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Relationship between Globalization and Environmental Degradation in Low Income Countries: An Application of Kuznet Curve

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Abstract

Objectives: This study aims to check the impact of globalization and macroeconomic variables on environment degradation in low income countries. This study also tested the existence of Kuznets curve. **Methods/Statistical Analysis:** Greenhouse gases emission is used as proxy of environment degradation. Panel data was taken from 1996 to 2015 for Zimbabwe, Burkina, Uganda, Tanzania, Malawi, Mali, Guinea, Gambia, Madagascar, Central Africa, Niger, Burundi, Faso, Rwanda, Senegal, Mozambique and Benin. After checking the cross sectional dependence, Cross Sectional Augmented Dickey Fuller (CADF) panel unit root test is used to check the stationary of the variables then Pedroni Panel Co-Integration Test and Fully Modified Ordinary Least Square (FMOLS) are applied. **Findings**: Co-integration is found among low income countries. Globalization, urban population and renewable energy have positive effect on environment degradation while innovation index has negative effect on greenhouse gases emission. The inverted U shaped relationship is found between environment and globalization which means that globalization decrease environment degradation after reaching at specific level. **Application/Improvements:** To improve the environment, globalization should be increased continuously because after reaching at certain level, it will decrease the environmental degradation.

Keywords: Environment Degradation; Globalization; Innovation Index; Kuznet Curve; Urbanization

1. Introduction

Globalization is the procedure where countries are being absorbed into the universal economy via Foreign Direct Investment (FDI), trade, regional agreements, labor migration and capital flows. Globalization process is one of the main reasons behind global environmental changes. Globalization encourages development without a doubt, yet it creates negative externalities through environmental degradation and ecological contamination. During last few decades, environmental effects and trade liberalization results due to globalization process is one of the fundamental issues in international trade[1,2], So the globalization process is one of the essential components especially for low income countries. Globalizations important due to: development, good governance, technological up gradation, religious and ethnic tolerance. Though, globalization process creates new opportunities and challenges like inequality, religious and ethnic tensions, environmental deterioration among countries. The theoretic literature debates that trade along with poor judicial system pertaining to the environment will expand environmental deterioration in global economy especially in the low-income countries[3,4].

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Estimation outcomes of globalization give sound observational realities to get ridden by reasonable uncertainty, irresolute causal cases and incompatible perspectives. Globalization Index (GI) is an integral asset to quantify, outline, communicate and convey the difficulties to globalization. It considered a comparative assessment and positioning of the performance of the economies[5] as for globalization, based on indicators. Two experimentally approved indexes are the Maastricht Globalization Index[6,7] and the KOF index of globalization[8,9].

Highly globalized nation assign bigger weights to environmental system, which can be viewed as negative from a sustainability point of view. In this way, the most globalized nations are not really the most sustainable nations. In any case, highly globalized does not really suggest positive results as outlined by the Mercantile Globalization Index that incorporates the Trade Ecological Footprint bio capacity as a proportion of ecological globalization. Recently, globalization and its consequences for the environment have gathered gigantic consideration regarding the warmed discussion over the supposed Pollution Haven Hypothesis (PHH), which contends that the industries with high pollution will move towards developing countries from developed countries due to careless ecological guidelines[10-12]. Past investigations of this subject in the economic aspects literature have for the most part experienced two principle imperatives with respect to the element of globalization, about every one of the examinations appear as either FDI or trade and measurements of globalization other than economic globalization have been to a great extent disregarded[13-15].

Globalization is a multidimensional concept incorporating not only economics but also other fields of study like sociology and politics. There are some economic elements of globalization like demand, production, finance, trade, investment and competition. The focal point of this study is to measure the effect of globalization and other macroeconomic variables on environment for low income countries. This study will suggest policy makers to improve the environment by taking globalization into the account. The most important millennium development goals are to reduce environment degradation and to increase the Global partnership by globalization Sustainable Development goal. This study tries to answer the question: is it possible to increase the globalization and to decrease the environment degradation? So there is need of study to check the relationship between globalization and environment degradation. So, the present study tries to contribute in the literature by investigating the effects of globalization on environmental degradation as well as existence of the U shaped or the inverted U shaped relationship between globalization and greenhouse gases emission. Greenhouse gas emission is used as a proxy of environmental degradation for low income countries. Globalization index used in this research is composed of four sub components and those components are economic, social, political and ecological. Globalization index is constructed by these four important components of globalization.

The current study is organized in four sections like review of literature, methodology, results, discussion and conclusion. Next section addresses review of literature followed by methodology, result, discussion and conclusion.

2. Literature Survey

The review of literature helps to combine the ideas to stretch particular relationship among globalization and environmental degradation. It also helps to for providing the base for making models.

According to past studies, there are two important attributes i.e. global warming and greenhouse gas emission focused on FDI with regard to economic development. Various past studies e.g John List and many other researchers have investigated properties of numerous sorts of contaminations to observe the pollution convergence levels crosswise over nations. A few prior studies[16-19] inspected the urbanization's effect on Carbon emissions. These investigations additionally give blended outcomes. It is obvious from the past studies that the urbanization's effect on Carbon emissions is positive as well as negative. One study explored negative effect of urbanization on Carbon emissions[20]. CO2 emission expanded during the

beginning times of urbanization however as the district turned out to be increasingly urbanized, CO2 emission began to decay[21,22].

Globalization is as an authentic procedure that changes the spatial association of social relations and exchanges by creating cross-country or interregional systems of collaborations through which control is worked out[23]. The Environmental Kuznets Curve was reviewed using CO_2 data from 1960 to 1998 by[24]. It is explored by reviewing the different studies that environmental quality in the Organization for Economic Co-operation and Development (OECD) countries is improved by less carbon emission from foreign investment of developed countries and improved technologies that diverse emissions from multinational enterprises[25]. Up to this point, exact research[26] in view of cross country information finds no help for vindictive impacts of exchange with specific proportions of low environmental quality.

One study used similar approaches to assess the impact of urbanization on Carbon emissions for 16 developing nations[27]. Data from 1971 to 2009 was used. Results from the investigation shows that there were variations crosswise over various estimation methods despite the fact that in a large portion of the details, an immaterial connection was found among urbanization and Carbon emissions.

The connection between globalization and environment was explored. Konjunkturforschungsstelle (KOF) globalization index was used in that study using panel data for large number of developed and developing nations from 1990 to 2009. It was concluded that increase in carbon emission (CO_2) is due to increase in globalization that varies from nation to nation. Further data gathered from the construction and manufacturing sector recommend that in OECD region, globalization is negatively associated to CO_2 while this relation was different in other country group. These outcomes mutually support the pollution effects in terms of environment and climate change. The estimated results were significant to various model settings by choosing different explanatory variable. Globalization disintegrates quality of environment and the size of this impact shifted through sub-panels dependent on various income levels[18].

The observational connection among urbanization and Carbon emissions was investigated from 1970 to 2011 for Malaysia[28]. Auto Regressive Distributed Lag (ARDL) model was used to test the model which demonstrated that due to structural breaks and causality, there exist U-shaped factors. The investigation further inferred that urbanization causes Carbon emissions. These results are also supported by other studies[29,30] who experimentally examined the connection between carbon emission and urbanization for Brazil, Russia, India and China (BRICS) nations from 1985– 2014. Their discoveries announced that urbanization caused Carbon emissions.

The effects of urbanization were investigated by utilizing data from 1970– 2015 in China[21]. ARDL model was applied to evaluate and measured the causality among the variables through a Vector Error Correction Model (VECM). The results demonstrated that urbanization increase carbon emanations in China. Even so, no causality was seen between these variables.

The effect of globalization on Carbon emissions is investigated for developing economies from 1970-2012[31]. The discoveries showed that globalization decreased carbon emission. According to various econometric specifications, there exist strong relationship between globalization and environmental degradation.

The effects of factors related with development like globalization, urban growth, industrial development, consumption of energy and growth (GDPPC) on carbon emission were inspected by taking data from 1985 to 2015[32]. The data was examined via ARDL. The short-run and long-run impacts can be evaluated by the co-integration among the independent variables and Error Correction Model (ECM). They found that globalization effects negatively on carbon emission while industrialization, energy consumption and economic growth increase carbon emission in long run which suggested policymakers in making appropriate policies for economic development. The main results revealed that growth, industrialization and energy consumption increase carbon emission, while globalization depresses emission in the long-run. Energy

consumption is one of the key factors of development and economic growth positively affects CO_2. Thus, it is needed to establish the approaches empowering effectiveness particularly diminishing waste of electricity, sparing energy sources and updating out of innovation towards modern energy savings. In[33] checked the multiple impacts of four kinds of urbanization on carbon emission from1990 to 2013. They concluded that economic urbanization and land urbanization increase carbon emission while, social urbanization and population growth decrease it.

So there is vast literature available on relationship between globalization and environment degradation but the major contribution of this study is to find the U shaped or the inverted U shaped relationship between environment degradation and globalization for low income countries. In previous literature, carbon emission is mostly used as proxy of environment degradation but in this study greenhouse gases emission is used as proxy for environment degradation. Next section addresses the methodology used in this study.

3. Methodology

This section describes the research methodology in order to achieve targeted research objectives.

3.1 Data

Data was taken from World-bank Development Indicators (WDI), Penn world 8.1, the International Country Risk Guide (ICRG), World Governance Indicator (WGI), KOF and Ecological Footprint Network of 16 low income countries for the period 1996–2015. Then theoretical and empirical model is specified.

3.2 Model Specification

Two models are specified in this study as following:

3.2.1 Model 1: Globalization, Energy and Environment

$$Y_{it} = f(GI_{it}, RNEC_{it}, INDUSTRY_{it} URB_{it}, INNO_{it}) \quad (1)$$

$$LNTGHGE_{it} = \beta_0 + \beta_1 GI_{it} + \beta_2 RNEC_{it} + \beta_3 INDUSTRY_{it} + \beta_4 URB_{it} + \beta_5 INNO_{2it} + \varepsilon_{it}) \quad (2)$$

Where,

- LNTGHGE= Emissions of total Greenhouse (kt of CO_2 equivalent)
- GI= Globalization Index (Author's own index)
- RNEC= Consumption of renewable energy (% of total)
- INDUSTRY= Industry, value added (% of GDP)
- URB= Urban population (% of total population)
- INNO= Innovation Index
- ε = Error Term

3.2.2 Model 2: Test for Kuznets Curves

$$Y_{it} = f(GI_{it}, GI_{it}^2) \quad (3)$$

$$LNTGHGE_{it} = \beta_0 + \beta_1 GI_{it} + \beta_2 GI_{it}^2 + \varepsilon_{it}) \quad (4)$$

Where,

- LNTGHGE= same as in above model
- GI= Globalization Index (Author's own index)
- GI^2= Square of Globalization Index
- $\mathcal{E}$ = Error Term

3.2.3 Econometric Methodology

This section explains the econometric methodology used here as following:

3.2.4 Cross Sectional Dependence

There is need to overcome the problem of cross sectional dependence to get unbiased estimators. In order to build the literature on panel data there is first need of data to check cross sectional dependence. In the most recent couple of decades we have encountered a regularly increasing financial and economic liberalization of nations and economic bodies, which recommends robust interlinked cross-sections. In panel studies[34] stresses on the significance to measure the cross-sectional dependence. The CD test which was introduced by[35,36] used to check cross sectional dependence in the current study.

The CD test measurement is as following:

$$CD = \sqrt{\frac{2T}{N(N-1)}}\left(\sum_{i=1}^{N-1}\sum_{j=i+1}^{N}\eta_{ij}^{2}\right) \qquad (5)$$

Under the null hypothesis (no cross sectional dependence) N (0,1) for N goes to infinity and T sufficiently large.

3.2.5 Checking stationary

After evaluating cross sectional dependence the study need to check the presence of stationarity in the sequence so as to acquire impartial approximations. In[37] suggested a methodology dependent on unit root measurements in a CADF regression. Generally representing by following formula:

$$\Delta Y_{it} = \alpha_i + \beta_i Y_{i,t-1} + \sum_{j-1}^{\rho_i}\Delta Y_{i,t-1} + d_i\tau + c_i\overline{Y}_{t-1} + \sum_{j=0}^{\rho_i}\varphi_{ij}\Delta Y_{i,t-j} + \varepsilon_{it} \qquad (7)$$

$$\overline{Y}_t = N^{-1}\sum_{j=1}^{N}Y_{jt} \qquad \Delta\overline{Y}_{i,t} = N^{-1}\sum_{j=1}^{N}\Delta Y_{jt} \qquad (8)$$

Let CADFi be the ADF measurements for i-th cross-sectional unit given by the t-proportion of the OLS estimates βˆi of βi in the CADF regression. In any case, gives basic estimates dependent on process for the CADF and CIPS-distribution for three cases: no intercept and no trend, no trend only intercept and intercept and trend[37].

3.2.6 Estimation of Panel Co-Integration Regression

On the off chance that all the variables are co-integrated, the following stride is to assess the long-run co-integration parameters.

Taking after Pedroni (2001), FMOLS method produces predictable estimates in small samples and the board FMOLS estimator for the coefficient β is characterized as:

$$\beta = N^{-1}\sum_{i=1}^{N}\left(\sum_{t=1}^{T}(y_{it}-\bar{y})^{2}\right)^{-1}\left(\sum_{t=1}^{T}(y_{it}-\bar{y})\right)z_{it}^{*} - T\hat{n}_i \qquad (9)$$

$$z_{it}^{*} = (z_{it}-\bar{z}) - \frac{\hat{L}_{21i}}{\hat{L}_{22i}}\Delta y_{it}\,,\ \hat{\eta}_i \equiv \hat{\Gamma}_{21i} + \hat{\Omega}_{21i}^{0} - \frac{\hat{L}_{21i}}{\hat{L}_{22i}}(\hat{\Gamma}_{22i} + \hat{\Omega}_{22i}^{0}) \qquad (10)$$

and $\hat{L}_i$ is a lower triangular decomposition of $\hat{\Omega}_i$.

3.2.7 Panel Regression FMOLS

In this study, the strategy of co-integration is exhibited by testing in part the common technique anticipated by the ongoing research of[38,39] for empirical modeling. This methodology comprises co-integration testing and Granger causality testing, changed in accordance with get panel datasets examination system. We wandered from this methodology in the last advance, utilizing an increasingly unequivocal modeling approach, in light of two OLS approximation techniques of co-integration: (DOLS) and (FMOLS) for instance[40].

Panel co-integration tests endeavor to give progressively consistent outcomes due to occurrence of co-integration with respect to those achieved by individual tests. Therefore, in the null postulate series are called co-integrated if the residuals from their linear combination are stationary too.

Noteworthy significance of Pedroni's methodology originates by isolating of short-run parameters unequivocal deterministic patterns in the underlying strategy[41,42]. In light of evaluated residuals[43] inferred seven diverse test insights which are normally alluded to as pooled or within dimension tests, and those accepting individual procedures eluded as grouped or between-dimension tests. It is indicated as:

$$y_{it} = \beta_i^{0}x_{it} + \mu_i^{0}D_{it} + e_{it} \qquad (11)$$

Here $x_{i,t}$ is an explanatory variable, generally, m-dimensional vector of explanatory variables.

3.2.8 Causality Test

Tests are established to check the causality of panel data set[44]. It also deliberates both types of heterogeneity: first is used to exam the Granger causality for regression model and other one is for casual relationship. It was considered as:

$$z_{it} = a_i + \sum_{m=1}^{M} \gamma_i^{(m)} z_{i,t-m} + \sum_{m=1}^{M} \beta_i^m y_{i,t-k} + \varepsilon_{it} \ldots\ldots\ldots\ldots \quad (12)$$

Here, stationary variables z and y are observed for T periods of N individuals. $\beta i = (\beta i(1), \ldots \ldots, \beta i(m))'$ and α_i are supposed constant with time. $\gamma_i(m)$ as autoregressive parameter and $\beta i(m)$ as regression coefficients are different transversely cross sections.

4. Results and Discussion

The results of cross section dependence are presented in Tables 1 for 6 low income countries. According to results there exists cross section dependence in all vari-

Table 1. Results of cross section dependence of countries

Variables	Pesaran CD Test		Correlation
	Statistics	Prob.	
TGHGE	26.408*	0.000	0.647
GI	40.403*	0.000	0.825
RNEC	4.933*	0.000	0.481
INDUSTRY	-0.192	0.847	0.344
URBANIZATION	37.616*	0.000	0.832
INNOVATION	18.972*	0.000	0.526

Table 2. Results of CADF panel unit root test

Variables	Level				First difference			
	Intercept	Prb	Intercept & trend	Prb	Intercept	prb	Intercept & trend	prb
TGHGE	-1.539	0.774	-1.896	0.936	-4.051	0.000	-3.980	0.000
GI	-1.913	0.237	-2.059	0.810	-2.764	0.000	-3.033	0.001
RNEC	-1.796	0.398	-2.088	0.777	-2.710	0.000	-2.900	0.007
INDUSTRY	-1.857	0.309	-2.487	0.206	-3.491	0.000	-3.855	0.000
LNURBANIZATION	-1.131	0.991	-2.598	0.104	-2.859	0.000	-3.423	0.000
INNOVATION	-1.103	0.993	-1.750	0.982	-3.542	0.000	-3.911	0.000

Table 3. Results of pedroni panel co-integration test

Dimensions	Test Statistics	Intercept	Prob.	Intercept and Trend	Prob.fx
Within-dimension	Panel v-statistic	-2.929697	0.9983	-4.721948	1.0000
	Panel rho-statistic	0.502424	0.6923	1.796855	0.9638
	Panel pp-statistic	-7.526784	0.0000	-7.195909	0.0000
	Panel ADF-statistic	-7.241406	0.0000	-5.443072	0.0000
Between-dimension	Group rho-statistic	2.367650	0.9910	3.271432	0.9995
	Group PP-statistic	-18.39459	0.0000	-31.19276	0.0000
	Group ADF-statistic	-12.98456	0.0000	-12.40378	0.0000

Table 4. Results of FMOLS

Regressors	FMOLS					
	Pooled without Trend			Pooled With Trend		
	Coef.	SE	Prob	Coef.	SE	Prob
GI	0.042626	0.006159	0.0000	0.043668	0.006266	0.0000
RNEC	0.011433	0.003737	0.0024	0.011902	0.003802	0.0019
INDUSTRY	0.007907	0.006492	0.2243	0.007240	0.006605	0.2740
URPOP	0.008511	0.003749	0.0031	0.007464	0.009957	0.0036
KEINNO	-0.001845	0.010164	0.8561	-0.002854	0.010341	0.7828
R2	0.97			R2	0.97	
No. of OBS	304			No. of OBS	304	

ables except industry that is cross section independent in low income countries. After checking the cross sectional dependence, second generation panel unit root test is used to check the stationary of the variables.

The results of CADF panel unit root test with intercept and intercept and trend are presented in Table 2 for low income countries. The test results suggested that all variables are non- stationary at level but stationary at first difference i.e. I (1).

After confirming the stationary level of all variables, co-integration is checked. To find the co-integrated relationship, Pedroni panel co-integration technique was applied. The estimated results of padroni are presented in Table 3. Long run association among the variables is found. The results are significant but only Panel v- statistic, Panel rho and group rho-statistic demonstrate insignificant results which means there exist co-integration among low income countries. Pedroni Panel co integration test observes whether there is co-integration or not but doesn't extend an estimate for the long run.

The results of FMOLS reveal that coefficients of globalization and renewable energy sources effect positively and significantly on Greenhouse gas emission. It implies that 1% increase in globalization and renewable energy sources increase greenhouse gas emission by 4% and 1% respectively in low income countries. Industry and innovation insignificantly effect greenhouse gas emission. The urban population has positive and significant effect on environment degradation. The results of this study are in line with other studies like other studies[45,46]. There is vast literature available on globalization and environmental quality[47,48] which concluded like this study that globalization causes huge environmental deterioration. Globalization also leads to higher energy utilization which results in higher emissions[49-52]. Industrialization has a positive correlation with environmental degradation. The empirical findings suggest that energy consumption has a positive and statistically significant impact on greenhouse gas emissions[53,54]. But the contribution of this study is to find the inverted U shaped relationship between globalization and environment degradation which shows that globalization decrease environmental degradation after reaching at certain point.

4.1 Kuznets Curves

Table 5 reports the results for existence of Kuznets curves of low income countries. The results of ordinary least square show the inverted U-shaped relationship between

Table 5. Kuznets curves estimates.

Independent variables	Dependent variables = Total Greenhouse Gas Emission			
	OLS		Fixed Effect models	
	(1)	(2)	(3)	(4)
Constant	13.562 (0.000)	5.425 (0.188)	8.297 (0.000)	6.010 (0.000)
Globalization	-0.040 (0.000)	0.262 (0.085	0.052 (0.00)	0.158 (0.000)
Globalization^2		-0.002 (0.046)		-0.001 (0.018)
No. of Countries	16	16	16	16
No. of observations	437	437	4307	437
R^2	0.027	0.036	0.96	0.96

Table 6. DH panel causality test results

Null Hypothesis	W-Stat.	Zbar-Stat.	Prob.
GI → TGHGE	6.85407	6.32292	0.000
TGHGE → GI	2.81497	0.63552	0.5251
RNEC → TGHGE	4.50280	3.01213	0.0026
TGHGE → RNEC	2.73379	0.52121	0.6022
INDUSTRY → TGHGE	2.97511	0.86101	0.3892
TGHGE → INDUSTRY	3.09752	1.03337	0.3014
URPOP → TGHGE	16.5045	19.9115	0.0000
TGHGE → URPOP	5.40148	4.27754	0.000
KEINNO → TGHGE	6.10906	5.27388	0.000
TGHGE → KEINNO	1.45694	-1.27671	0.2017
RNEC → GI	3.63301	1.78739	0.0739
GI → RNEC	4.00109	2.30568	0.0211
INDUSTRY → GI	1.83814	-0.73994	0.4593
GI → INDUSTRY	4.25498	2.66318	0.0077
URPOP → GI	4.20721	2.59591	0.0094
GI → URPOP	6.32875	5.58322	2.E-08
KEINNO → GI	4.40384	2.87278	0.0041
GI → KEINNO	3.38679	1.44068	0.1497
INDUSTRY → RNEC	3.00582	0.90424	0.3659
RNEC → INDUSTRY	3.54701	1.66629	0.0957
URPOP → RNEC	6.69659	6.10117	0.000
RNEC → URPOP	3.21496	1.19873	0.2306

KEINNO → RNEC	6.63685	6.01705	0.000
RNEC → KEINNO	5.49314	4.40661	0.000
URPOP → INDUSTRY	5.65260	4.63114	0.000
INDUSTRY → URPOP	3.60690	1.75063	0.0800
KEINNO → INDUSTRY	5.56709	4.51073	0.000
INDUSTRY → KEINNO	2.64561	0.39705	0.6913
KEINNO → URPOP	2.87098	0.71438	0.4750
URPOP → KEINNO	5.35178	4.20756	0.000

greenhouse gas emission and globalization for 16 low income countries. Column 3 and 4 reported the results of Fixed Effect model. β_1 in column 3 is positive and β_2 in column 4 is negative, both are statistically significant. Thus FE results also show the inverted U-shaped relationship between greenhouse gas emission and globalization for low income countries.

4.2 DH panel Causality Test Results

Table 6 represents the direction of causality between all variables taken into this study. Bi-directional panel causality is found between globalization and renewable energy consumption, globalization and urban population. Urban population causes globalization, industry, total greenhouse gases consumption and innovation in low income countries while globalization causes industry, renewable energy consumption and total greenhouse gas emission in low income countries.

5. Conclusion and Suggestion

The study explored the effects of globalization on environmental degradation in low income countries by using the panel data techniques over the period 1996-2015. There exists cross section dependence in all variables except industry. The CADF test results of low income countries suggested that the entire variable are stationary at first difference i.e. I (1). Then co-integration was checked between the variables after checking the stationary level. To find the co-integrated relationship, Pedroni panel co-integration technique was applied. According to Pedroni panel co-integration test, there exists co-integration among low income countries.

The results of FMOLS reveal that coefficients of globalization and renewable energy sources are statistical significant when Greenhouse gas emission is used as dependent variable. Greenhouse gas emission is significantly and positively affected by globalization and renewable energy sources. Thus OLS and FE results indicate the inverted U-shaped relationship between greenhouse gas emission and globalization for low income countries. Globalization causes industry, renewable energy consumption and total greenhouse gas emission in low income countries. This research suggested that infrastructure should be developed to encourage the environment friendly innovation for reducing the environmental degradation in all low income countries. Globalization should be increased continuously because after reaching at certain level, it will decrease the environmental degradation.

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