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DETERMINANTS OF ENVIRONMENTAL SUSTAINABILITY IN NEPAL

KESHAV RAJ PANTHEE,

Faculty of Environmental Management, Prince of Songkla University, Songkhla, Thailand

PRAKRIT NOPPRADIT,

Marine and Coastal Resources Institute, Prince of Songkla University, Songkhla, Thailand

SAROJ GYAWALI

Sustainable Study and Research Institute, Kathmandu, Nepal

Abstract

This paper explores the determinants of environmental sustainability in Nepal. Carbon intensity has been used as an alternative to measure environmental sustainability. Using the auto regressive distributed lag model (ARDL) based on timeline data for the period 1984 to 2014 the study concludes that economic globalization, urban population growth, GDP per capita growth and energy consumption have a significant and positive impact on carbon intensity in the long run. The outcome justified by the diagnostic tests shows the threat to the environmental sustainability in Nepal as all the selected variables are found increasing total carbon intensity.Without sincere and grass-root effort such negative impact on the environment through reduction in carbon intensity seems impossible in the present context of slow industrial development. Based on the outcome the study suggests for the sector-wise carbon intensity reduction strategy. It further demands for the in-depth research and development on determinants of carbon intensity for the effective implementation of climate change policy as well as for promoting green economy as envisioned in 15th five year plan of government of Nepal.

Keywords: Carbon intensity, Economic globalization, Energy Use, Environment, Energy, ARDL, Nepal

1. Introduction

Climate is a nonlinear, discontinuous, chaotic system chock full of feedback systems beyond our comprehension [1]. So, disturbance in the natural ecosystem caused by human induced activities bring adverse impact in the climate change. Human induced climate change is already affecting many weather and climate extremes in all regions of the world [2]. In the context of climate change, energy-related carbon emissions have attracted a lot of attention in recent years[3].Advancement in human life style has geared up CO2 emissions through increased energy consumption and it has become threat for the environmental sustainability. This fact was formally realized worldwide after the United Nations Framework Convention on Climate Change in 1992. Thereafter, joint voice for reducing energy relatedCO2 emissions was raised in the form of Kyoto Protocal 1997, Paris Agreement 2015, and Sustainable Development Goals 2015 (clause: 7.1,7.2 and 7.3). The ultimate aim of such joint global efforts isto ensure environmental sustainability. Therefore, in recent energy economics literature, the problem of CO2 emission is often considered a fertile research area due to its growing global significance [4]. Is measuring

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total CO_2 emission sufficient for tracking environmental sustainability? Obviously not. The scholars now a days have been using carbon intensity (CI) along with the CO_2 emissions for measuring environmental sustainability. It is because CO_2 emission reports only a total number which may not clearly indicate the carbon efficiency of the activities. However, CI generally tracks total carbon emissions divided by some activity and such CI measurements normalize environmental impact data against a business or performance (either for fast-growing or declining businesses) and allow for benchmarking and performance analyses[5].This indicator is helpful for tracking the achievement of carbon efficiency measures in the context of growing debate in international climate negotiations on the obligation to reduce greenhouse gas emissions between developing and developedeconomies [6].The previous studies also signify the growing importance of the carbon metric, carbon intensity [6-9].

Nepal, surrounded by the world's first and third most carbon polluters China and India[10], is facing the adverse impact of environmental degradation in recent years.CO_2 emission as well as overall CO_2 intensity (fig 1) is also in increasing trend. The average growth rate of carbon intensity(0.31)during past 30 year (table 1)indicates the need of prompt attempt for initiating sustainable environment measure. Urban Population growth rate and economic integration with the outer world is increasing threat to environmental sustainability via increased energy consumption. As said by Weng&Mokhtar [11] land clearances for farming, housing, highways and dams have caused negative environmental problems in Nepal along with increased urbanization and population growth. The real growth of CO_2 emission has not been realized yet as the level of industrial growth is still low. The contribution of manufacturing industry to the economic growth rate is 5.33 percent in FY 2020/21 and average growth rate of primary, secondary and tertiary sector for past decade is only 3.07 %, 4.95% and 4.63 % respectively [12]. As per the new political structure, diversified economic activities along with the formation of province structure shows possibility for spurring industrial activities in the coming years. Increasing urban population, growth in theuse of different forms of energy has become threat for the environmental sustainability in Nepal. Disturbance in the schedule of rainfall, unexpected change in winter and summer temperatures have urged the policy makers for adopting sustainable environment measures.

In this context, the paper has attempted to study the determinants of CI, a proxy variable for environmental sustainability in Nepal. It aims to establish the linkage between environmental sustainability and other factors such as energy use, economic globalization index, urban population growth and GDP growth of Nepal. These determinants are selected realizing the fact that the carbon intensity in the economy is determined by the carbon intensity of each sector and their structure in the economy [12]. However, this study uses total carbon intensity. The issue of linking CO_2 emissions with globalization has been one of the most debated issues since1970[13]. Similarly the impact of urban population growth, GDP growth and energy demand on CO_2 emissions are also widely discussed issues in the academic literatures since past two decades. As per the researchers knowledge this is a first paper studying on the determinants of CO2 intensity of Nepal including the variable economic integration (measured in terms of economic globalization index).Similarly, most of the available literature [4, 15-18] have explored the determinants of CO2. Very less literatures have used carbon intensity for testing the determinants of environmental sustainability. Hence, this paper will contribute to the carbon-intensity based literatures. In the context of nationally determined contribution (NDC) set forth by the government of Nepal under the Paris Agreement for the period 2021-2030 [19] this paper will give some insights regarding the significance of measuring carbon intensity for environmental sustainability and its major determinants.

2. A Review of relevant literature

Majority of the literatures based on the study of single country or multi country case have linked CO2 emission with several socio-economic and political factors. Balogh and Jambor[18] examined economic growth, tourist arrivals, energy use, trade, foreign direct investment, industrial structure and agriculture as the major global determinants of carbon dioxide emissions by using GMM models. Based on the 24 years data from124 countries the study found a positive role of renewable energy and nuclear power in reducing CO2 emissions. Size of industrial sector, agricultural land productivity, tourist arrival and use of coal had significant positive impact on pollution. Using the same GMM method Bae et al.[20] examined the determinants of CO2 emission in 15 post- Soveit Union independent countries. The study established both the direct and indirect impact of GDP and corruption on CO2 emission. But economic freedom and political democracy showed indirect effect on CO2 emission.

In the South Asian countries Bangladesh, India, Nepal and Sri Lanka, Alam[15] showed that agricultural value added to GDP has a significant negative impact on CO2 emission. Similarly, industrial and service value added in the GDP has a significant positive impact on CO2 emission. By rejecting the application of environment Kuznet curve the study showed the statistically significant positive correlation between import, export, fossil fuel energy consumption, electricity power consumption, energy use, energy production and CO2 emission. The study was based on a simple regression model using the data from the period 1972 to 2010. By the use of autoregressive distributed lag model Nain et al.[4] showed the existence of long-term relationship between energy consumption, GDP and CO2 in India during 1971 to 2011. The study was based on disaggregated causal analysis.

Bastola&Sapkota[21] showed a long-term relationship between energy consumption, economic growth and pollution emission in Nepal by using Johansen co-integration and ARDL bound test for the period 1980 to 2011. By using Granger causality test they showed long run bidirectional causality between carbon emission and energy consumption. However, a unidirectional causality running from economic growth to both energy consumption and carbon emission was observed. It means economic growth in Nepal during the study period seems to be causing more energy consumption and carbon emissions. Sharma et al. [17] examined the link between aid, remittance, growth, and carbon emission in Nepal using annual data from 1971 to 2013. They found that higher foreign aid and remittances lower CO2 emissions in the long run. However, financial development and higher income (per capita GDP) increase CO2 emission.

In Pakistan, Mansoor & Sultana[16] found increase in CO2 emission resulting from energy demand and population growth in long run. However, the negative relation between CO2 emission and GDP was confirmed in long run. The study was based on ARDL bounds testing over the period 1975-2016. Yuping et al.[22] studied the determinants of carbon emissions in Argentina during the period 1970 to 2018. They used the Maki co-integration tool and discovered the long-term relationship between globalization, carbon-dioxide emissions, renewable and non-renewable energy consumption and economic growth. The elasticity estimates from the ARDL model showed renewable energy consumption and globalization as major factors that reduce carbon emissions in the short and long run. However, in the long run,non-renewable energy and globalization were found jointly boosting carbon emission.

Shahbaz et al. [14] tested the dynamic relationship between carbon dioxide emissions and globalization between the 87 low, middle and high income countries. Of the 30 high income countries, 50.3 % showed positive and significant correlation and 43.3 % showed negative and significant correlation between CO2 emissions and globalization. Out of 48 middle income countries globalization in 36 countries (75%) show positive correlation and 6 countries (12.5%) have negative and insignificant relation with CO2 emissions. Out of 9 low income countries the average carbon emission was found positive in 5 countries (55.5%) and negative and significant correlation between CO2 emissions and globalization was found for 3 countries (33.3%). Positive and highly significant correlation between the selected variables was found for Nepal. U-shaped relation between environmental degradation and globalization was confirmed for only 8 % countries. The study covered the period 1970 to 2012.

Begum et al. [23] studied the dynamic impact of CO2 emissions, population growth and energy consumption on CO2 emissions in Malaysia during the period 1970 to 2009. The study confirmed the long term positive impact of per capita GDPand per capita energy consumption on per capita carbon emissions. The result showed no any significant impact of population growth rate on per capita CO2 emissions. The study used ARDL bounds test, dynamic ordinary least squared method and the Sasabuchi-Lind-Mehlum U tests. However, a review study by Liddle[24] justified a positive relation between urbanization and carbon emissions. But population density was found associated with lower carbon emissions.

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Ssali et al. [25] studied the effect of economic growth, energy use and population growth on carbon emissions in sub Saharan Africa for the period 1990-2014. By the use of the vector error correction model and fully modified ordinary least Square method they showed a positive and significant influence of energy use and population growth on CO_2 concentration. But economic growth had insignificant impact on CO_2 emissions.

The link between CO_2 intensity and other influencing variables is studied only by few scholars. Fan et al. [6] measured the impact of international trade on carbon emission intensity using a multiregional input-output model. Based on the study of 14 major economies for the period 1995 to 2009 they found that developing and transition economies had 3.5 times more export carbon intensity than import carbon intensity. Bashir et al. [8] studied the role of export diversification for carbon intensity and energy intensity (proxy for energy efficiency) in 29 OECD countries by taking data from 1990 to 2015. The empirical findings showed that diversification in export portfolio and trade relations help to improve energy efficiency in OECD countries. The study further showed asignificant and negative impact of economic growth and trade openness on carbon intensity. Similarly, impact of urbanization on carbon intensity was found negative. The findings was derived by the use of System GMM and difference GMM. Among the single country scenario, Guan et al. [13] studied the determinants of changing sectoral carbon intensity in 30 provinces of China for the period 2002 to 2009. The study found sectoral level carbon efficiency only in two richest coastal provinces. They further showed that carbonizing production structure improved carbon efficiency irrespective of the growth of the production, even by ten folds in the production of heavy machinery.

3. Methodology

This section includes the description of the model and econometric technique of testing it. On the basis of above sections we have mainly focused on identifying the determinants of carbon intensity. For this purpose, following model have been developed.

CI_t = f (Euset, Eglobt, Upopgt, GDPgt)……………(i)

Where,

CI_t = Carbon intensity

Euset = Energy use

Eglobt = Economic globalization index

Upopgt= Urban population growth

GDPgt = Per capita GDP growth

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All the variables in model (i) are transformed into following logarithmic form:

$lnCI_t = \alpha + \beta_0 lnEuse_t + \beta_1 ln\ Eglob_t + \beta_2 lnUpopg_t + \beta_3 lnGDPg_t + \varepsilon$…..(ii)

3.1 Econometric Technique

We begin by examining time series properties of the selected variables and find the order of integration. For this, we use Augmented Dickey Fuller (ADF) and Phillipps-Perron (P-P) tests. Based on the order of integration, we select the appropriate method to find existence of co-integration among the variables. Modeling time series in order to keep their long-run information intact can be done through cointegration[26]. The presence of co-integration estimates indicates the existence of a long-run relationship between the variables [27].The integration order of our variables are different. So, instead of using the usual co-integration techniques developed by Engle and Granger [28] and Johansen and Juselius [29] which are only valid in cases with the same order of integration (Nepal & Paija, [30] we have used ARDL technique developed by Pesaran et al. [31]. The ARDL technique is more authentic in small samples and avoids endogeneity problems and helps to estimate coefficients in the long run (Ahmed and Long, [32]). It supports variables irrespective of integration order:I (0), I (1) or a combination of both. After confirmation of the long-run relationship through the ARDL bound test, we present the model results and further perform diagnostic and stability tests to verify the strength and stability of the selected ARDL model.

3.2 Data

The empirical part is designed as per the availability of data on carbon intensity and other needy variables for the selected model. Data on carbon intensity (kg per kg of oil equivalent energy), energy use (kg of oil equivalent per capita), urban population growth (annual %), per capita GDP growth (annual %) are sourced from world development indicators of the World Bank. The Economic globalization index is extracted from KOFGlobalisation Index [33]. This index includes both the trade and financial globalization of the country.The study covers the time frame of 1984 to 2014.

Table 1 shows the descriptive statistics in level form. The mean of carbon intensity, energy use, per capita GDP growth, economic globalization index, and urban population growth is 0.32 kg per kg of oil equivalent energy, 336.89 kg of oil equivalent per capita, 4.69 %, 24.07 and 4.80% respectively. The value of the Jarque-Bera (J-B) test indicates that the variables under study are normally distributed.

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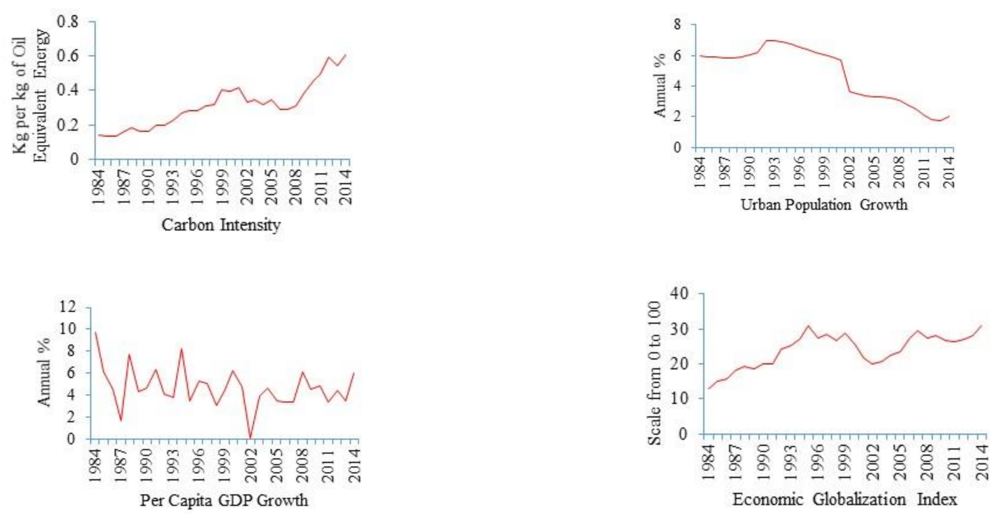
Table 1: Descriptive Statistics

Variables	CI	EUSE	GDPG	EGLOB	UPOPG
Mean	0.3127	336.8867	4.6909	24.0660	4.7988
Median	0.3087	326.6779	4.5331	25.8100	5.8621
Maximum	0.6099	434.4645	9.6811	31.0102	6.9946
Minimum	0.1331	301.6274	0.1201	12.9619	1.7558
Std. Dev.	0.1323	35.5192	1.8420	4.8530	1.8010
Skewness	0.5776	1.0536	0.3897	-0.5952	-0.4049
Kurtosis	2.6685	3.4527	4.2526	2.3466	1.5503
J-B test	1.8658	6.0001	2.8114	2.3821	3.5616
P-value	0.3934	0.0498	0.2452	0.3039	0.1685

Time series plots of above mentioned variables are shown in fig. 1. Carbon intensity, energy use and economic globalization index are in increasing trend. Per capita GDP growth is fluctuating around the constant mean and urban population growth is in declining trend during the study period.

Fig 1: Data Series



4. Estimation and Results

This section includes the results of unit root tests and ARDL estimations. Table 2shows that two variables are stationary at the level and three variables are stationary at first

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difference. I (0) and I (1) level of integration of the variables allow us to employ ARDL model.

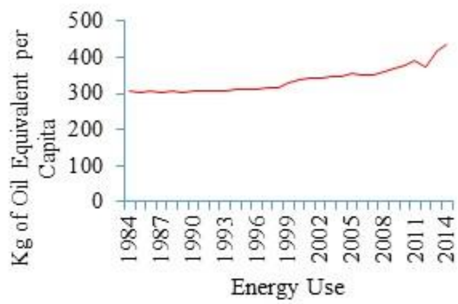

Table 2: Augmented Dicky Fuller (ADF) and Phillips Perron (P-P) unit root test

		lnCI	lnGDPG	lnEGLOB	lnEuse	lnUPOPG
At Level						
ADF	Intercept	-0.6225	-5.6843***	-2.7125*	1.8174	0.5651
	Intercept and Trend	-2.3811	-5.6036***	-2.6808	-1.0372	-1.6376
P-P	Intercept	-0.6002	-5.6910***	-2.6690*	3.3225	0.5651
	Intercept and Trend	-1.8235	-5.6354***	-2.4817	-0.5789	-1.6606
At First Difference						
ADF	Intercept	-5.5714***	-5.8843***	-5.6354***	-5.8987***	-3.8748***
	Intercept and Trend	-5.4712***	-5.7445***	-9.1649***	-7.0294***	-4.0219**
P-P	Intercept	-5.5667***	-21.4793***	-4.5075***	-5.8995***	-3.8720***
	Intercept and Trend	-5.4706***	-25.3949***	-4.4461***	-7.2677***	-3.8011**

Note: *, ** and *** indicates 1%, 5% and 10% level of significance respectively.
The best ARDL model for equation (ii) is selected based onthe AIC model selection criteria table. The top 5 ARDL models as per the AIC criterion are presented in table 3.The

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best model having the lowest AIC criterion is ARDL (1,0,1,0,2). The output of the selected ARDL model is presented in Appendix A.

Table 3: ARDL Model Selection Criteria

Model	LogL	AIC	Adj. R-sq	Specification
1	32.0138	-1.5872	0.9433	ARDL(1, 0, 1, 0, 2)
2	32.9325	-1.5816	0.9440	ARDL(1, 0, 2, 0, 2)
3	30.5334	-1.5540	0.9402	ARDL(1, 0, 0, 0, 2)
4	32.3040	-1.5382	0.9415	ARDL(1, 0, 1, 1, 2)
5	29.2567	-1.5349	0.9377	ARDL(1, 0, 0, 0, 1)

Table 4 shows the F-bound test where at all levels of significance, the calculated value of F-statistics (4.47) is greater than I(0) and I (1) bound values. This fulfills the required condition for the existence of a long-run relationship among the variables. Now, we further move to find the long-run relation of the dependent variable with selected independent variables.

Table 4: ARDL Bound Test for co-integration

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	4.47	10%	2.2	3.09
K	4	5%	2.56	3.49
		1%	3.29	4.37

Table 5 shows the long-run coefficients of the selected determinants of carbon intensity.

As shown in table 5,all the independent variables of the model have positive and significant impact

Table 5: Long Run Relationship of the Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
lnEGI	0.7736	0.2894	2.6732	0.0146**
lnEUSE	5.9110	1.6065	3.6794	0.0015***
lnGDPG	0.2008	0.1056	1.9022	0.0716*
lnUPG	0.8199	0.3152	2.6014	0.0171**
C	-39.5578	9.3640	-4.2244	0.0004

Note: *, ** and *** indicates 1%, 5% and 10% level of significance respectively.

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on carbon intensity in the long run. lnEUSE has positive and highly significant impact on carbon intensity (CI). The result is as expected because for the country at developing stage, there is room for growth in business and industrial activities and thus increase in energy consumption. This also indicates the inefficient use of energy products and lack of energy efficiency practices in Nepal. This fact is realized by the government of Nepal in its Energy Efficiency Strategy 2018 [34]. Though the use renewable energy is in increasing trend yet it is insufficient to offset the adverse impact of non-renewable energy.

Economic globalization index and urban population growth rate havea significant and positive impact on carbon intensity at 5 percent level of significance. It contradicts with the findings of Bashir et al. [8].As Nepal is still at the growing phase, greater economic integration has led to increasing import of capital and energy products resulting increase in CI. GDP per capita growth also has significant and positive impact on CI. These outcomes can further be justified based on the findings of Ssali et al. [25], Shahbaz et al. [14], Begum et al. [23] and Sharma et al. [17].

Table 6: ARDL Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LnEUSE)	1.2507	0.6227	2.0085	0.0583
D(LnUPGR)	-0.4294	0.1931	-2.2237	0.0379
D(LnUPGR(-1))	-0.4304	0.1783	-2.4134	0.0255
CointEq(-1)*	-0.4749	0.0820	-5.7921	0.0000

* p-value incompatible with t-Bounds distribution.

The negative (-0.4749) and significant error correction coefficient shown in table 6 further supports the cointegartion of the dependent variable (carbon intensity) with its regressors. It further implies that carbon intensity readjusts to long run equilibrium at the speed of 47%. Among the selected regressors in the model, only energy consumption and urban population growth rate have significant short run impact on the carbon intensity.

4.1 Diagnostic Test

Table 7 shows the residual diagnostic test of the selected model. The probability values of normality test, serial correlation test and heteroskedasticity test justify the consistency and efficiency of the model. Similarly, cumulative sum of recursive residuals (CUSUSM) test and the cumulative sum of squares of recursive residuals (CUSUMQ) test are shown in figure 2. CUSUM and CUSUM of Squares lines that lie within the boundries indicated by two dotted line are significant at 5 percent. It further justifies the stability and reliability of the model used in this study.

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Table 7: Results of Diagnostic Test

Diagnostic Test	Method	Test statistics	Prob.
Normality	Jarque-Bera	0.6227	0.0583
Serial Correlation	Breusch-Godfrey	0.0368	0.9427
Heteroskedasticity	Breusch-Pagan-Godfrey	0.6215	0.6777

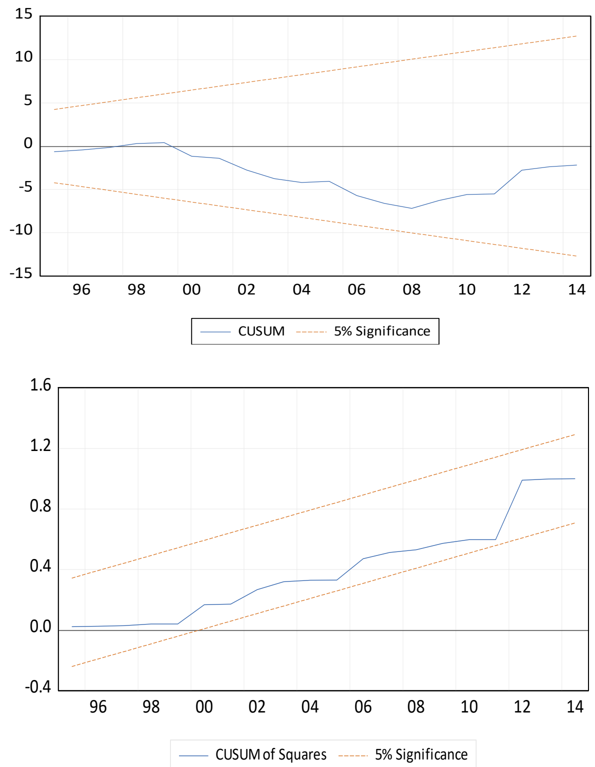

Fig 2: CUSOM and CUSUM Q Stability Test

Conclusion

This study examined the determinants of environmental sustainability in Nepal by using the ARDL model. Carbon intensity has been used as a proxy for measuring environmental sustainability. The major finding of the study is that energy consumption has a positive and highly significant impact on carbon intensity. One percent increase in energy consumption leads to 5.91 percent increase in carbon intensity. This fact demands strong policy intervention for the sustainable environment through reducing carbon intensity.

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Likewise, economic integration, urban population growth rate and GDP growth rate also have a significant impact on carbon intensity in the long run. However, energy consumption and urban population growth rate only have a significant influence on carbon intensity in the short run. So, for a sustainable environment in Nepal, key focus has to be given for minimizing carbon intensity resulting from energy consumption, economic globalization, GDP growth rate and urban population growth. Similarly, energy conservation, development of alternative energy sources and improved energy efficiency are needed to stabilize climate change [35]. By realizing the impact of carbon emission on sustainable growth and development, Nepalese government should focus on carbon intensity reduction strategy to promote green economy as envisioned in 15th five year plan as well as for the effective implementation of energy efficiency strategy 2018 and climate change policy 2019. The study further shows the need of in-depth study on sector wise determinants of carbon intensity.

References

1. Nersesian RL. Energy economics: markets, history and policy. Routledge; 2016 Mar 2.
2. Eyring V, Gillett NP, Achutarao K, Barimalala R, Barreiro M, Bellouin N, Cassou C, Durack P, Kosaka Y, McGregor S, Min SK. Climate Change 2021: The Physical Science Basis. Contribution of Working Group14 I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change; Chapter Three; Human influence on the climate system.
3. Meng J, Liu J, Guo S, Huang Y, Tao S. The impact of domestic and foreign trade on energy-related PM emissions in Beijing. Applied energy. 2016 Dec 15;184:853-62.
4. Nain MZ, Ahmad W, Kamaiah B. Economic growth, energy consumption and CO2 emissions in India: a disaggregated causal analysis. International Journal of Sustainable Energy. 2017 Sep 14;36(8):807-24.
5. Miguel J, Scott M. Can Carbon Intensity Metrics Help Achieve Net Carbon Reductions? [Internet]. June 2021 [cited 2022 Feb 15]. Available from: https://faculty.engineering.ucdavis.edu/jaller/wp-content/uploads/sites/298/2021/06/92021-Jaller-and-Matthews-Can-Carbon-Intensity-Metrics-Help-Achieve-Net-Carbon-Reductions.pdf
6. Fan JL, Zhang X, Wang JD, Wang Q. Measuring the impacts of international trade on carbon emissions intensity: A global value chain perspective. Emerging Markets Finance and Trade. 2021 Mar 16;57(4):972-88.
7. Andersson FN, Karpestam P. CO2 emissions and economic activity: Short-and long-run economic determinants of scale, energy intensity and carbon intensity. Energy Policy. 2013 Oct 1;61:1285-94.
8. Bashir MA, Sheng B, Doğan B, Sarwar S, Shahzad U. Export product diversification and energy efficiency: Empirical evidence from OECD countries. Structural Change and Economic Dynamics. 2020 Dec 1;55:232-43.
9. Juntueng S, Chiarakorn S, Towprayoon S. CO2 intensity and energy intensity of Iron and Steel production in Thailand. Environment and Natural Resources Journal. 2012;10(2):50-7.
10. Climate trade. Which countries are the world's biggest carbon polluters? Available from :https://climatetrade.com/which-countries-are-the-worlds-biggest-carbon-polluters/
11. Weng TK, Mokhtar MB. Emerging issues towards sustainable river basin management in Cameron Highlands, Malaysia. Environment and Natural Resources Journal. 2011;9(2):58-6

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DOI 10.17605/OSF.IO/VJTC4

12. Ministry of Finance (NP). Economic Survey 2020/21. May 2021.
13. Guan D, Klasen S, Hubacek K, Feng K, Liu Z, He K, Geng Y, Zhang Q. Determinants of stagnating carbon intensity in China. Nature Climate Change. 2014 Nov;4(11):1017-23.
14. Shahbaz M, Mahalik MK, Shahzad SJ, Hammoudeh S. Testing the globalization-driven carbon emissions hypothesis: international evidence. International Economics. 2019 Aug 1;158:25-38.
15. Alam J. Impact of agriculture, industry and service sector's value added in the GDP on CO2 emissions of selected South Asian countries. World Review of Business Research. 2015;5(2):39-59.
16. Mansoor A, Sultana B. Impact of population, GDP and energy consumption on carbon emissions: Evidence from Pakistan using an analytic tool IPAT. Asian Journal of Economics and Empirical Research. 2018;5(2):183-90.
17. Sharma K, Bhattarai B, Ahmed S. Aid, growth, remittances and carbon emissions in Nepal. The Energy Journal. 2019 Jun 1;40(1).
18. Balogh JM, Jámbor A. Determinants of CO2 emission: A global evidence. International Journal of Energy Economics and Policy. 2017;7(5):217.
19. Government of Nepal. Second Nationally Determined Contribution (NDC). Kathmandu. December 08, 2020.
20. Bae JH, Li DD, Rishi M. Determinants of CO2 emission for post-Soviet Union independent countries. Climate Policy. 2017 Jul 4;17(5):591-615.
21. Bastola U, Sapkota P. Relationships among energy consumption, pollution emission, and economic growth in Nepal. Energy. 2015 Feb 1;80:254-62.
22. Yuping L, Ramzan M, Xincheng L, Murshed M, Awosusi AA, BAH SI, Adebayo TS. Determinants of carbon emissions in Argentina: The roles of renewable energy consumption and globalization. Energy Reports. 2021 Nov 1;7:4747-60.
23. Begum RA, Sohag K, Abdullah SM, Jaafar M. CO2 emissions, energy consumption, economic and population growth in Malaysia. Renewable and Sustainable Energy Reviews. 2015 Jan 1;41:594-601.
24. Liddle B. Impact of population, age structure, and urbanization on carbon emissions/energy consumption: evidence from macro-level, cross-country analyses. Population and Environment. 2014 Mar;35(3):286-304.
25. Ssali MW, Du J, Hongo DO, Mensah IA. Impact of economic growth, energy use and population growth on carbon emissions in sub-Sahara Africa. J. Environ. Sci. Eng. 2018;7:178-92.
26. Nkoro E, Uko AK. Autoregressive Distributed Lag (ARDL) cointegration technique: application and interpretation. Journal of Statistical and Econometric methods. 2016;5(4):63-91.
27. Siddiqui AH. Export diversification and growth in Pakistan: An empirical investigation from 1972 to 2015 1. Business and Economic Review. 2018;10(1):107-31.
28. Engle R, Granger C. Long-run economic relationships: Readings in cointegration. Oxford University Press; 1991.
29. Johansen S, Juselius K. Maximum likelihood estimation and inference on cointegration—with appucations to the demand for money. Oxford Bulletin of Economics and statistics. 1990;52(2):169-210.
30. Nepal R, Paija N. Energy security, electricity, population and economic growth: The case of a developing South Asian resource-rich economy. Energy policy. 2019 Sep 1;132:771-81.
31. Pesaran MH, Shin Y, Smith RJ. Bounds testing approaches to the analysis of level relationships. Journal of applied econometrics. 2001 May;16(3):289-326.

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32. Ahmed K, Long W. Environmental Kuznets curve and Pakistan: an empirical analysis. Procedia Economics and Finance. 2012 Jan 1;1:4-13.

33. KOF Swiss Economic Institute. KOF Globalization Index 2020.

34. Government of Nepal. Ministry of Energy, Water Resources and Irrigation. National Energy Efficiency Strategy, Nov 19, 2018.

35. Punyawadee V. Management of energy demand in Thailand. Environment and Natural Resources Journal. 2010; 8(1):44-53.

Appendix A

Table A 1: ARDL Output

Dependent Variable: LNCO2I				
Maximum dependent lags: 2 (Automatic selection)				
Model selection method: Akaike info criterion (AIC)				
Dynamic regressors (2 lags, automatic): lnEGIlnEUSElnGDPGR lnUPG				
Model selection method: Akaike info criterion (AIC) Selected Model: ARDL(1, 0, 1, 0, 2)				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
lnCO2I(-1)	0.5251	0.1432	3.6668	0.0015
lnEGI	0.3674	0.1621	2.2669	0.0346
lnEUSE	1.2507	0.9553	1.3092	0.2053
lnEUSE(-1)	1.5566	1.0616	1.4662	0.1581
lnGDPG	0.0953	0.0408	2.3377	0.0299
lnUPG	-0.4294	0.3192	-1.3452	0.1936
LNUPGR(-1)	0.3884	0.4174	0.9304	0.3632
LNUPGR(-2)	0.4304	0.2573	1.6729	0.1099
C	-18.7866	7.0490	-2.6651	0.01487
R-squared	0.9595	Mean dependent var		-1.2014
Adjusted R-squared	0.9433	S.D. dependent var		0.4058
S.E. of regression	0.0966	Akaike info criterion		-1.5872
Sum squared resid	0.1867	Schwarz criterion		-1.1628
Log likelihood	32.0138	Hannan-Quinn criter.		-1.4543
F-statistic	59.2677	Durbin-Watson stat		2.0598
Prob(F-statistic)	0.0000			
*Note: p-values and any subsequent tests do not account for model selection.				