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Measuring the impact of global tropospheric ozone, carbon dioxide and sulfur dioxide concentrations on biodiversity loss

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ABSTRACT

The aim of this study is to examine the impact of air pollutants, including mono-nitrogen oxides (NOx), nitrous oxide (N_2O), sulfur dioxide (SO_2), carbon dioxide emissions (CO_2), and greenhouse gas (GHG) emissions on ecological footprint, habitat area, food supply, and biodiversity in a panel of thirty-four developed and developing countries, over the period of 1995–2014. The results reveal that NOx and SO_2 emissions both have a negative relationship with ecological footprints, while N_2O emission and real GDP per capita have a direct relationship with ecological footprints. NOx has a positive relationship with forest area, per capita food supply and biological diversity while CO_2 emission and GHG emission have a negative impact on food production. N_2O has a positive impact on forest area and biodiversity, while SO_2 emissions have a negative relationship with them. SO_2 emission has a direct relationship with per capita food production, while GDP per capita significantly affected per capita food production and food supply variability across countries. The overall results reveal that SO_2, CO_2, and GHG emissions affected potential habitat area, while SO_2 and GHG emissions affected the biodiversity index. Trade liberalization policies considerably affected the potential habitat area and biological diversity in a panel of countries.

1. Introduction

The ecosystem and biological diversity loss are the two most crucial challenges that faced by the planet due to rapid industrialization, trade liberalization policies, economic gains, massive population growth, etc. These factors severely damaged the tropospheric ozone that latterly influenced human health, ecosystems and biodiversity loss. One of the biggest discussions is going on in "The International Cooperative Programme on Effects of Air Pollution on Natural Vegetation and Crops" that separating the mapping for South and North Europe (ICP, 2015). This study is limited to the ecosystems and biodiversity loss that merely influenced by the mono-nitrogen oxides (NOx), nitrous oxide (N_2O), sulfur dioxide (SO_2), carbon dioxide emissions (CO_2), and greenhouse gas (GHG) emissions respectively. In addition, this study used two growth measures, i.e., real economic growth and trade openness that cumbersome the certain ecosystems, including ecological footprint, potential habitat area (proxy by the forest area), food production per capita variability, and food supply per capita variability. This study constructed the biodiversity index by taking the different ecosystems for measuring the single relative weighted principal component, that's we labeled the 'biodiversity index'.

In search of the literature, we received plenty of research work that is related to the scope of the study; however, this study is unique in a sense, as it is used diversified portfolio of ecological biodiversity, which is influenced by the numerous air pollutants and growth factors across the globe. Wilson (1989) addressed the 'threats to the biodiversity' and concluded that global climate change is the significant contributor to the biodiversity loss in Polar Regions. McNeely (1992) argued that air pollution damages the biodiversity and ecosystems that merely due to the rapid industrialization process, which proven the fact that it provides greater payoffs to the society and for the economic development; however, the cost in the form of ecosystems and biodiversity loss is hidden that should be measured by 'Five–I' approaches i.e., investigation, information, incentives, integration, and international support. This 'Five–I' approach would provide the ecological justice for balancing our natural flora. Myers (1993) suggested some precautionary measures, including biological, ecological, and economic measures that should be balanced to conserve biological diversity. Kappelle et al. (1999) investigated the possible effects of climatic changes on biodiversity loss and argued that this relationship is complex, as the

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variability of climatic factors associated with the other environmental stressors that already cumbersome the biodiversity, therefore, there is substantial need to build the climate change model that evaluates the possible impact on biodiversity loss across the countries. Noss (1999) presented the forestry management framework for evaluating the potential habitat area for the forest species and identified the different factors that impact on the biodiversity loss, including simplification of the forest structure, forest patch sizes, increasing seclusion of patches, disruption of natural fire, and increased road infrastructures. The study further stresses the management of the ecological indicators that would helpful to conserve the forestry management around the globe. Greenfacts (2010) reports identified the five main threats to the global biodiversity, including insidious alien species, greenhouse gas emissions, carbon dioxide emission, forest area, and overexploitation of natural resources. Moreover, there are the following indirect factors that affected the biodiversity, including socio-economic and political-technological factors. This report recognizes the potential threats to the biodiversity and possible mitigation strategies to preserve the global environment. Dietz and Adger (2003) examined the relationship between per capita income and biodiversity loss in the environmental Kuznets curve (EKC) framework in the panel of countries and found that there is an indirect relationship between per capita income and biodiversity, however, the result does not confirm the EKC hypothesis in the relationship between the rates of loss of habitat & species and per capita GDP in the region.

Asafu-Adjaye (2003) investigated the dynamic relationship between economic growth and biodiversity loss in the panel of low income countries and found that economic growth damages both the ecosystem and biological diversity in the region. Binder and Neumayer (2005) investigated the possible impact of environmental pressure groups, i.e., environmental NGO (ENGO) groups on different pollution level across the globe. The results confirmed that ENGO has a considerable impact on the different air pollutants, including SO_2, smoke, and concentration of heavy particulates in a cross-country region. Mozumder et al. (2006) investigated the relationship between GDP per capita and biodiversity loss in cross-countries setting and used different indicators of biodiversity including species, genetic and ecosystem drivers. The results do not support the EKC relationship between the variables. Biggs et al. (2008) explored the possible impacts of population growth, climate changes and future land use practices on the biodiversity loss in the Southern Africa, and conclude that the mitigation strategies for climatic factors, land–use changes, and reduction in the population growth strategies should required for aligning the biodiversity conservation in the region. Xiankai et al. (2008) investigated the global impact of nitrogen deposition on forest biological diversity and found that nitrogen deposition changes species diversity, however, disproportionate nitrogen may reduce the richness, abundance and even loses special species, that should be taken care while devising the conservation framework for forest biodiversity. Stevens et al. (2010) argued that excessive nitrogen deposition reduces the richness of the plant species which measured by the Soil Ph, in acid grasslands across the Europe. Paul and Uddin (2011) determined the long-run and casual relationships between energy and output dynamics in case of Bangladesh and confirmed an inverse relationship between output residuals and energy residuals, between output cycles, and energy cycles, and between output growth and energy growth. The Granger causality estimates confirmed the unidirectional causality running from output residuals to energy residuals but not vice versa. The study argued that energy conservation policies should be more supportive for broad-based growth that would helpful to integrate an energy based model in a country. Maes et al. (2012) investigated the interrelationship between ecosystems, biodiversity and conservation of habitat area in European scale and found that there is a significant and positive relationship between biodiversity indicators and ecosystem service supply, while habitat area linked with the conservation of biodiversity that had a higher potential of ecosystem supply in the region. Al Mamun et al. (2014) confirmed environmental Kuznets curve (EKC) in an aggregated panel of countries by using the consistent time period from 1980 to 2009. The results show that EKC is widely visible across countries except high income countries, which is further followed in the form of high pollution during the transformation process from industrial activities to services sector, while low and middle income countries shows less pollution during the sectoral transformation process. The sustainability agenda is all across the viable policy agenda for environmental reforms. Stevens et al. (2014) conducted the survey on the acid grasslands in the UK for assessing the possible impact of atmospheric nitrogen deposition on species richness and confirmed that atmospheric nitrogen deposition reduces the richness of the species of acid grasslands in the UK.

Shahbaz et al. (2014a) confirmed the EKC hypothesis in the context of Tunisian economy by using the data set from 1971 to 2010 and confirmed the long-run association between energy demand, per capita income, air pollution, and trade openness. The results emphasized the need of cleaner production technologies to adopt renewable energy mix for lessening the carbon emissions in a country. Shahbaz et al. (2014b) further investigated the long-run relationships between energy demand, industrialization, and air pollution in the context of Bangladesh by using the countrywide data from 1975 to 2010 and found an inverted U-shaped relationships between carbon emissions and industrialization, which further confirmed the finance led trade and trade led industrial development in a country. The results conclude that trade induce energy pollutants widely indicate the existence of 'pollution haven' hypothesis, thus the country's required sustainable policy efforts to reduce CO_2 emissions through cleaner technology production. Salomon et al. (2016) concluded that reactive nitrogen compounds are one of the biggest threats to the atmosphere, soil, and water resources that ultimately damage the biological diversity and human health, which merely due to the agricultural practices and fuel combustion processes in a country. Ahmed et al. (2016) investigated the relationship between CO_2 emissions, per capita income, and biomass energy consumption in a panel of 24 selected European countries for the period of 1980–2010 and confirmed an inverted U-shaped Kuznets curve between CO_2 emissions and economic growth, while technological innovation substantial decreases CO_2 emissions, which corresponds to digitalize renewable energy consumption for green growth. Thus, biomass energy is vital for sustainable actions for European countries. Uddin et al. (2016) examined the causal relationships between energy demand, air pollution, per capita income, and trade openness in the context of Sri Lanka for the period of 1971–2006 and confirmed the growth led carbon emissions, and growth led energy consumption in a country. The study emphasized the need of low carbon policies to support country's economic growth. Nguyen et al. (2017) determined the impact of investment and trade openness on energy demand, economic growth, and CO_2 emissions in the context of China and India and found that Chinese economy is diversified by the economic gains of trade and investment, which largely explained the energy-growth-pollution nexus, however, this result is absent in case of India. The study concludes that investment activities and trade openness both associated with high economic growth and energy demand on the cost of environmental deterioration, thus sustainable environmental policies should largely included in global policy agenda. Sohag et al. (2017) considered a panel of middle income countries to determined the impact of sectoral value added and energy demand on CO_2 emissions and confirmed that sectoral value added in the form of industrialization substantially deteriorate the countries natural environment, which further followed by energy demand that escalates CO_2 emissions, however, the results does not establish any significant association between population growth and CO_2 emissions in a panel of countries. Thus, the policies to reduce industrial emissions required renewable energy sources to promote sustainable development across countries. Charfeddine (2017) analyzed the environmental sustainability agenda in the context of Qatar economy by using the annul time series data from 1970 to 2015, for this purpose,