulfur emissions from 1850 to 2000. *Chemosphere.* 2005; 58: 163-175.

ISSN: 2455-8834

Volume:02, Issue:09 "September 2017"

Stern DI. The rise and fall of the Environmental Kuznets Curve. *World Dev*. 2004; 32: 1419-1439.

The World Bank. World Development Indicators. Washington DC, The World Bank. 2012. Available from URL: http://databank.worldbank.org/ddp/ Cited 28 July 2012.

Torras M, Boyce JK. Income, inequality, and pollution: a reassessment of the Environmental Kuznets Curve. *Ecol. Econ.* 1988; 25 (2): 147-160.

