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RESEARCH ARTICLE

Climate change and air pollution jointly creating nightmare for tourism industry

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Abstract The objective of the study is to examine the long-run and causal relationship between climate change (i.e., greenhouse gas emissions, hydrofluorocarbons, per fluorocarbons, and sulfur hexafluoride), air pollution (i.e., methane emissions, nitrous oxide emissions, and carbon dioxide emissions), and tourism development indicators (i.e., international tourism receipts, international tourism expenditures, natural resource depletion, and net forest depletion) in the World's largest regions. The aggregate data is used for robust analysis in the South Asia, the Middle East and North Africa, sub-Saharan Africa, and East Asia and the Pacific regions, over a period of 1975–2012. The results show that climatic factors and air pollution have a negative impact on tourism indicators in the form of deforestation and natural resource depletion. The impact is evident, as we have seen the systematic eroding of tourism industry, due to severe changes in climate and increasing strain of air pollution. There are several channels of cause–effect relationship between the climatic factors, air pollution, and tourism indicators in the World's region. The study confirms the unidirectional, bidirectional, and causality independent relationship between climatic factors, air pollution, and tourism indicators in the World. It is conclusive that tourism industry is facing all time bigger challenges of reduce investment, less resources, and minor importance from the government agencies because of the two broad challenges, i.e., climate change and air pollution, putting them in a dismal state.

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Introduction

Tourism and travel is a fundamental contributor to the global economy and particularly imperative for many developing countries. Climate change is one of the most severe intimidations to the society, the economy, and the environment and has been the subject of international disquiet for decades (UNWTO 2009). Tourism has a potential driver for growth of the world economy. The tourism economy represents 5 % of the world GDP, while it contributes to 6–7 % of total employment. International tourism ranks fourth (after fuels, chemicals, and automotive products) in global exports, with an industry value of US $1 trillion a year, accounting for 30 % of the world's exports of commercial services or 6 % of total exports; 935 million international tourists were recorded in 2010 and 4 billion domestic arrivals in 2008. In over 150 countries, tourism is one of the five top export earners, and in 60, it is the number one export. It is the main resource of foreign exchange for one third of developing countries and one half of less-developed countries (UNEP 2011).

The substantial impacts of climate change have a direct impacts on tourism including warmer summers, warmer winters, increase in extreme weather events, droughts, marine biodiversity loss, sea level rise, increase in disease outbreaks, and increasing costs of travel from governments around the world executing policies to reduce emissions, such as carbon taxes and emissions trading schemes. A sustainable growth strategy provided the some solutions to enable synchronized economic development of the area and the protection of the coastal and marine ecosystems of the Mediterranean Sea (Hilmi et al. 2013).

Tourism is very important for the economies of many countries in the Southeast Asia region, i.e., hotels, restaurants, businesses, travel, and all the other aspects of the tourism industry bring a large amount of revenue but on the cost of generating greenhouse gasses and harming the environment (CDKN 2013). Table 1 shows the climate change vulnerability in Southeast Asia.

Fighting climate change needs global solutions built on common but discriminated responsibility and respective capacity principles. Given high stakes for the region, Southeast Asia should engage in recreation in such global action (ADB 2013). According to the IPCC (2007) report, there are severe climate-related impacts on socioeconomic sectors in coastal zones which are described in Table 2.

Africa has a great prospective for sustainable, demanding farming through investments in new technologies and the management of vegetation, soil, and water. These approaches give a "triple dividend" sustaining adjustment to climate variability and change, mitigating carbon emissions, and promoting food security. In sub-Saharan Africa, the economic potential from agricultural soil carbon sequestration is estimated to be 150 million tons of greenhouse gasses a year. On the price per ton of carbon dioxide, Africa stands to benefit significantly from this new revenue stream (Okonjo-Iweala 2010).

Tourism is an economic sector in the Asia and Pacific region as it makes employment in many related sectors and contributes to the overall economic growth. Asia and the Pacific has given the second largest number of tourism arrivals, behind Europe, with 28.4 % of the world's total. In 2011, 283.9 million arrivals in Asia and the Pacific were recorded, which is an increase of 21.5 million tourism arrivals from 2010. Between 2005 and 2011, the average annual growth in tourism arrivals was 6 %. Inbound tourism expenditure in 2011 was $362.6 billion, which is $51.8 billion more than in 2010 and equal to 28.9 % of the total global inbound expenditure (UNESCAP 2013).

Table 1 Components of vulnerability to climate change in Southeast Asia

High exposure	High sensitivity	Low adaptive capacity
(Temperature >1.5 °C; rainfall, ±20 %)	(Dependence on climate sensitive sectors)	(Income-related poverty, institutions, and skills)
Cambodia	Cambodia	Cambodia
Lao PDR	Indonesia	Lao PDR
Indonesia	Lao PDR	Myanmar
Malaysia	Myanmar	
Myanmar	Thailand	
Philippines	Vietnam	
Singapore		
Thailand		
Vietnam		

Source: ADB (2013)

A major objective of tourism studies has thus been to quantify the environmental impacts of leisure-related activities and to evaluate these with acceptable levels of pollution (Gössling et al. 2005). Saenz-de-Miera and Rosselló (2013) discovered tourists' involvement to air pollution through an analysis of tropospheric ozone levels in Mallorca (Spain). The results show that the rising tourism activity in Mallorca is connected with rising daily concentrations of tropospheric ozone, which is created by transport, air conditioning, and other activities. In another study, Saenz-de-Miera and Rosselló (2014, p. 273) conclude that,

> Tourism has begun to be acknowledged as being a significant contributor to the increase in environmental externalities, especially to climate change

Akhmat et al. (2014a), b examined the causal relationship between energy consumption and environmental pollutants in selected South Asian Association for Regional Cooperation ((SAARC) countries, over the period of 1975–2011. The results indicate that energy consumption acts as an imperative driver to increase environmental pollutants in SAARC countries. Granger causality runs from energy consumption to environmental pollutants, but not vice versa, except carbon dioxide (CO_2) emissions in Nepal where there exists bidirectional causality between CO_2 and energy consumption. Seetaram et al. (2013) examined the effect of the air passenger duty (APD) on UK outbound tourism demand for 10 international destinations. The results indicate that the income and price elasticities ranged between 0.36 and 4.11 and −0.05 and −2.02, respectively. The estimated tax elasticities suggest that the implementation of APD had a negative effect on UK outbound travel for five destinations, and the demand is inelastic to changes in taxes although the magnitudes vary across destinations. According to Araña et al. (2013), p. 82),

> Tourism destinations are increasingly concerned about global climate change and considering to become involved in the adoption of mitigation policies that reduce global emissions. On the other hand, behavioral sciences have shown that consumers' choices may be significantly influenced by the way that they are framed.

Knez et al. (2013) investigate the effects of different groups of individuals (residents, tourists, experts, decision makers, and members of tourist industry) and demographic variables (gender, age, education) on climate change-related concerns, beliefs, and emotions. The results show that some individuals

Table 2 Climate-related impacts on socioeconomic sectors in coastal zones

Coastal socioeconomic sector	Temperature rise (air and seawater)	Extreme events (storms, waves)	Floods (sea level, runoff)	Rising water tables (sea level)	Erosion (sea level, storms, waves)	Salt water intrusion (sea level, runoff)	Biological effects (all climate drivers)
Freshwater resources	Strong impact	Strong impact	Strong impact	Strong impact	Negligible impact	Strong impact	Weak impact
Agriculture and forestry	Strong impact	Strong impact	Strong impact	Strong impact	Negligible impact	Strong impact	Weak impact
Fisheries and aquaculture	Strong impact	Strong impact	Weak impact	Negligible impact	Weak impact	Strong impact	Strong impact
Health	Strong impact	Strong impact	Strong impact	Weak impact	Negligible impact	Strong impact	Strong impact
Recreation and tourism	Strong impact	Strong impact	Weak impact	Negligible impact	Strong impact	Negligible impact	Strong impact
Biodiversity	Strong impact	Strong impact	Strong impact	Strong impact	Strong impact	Strong impact	Strong impact
Settlements/ infrastructure	Strong impact	Strong impact	Strong impact	Strong impact	Strong impact	Strong impact	Negligible impact

Source: IPCC (2007)

do, and some do not bother about environmental long-term risks such as climate change. Pang et al. (2013) presented an overview of the relationship between tourism and global climate change. The results show that the broader tourism sector is a significant contributor to greenhouse gas emissions. Growth in this area has tracked growth in interest in climate change in general, with tourism-related papers representing consistently about 0.5 % of the published research on climate change. Khan et al. (2014) examined the relationship between energy consumption and greenhouse gas emission for different groups of countries comprising lower middle income, upper middle income, and heavily indebted countries, East Asia and Pacific, East Europe and Central Asia, Latin America and Caribbean, Middle East and North Africa, South Asia, and sub-Saharan Africa, and for an aggregate data of the world. The results of Granger causality indicate that energy consumption Granger causes greenhouse gas emission but not vice versa. Kaján and Saarinen (2013) study was based on a systematic review of the tourism and adaptation literature prior to 2012. The study concludes that adaptation studies in tourism have so far had a limited focus on community perceptions, which in general has been an area of major interest in tourism research. Shah and Zaman (2014) empirically investigate the relationship between tourism development, economic growth, and exchange rate in Oman during the period of 1995 to 2011. The results show that there is a bidirectional casualty between tourism receipts and GDP, while there is a unidirectional causality between tourism receipt and exchange rate in the context of the development of Oman. Mudakkar et al. (2013) investigates the causal relationship between energy consumption, economic growth, industrialization, environmental degradation, and resource depletion in Pakistan over a period of 1975–2011. The results indicate that there exists a unidirectional causality running from nuclear energy to industrial GDP, nuclear energy to water resources, and nuclear energy to carbon dioxide emissions but not vice versa.

Zaman et al. (2013) empirically estimate the impact of carbon dioxide emissions and arable land on specific growth factors in Pakistan, over a period of 1975–2009. The results show that GDP and industrialization have a significant and positive contributor to stimulate carbon emission in Pakistan. However, financial development has a significantly negative impact on carbon dioxide emissions. Similarly, GDP and financial development have a positive impact on arable land, while industrialization has a negative effect on arable land. Khan et al. (2013) investigates the long-run and the causal relationship between greenhouse gas emissions, economic growth per unit of energy use, and energy consumption in Pakistan, over a 36-year time period, i.e., between 1975 and 2011. The finding suggests that energy consumption acts as an important driver for increase in greenhouse gas emissions in Pakistan. The results indicate that on average, causality runs from energy consumption to greenhouse gas emissions but not vice versa. Mushtaq and Zaman (2013) examined the impact of various macroeconomic factors, i.e., per capita GDP, gross capital formation, trade openness, and consumer price index on tourism receipts in selected SAARC countries from 1995 to 2011. The results reveal that per capita GDP and trade openness both have a positive impact on tourism receipts, while gross capital formation has a significant negative impact on tourism receipt in SAARC region. Zaman et al. (2012) investigate the influence of agricultural technologies on carbon emissions in Pakistan by using annual data from 1975 to 2010. The results reveal that agricultural technologies act as an important driver for increase in carbon emissions in Pakistan. There is a unidirectional causality runs from agriculture machinery to carbon emissions but not vice versa.

Zaman et al. (2011a) empirically investigate a two-way statistical relationship between the tourism development indicators and carbon emissions in Pakistan over a period of 1991–2010. The results show that tourism indicators significantly increase carbon emissions in Pakistan. The causality results only moderately support the conventional view that tourism indicators have significant long-run casual effect on carbon emissions in Pakistan. In another study by Zaman et al. (2011b) which examined the students' perceptions about social, economical, and environmental impacts of tourism in the tourists' destination of Chitral-Khyber Pakhtonkhuwa, Pakistan. The study is based on primary data collected from 100 students in different universities of Abbottabad which belong to Chitral and Gilgit Baltistan. The result showed that students perceived economic impacts of tourism most favorably, followed by environmental impacts and social impacts. Students believed that tourism has provided job opportunities and can help to trigger the economy in the region. They have high hopes and positive outlook of developing tourism in Chitral. Kroesen (2013) objectify people's subjective viewpoints toward air travel and climate change by using an online questionnaire for 491 subjects in the Netherlands. The results show that air travel behavior does not significantly correlate with general environmental awareness. Lei et al. (2014) examine different sulfonamides, quinolones, and tetracyclines in surface water and in surficial sediment samples, of Bosten Lake, in Xinjiang, China. The results showed the presence of 10 out of the 12 selected antibiotics in both water and sediment. Amelung and Nicholls (2014) examine the effects of projected climate change on Australia's tourism industry. The results suggest that the proactive attitude toward climatic factors would enhance the successful adaptation. According to Saarinen (2014, p. 1),

> Climate and weather have always been important issues in tourism systems and discussions on destination attractiveness. During the past two decades, the role of climate and especially climate change has emerged as a major issue in tourism development and management frameworks.

Becken et al. (2014) conclude that the climatic factor adaptation is a prerequisite for the sustainable economic development. From the local level, stakeholders often find themselves inundated with climate change information presented at both small temporal and spatial scales. The above discussion confirms the strong correlation between climate change, air pollution, and tourism indicators. In the subsequent section, an action has been made to find the long-run and causal relationship between climatic factors, air pollution, and tourism indicators in the four largest regions of the World.

Data source and methodological framework

The present study is based on aggregate regional data covering the time period from 1975 to 2012 for South Asia, Middle East and north Africa (MENA), sub-Saharan Africa, and East Asia and Pacific regions. The data consists of three broad categories of the variables, i.e.,

(I) Climate change

- Greenhouse gas (GHG) emissions [million ton (Mt) of CO_2 equivalent]
- Hydrofluorocarbons (HFC) gas emissions (thousand metric tons of CO_2 equivalent)
- Per fluorocarbon (HFC) gas emissions (thousand metric tons of CO_2 equivalent)
- Sulfur hexafluoride (SF6) gas emissions (thousand metric tons of CO_2 equivalent)

(II) Tourism

- International tourism receipts (current US $)
- International tourism expenditures (current US $)
- Natural resource depletion (% of gross national income (GNI))
- Net forest depletion (% of GNI)

(III) Air pollution

- Methane emissions (kt of CO_2 equivalent)
- Nitrous oxide emissions (thousand metric tons of CO_2 equivalent)
- Carbon dioxide emissions (metric tons per capita) tons per capita)

The data set of the variables is taken from *World Development Indicator* which is published by World Bank (2013) and *International Financial Statistics* which is published by IMF (2012). This study developed a comprehensive model based upon previous studies from Becken (2005, 2007), Gössling (2006), and Saenz-de-Miera and Rosselló (2014).

Environmental management literature generally considers the air pollution framework in growth accounting. The previous studies contain carbon dioxide emissions, greenhouse gas emissions, and other greenhouse gas emissions are the most important contributor in the field of environmental literature. Omission of one of the variables in the model leads to serious bias in the model (Akhmat et al. 2014a, b). In the study of Becken (2005) on the tourist resorts in Fiji, the number of promising variables has been used for climate change and air pollution on the tourist resort. The aim is to reduce climate change through reductions in carbon dioxide emissions.

Another study by Becken (2007) on tourism industry of New Zealand, in which the study concludes that the international air travel's effect on the global climate which has to be minimized by the adaptation of climate change policies. Gössling et al. (2005) conclude that the tourism is one of the most significant sectors of the world economy; however, energy prices substantially decrease the economic welfare of countries and destinations. Saenz-de-Miera and Rosselló (2014) consider the environmental externalities which are related to the climate change. The following equation was used for examining the impact of air pollution and greenhouse gas emissions on tourism indicators, i.e.,

$$\ln(Y)_t = \alpha_0 + \alpha_1 \ln(\lambda)_t + \alpha_2 \ln(\gamma)_t + \varepsilon_t \quad (1)$$

where ln(Y) is the natural logarithm of tourism indicators [i.e., international tourism receipts (ITR), international tourism expenditures (ITE), natural resource depletion (NRD), and net forest depletion (NFD)]; λ is the set of climate change variables [i.e., GHG emissions, HFC gas emissions, per fluorocarbon (HFC) gas emissions, and SF6 gas emissions] and γ is the set of air pollution variables [i.e., methane emissions (METH), nitrous oxide emissions (NOX), and carbon dioxide emissions (CO_2)].

The dependent and independent variables used in this study are listed in Table 3. Tourism indicator is used as a dependent variable, while independent variables are climate change and air pollution variables.

Econometric framework

The time series data often exhibit the nonstationary series; therefore, there is a need to decompose the time series data into stationary series. For this purpose, the augmented Dickey–Fuller (ADF) technique is used to find the unit root problem in the individual data sets. Subsequently, the appropriate lag length selection for the model, the study estimate vector autoregression (VAR) model, includes all variables in the non-differenced data set. The model that minimizes the AIC and the SBC is selected as the one with the optimal lag length. Moreover, the study used multivariate Johanson's cointegration test (i.e., Johansen and Juselius 1990) to find the long-run relationship between the variables. For this purpose, the study used five different deterministic components in the multivariate system. The first and fifth model is not that realistic, and they are also implausible in terms of economic theory; therefore, the problem reduces to a choice of one of the three remaining models (models 2, 3, and 4).

Further, the study used autoregressive distributed lag model (ARDL) to find the long-run elasticities between the variables. Following Pesaran et al. (2001), we assemble the VAR of order p, denoted VAR (p), for the following growth function:

$$Z_t = \mu + \sum_{i=1}^{p} \beta_i z_{t-i} + \varepsilon_t \quad (2)$$

where z_t is the vector of both x_t and y_t, y_t is the dependent variable defined as tourism indicators, x_t is the vector matrix

Table 3 List of variables

Variables	Measurement	Expected sign	Data source
Dependent variable			
Tourism development indicators			
International tourism Receipts (ITR)	Current US $		World Bank (2013)
International tourism expenditures (ITE)	Current US $		World Bank (2013)
Natural resource depletion (NRD)	% of GNI		World Bank (2013)
Net forest depletion (NFD)	(% of GNI)		World Bank (2013)
Independent variables			
Climate change			
Greenhouse gas emissions (GHG)	Million ton (Mt) of CO_2 equivalent	Negative	IMF (2013)
Hydrofluorocarbons gas emissions (HFC)	Thousand metric tons of CO_2 equivalent	Negative	IMF (2013)
Per fluorocarbon gas emissions (PFC)	Thousand metric tons of CO_2 equivalent	Negative	IMF (2013)
Sulfur hexafluoride gas emissions (SF6)	Thousand metric tons of CO_2 equivalent	Negative	IMF (2013)
Air pollution			
Methane emissions (METH)	Kiloton of CO_2 equivalent	Negative	World Bank (2013)
Nitrous oxide emissions (NOX)	Thousand metric tons of CO_2 equivalent	Negative	World Bank (2013)
Carbon dioxide emissions (CO_2)	Metric tons per capita	Negative	World Bank (2013)

which represents a set of explanatory variables, and t is a time or trend variable. The VECM procedures described above are imperative in the testing of at most one cointegrating vector between dependent variable y_t and a set of regressors x_t. To derive a model, we followed the postulations made by Pesaran et al. (2001) in case III, that is, unrestricted intercepts and no trends. After imposing the restrictions $\lambda_{YY}=0$, $\mu\neq0$, and $\alpha=0$, the hypothetical function can be stated as the following unrestricted error correction model (UECM), i.e.,

$$\begin{aligned}\Delta\ln(\mathrm{TOUR})_t = \beta_0 + \beta_1\ln(\mathrm{TOUR})_{t-1} + \beta_2\ln(\mathrm{CLIMATE})_{t-1} \\ + \beta_3\ln(\mathrm{AIR})_{t-1} + \sum_{i=1}^{p} \beta_7 \Delta\ln(\mathrm{CLIMATE})_{t-i} \\ + \sum_{i=0}^{q} \beta_8 \Delta\ln(\mathrm{AIR})_{t-i} + \varepsilon\end{aligned} \tag{3}$$

where, TOUR represents four promising tourism development indicators, i.e., ITR, international tourism expenditures (ITE), NRD, and NFD; CLIMATE represents climatic factors, i.e., GHG, HFC, PFC, and SF6; AIR represents air pollution variables, i.e., METH, NOX, and CO_2; Δ is the first difference operator and u_t is a white noise disturbance term.

The Granger causality test is then used to determine the direction of causality among the variables in this study. However, if the variables are I(1) and cointegrated, the Granger causality test within the first difference VAR model will be misleading (Engle and Granger 1987). In such circumstances, Granger causality should be tested using the ECM as follows:

$$\begin{aligned}\Delta\ln(\mathrm{TOUR})_t = \alpha_1 + \sum_{i=1}^{k} k1i\Delta\ln(\mathrm{TOUR})_{t-i} \\ + \sum_{i=0}^{k} \nu1i\Delta\ln(\mathrm{CLIMATE})_{t-i} \\ + \sum_{i=0}^{k} \delta1i\Delta\ln(\mathrm{AIR})_{t-i} + \vartheta1\varepsilon_{t-1} + \xi1t\end{aligned} \tag{4}$$

$$\begin{aligned}\Delta\ln(\mathrm{CLIMATE})_t = \alpha_1 + \sum_{i=1}^{k} k1i\Delta\ln(\mathrm{CLIMATE})_{t-i} \\ + \sum_{i=0}^{k} \nu1i\Delta\ln(\mathrm{TOUR})_{t-i} \\ + \sum_{i=0}^{k} \delta1i\Delta\ln(\mathrm{AIR})_{t-i} + \vartheta1\varepsilon_{t-1} + \xi1t\end{aligned} \tag{5}$$

$$\begin{aligned}\Delta\ln(\mathrm{AIR})_t = \alpha_1 + \sum_{i=1}^{k} k1i\Delta\ln(\mathrm{AIR})_{t-i} \\ + \sum_{i=0}^{k} \nu1i\Delta\ln(\mathrm{TOUR})_{t-i} \\ + \sum_{i=0}^{k} \delta1i\Delta\ln(\mathrm{CLIMATE})_{t-i} + \vartheta1\varepsilon_{t-1} + \xi1t\end{aligned} \tag{6}$$

The equations above consist of short- and long-run elements. Δ and ln are the notations for first difference and natural logarithm, respectively. The residuals ζit are assumed to be normally distributed and white noise. From the above equations, εt−1 is the one period lagged error correction term derived from the cointegrating equation. However, in the absence of cointegration, the εt−1 term will be excluded from the above equation, thus it remains as the standard first difference VAR model. To examine the short-run Granger causality, we apply the standard Wald test on the first difference lagged explanatory variables. However, to examine the long-run Granger causality, we employ the standard Wald test on both the first difference lagged explanatory variables and the εt−1 term.

Results

The standard ADF unit root test was exercised to check the order of integration of these variables. The results obtained are reported in Table 4. Based on the ADF unit root test statistic, it was concluded that most of the variables are nonstationary at their level but stationary after taking first difference, i.e., I(1) variables; however, NFD in South Asia, PFC and SF6 in East Asia and Pacific are stationary at their level, i.e., I(0) variables.

Johansen cointegration test

The relationship between dependent variable (i.e., tourism indicators) and the independent variables (i.e., climatic change and air pollution) is observed using the multivariate cointegration methodology proposed by Johansen (1988) and Johansen and Juselius (1990). The Johansen's cointegration test designates at least one cointegrating vector. Thus, long-run relationship is maintained by the data generating method. Using Johansen and Juselius (1990) multivariate cointegration tests, the study finds a statistically significant relationship between climate change, tourism, and air pollution in different regions of the world. The following cointegrating vector has been determined in Table 5.

Table 4 ADF unit root results

Variables	South Asia	MENA	Sub-Saharan Africa	East Asia and Pacific
Tourism development indicators at level				
ITR	$p>0.05$	$p>0.05$	$p>0.05$	$p>0.05$
ITE	$p>0.05$	$p>0.05$	$p>0.05$	$p>0.05$
NRD	$p>0.05$	$p>0.05$	$p>0.05$	$p>0.05$
NFD	$P<0.05$	$p>0.05$	$p>0.05$	$p>0.05$
Tourism development indicators at first difference				
ΔITR	$p<0.05$	$p<0.05$	$p<0.05$	$p<0.05$
ΔITE	$p<0.05$	$p<0.05$	$p<0.05$	$p<0.05$
ΔNRD	$p<0.05$	$p<0.05$	$p<0.05$	$p<0.05$
ΔNFD	$p<0.05$	$p<0.05$	$p<0.05$	$p<0.05$
Climate change at level				
GHG	$p>0.05$	$p>0.05$	$p>0.05$	$p>0.05$
HFC	$p>0.05$	$p>0.05$	$p>0.05$	$p>0.05$
PFC	$p>0.05$	$p>0.05$	$p>0.05$	$p<0.05$
SF6	$p>0.05$	$p>0.05$	$p>0.05$	$p<0.05$
Climate change at first difference				
ΔGHG	$p<0.05$	$p<0.05$	$p<0.05$	$p<0.05$
ΔHFC	$p<0.05$	$p<0.05$	$p<0.05$	$p<0.05$
ΔPFC	$p<0.05$	$p<0.05$	$p<0.05$	$p<0.05$
ΔSF6	$p<0.05$	$p<0.05$	$p<0.05$	$p<0.05$
Air pollution at level				
METH	$p>0.05$	$p>0.05$	$p>0.05$	$p>0.05$
NOX	$p>0.05$	$p>0.05$	$p>0.05$	$p>0.05$
CO_2	$p>0.05$	$p>0.05$	$p>0.05$	$p>0.05$
Air pollution at first difference				
ΔMETH	$p<0.05$	$p<0.05$	$p<0.05$	$p<0.05$
ΔNOX	$p<0.05$	$p<0.05$	$p<0.05$	$p<0.05$
ΔCO_2	$p<0.05$	$p<0.05$	$p<0.05$	$p<0.05$

The null hypothesis is that the series is nonstationary or contains a unit root. The rejection of the null hypothesis is based on MacKinnon critical values. The lag length are selected based on SIC criteria; this ranges from lag zero to lag five. The model with constant and trend was used to estimate the unit root tests. $p<0.05$ shows that the variables are significant at 5 % level, while $p>0.05$ shows insignificant variable

The presence of the cointegration vectors in Table 5 shows that there exists a long-run relationship among the variables, as minimum one cointegration equation and maximum six cointegration equations been found in four World's region. This study further examined the existence of long-run relationship between the variables. We used a Hendry's general-to-specific modeling approach and selected the maximum lag order of three for the conditional ARDL-VECM. Maximum lag order of 3 years is sufficient to capture the system's dynamics for the yearly data analysis (Enders 2004). Table 5 reports the results of bound test with F-statistics when each variable is considered as a dependent variable in ARDL-OLS regressions. Based on the Narayan (2005) critical values, all model specification i.., F_{ITR}, F_{ITE}, F_{NRD}, and F_{NFD} is significant at 5 % level. Thus, the null hypothesis of no cointegration is rejected in all selected regions of the world, implying long-run cointegration relationships between the variables.

A number of diagnostic tests are conducted to ensure that the selected autoregressive distributet lag (ARDL) model is appropriate. Overall, in majority of the region, the selected ARDL model is free from heteroscedasticity, serial correlation, and general specification error; normality issue has been found in MENA region and sub-Saharan Africa; autocorrelation problem exists in South Asia; and specification error of the model in East Asia and Pacific region. Moreover, both CUSUM and CUSUM of square tests reject the presence of structural break. Table 5 presented the calculated F-statistics for cointegration, the critical values provided by Narayan

Table 5 Cointegration test results

Multivariate Johansen–Juselius cointegration test				
Dependent variable	South Asia	MENA	Sub-Saharan Africa	East Asia and Pacific
ITR	Five cointegration equations	Six cointegration equations	Two cointegration equations	Four cointegration equations
ITE	Three cointegration equations	Five cointegration equations	One cointegration equations	Four cointegration equations
NRD	Three cointegration equations	Two cointegration equations	Three cointegration equations	One cointegration equations
NFD	Four cointegration equations	Five cointegration equations	Six cointegration equations	Three cointegration equations
Bounds testing approach to cointegration				
Regions	Model			Wald F-statistics
South Asia	$F_{\mathrm{ITR}}(ITR \mid GHG,\mathrm{HFC,PFC,SF6,METH,NOX,CO2})$			$p<0.05$
	$F_{\mathrm{ITE}}(ITE \mid GHG,\mathrm{HFC,PFC,SF6,METH,NOX,CO2})$			$p<0.05$
	$F_{\mathrm{NRD}}(NRD \mid GHG,\mathrm{HFC,PFC,SF6,METH,NOX,CO2})$			$p<0.05$
	$F_{\mathrm{NFD}}(NFD \mid GHG,\mathrm{HFC,PFC,SF6,METH,NOX,CO2})$			$p<0.05$
MENA	$F_{\mathrm{ITR}}(ITR \mid GHG,\mathrm{HFC,PFC,SF6,METH,NOX,CO2})$			$p<0.05$
	$F_{\mathrm{ITE}}(ITE \mid GHG,\mathrm{HFC,PFC,SF6,METH,NOX,CO2})$			$p<0.05$
	$F_{\mathrm{NRD}}(NRD \mid GHG,\ \mathrm{HFC,PFC,SF6,METH,NOX,CO2})$			$p<0.05$
	$F_{\mathrm{NFD}}(NFD \mid GHG,\ \mathrm{HFC,PFC,SF6,METH,NOX,CO2})$			$p>0.05$
Sub-Saharan Africa	$F_{\mathrm{ITR}}(ITR \mid GHG,\ \mathrm{HFC,PFC,SF6,METH,NOX,CO2})$			$p<0.05$
	$F_{\mathrm{ITE}}(ITE \mid GHG,\ \mathrm{HFC,PFC,SF6,METH,NOX,CO2})$			$p>0.05$
	$F_{\mathrm{NRD}}(NRD \mid GHG,\ \mathrm{HFC,PFC,SF6,METH,NOX,CO2})$			$p>0.05$
	$F_{\mathrm{NFD}}(NFD \mid GHG,\ \mathrm{HFC,PFC,SF6,METH,NOX,CO2})$			$p<0.05$
East Asia and Pacific	$F_{\mathrm{ITR}}(ITR \mid GHG,\ \mathrm{HFC,PFC,SF6,METH,NOX,CO2})$			$p<0.05$
	$F_{\mathrm{ITE}}(ITE \mid GHG,\ \mathrm{HFC,PFC,SF6,METH,NOX,CO2})$			$p<0.05$
	$F_{\mathrm{NRD}}(NRD \mid GHG,\ \mathrm{HFC,PFC,SF6,METH,NOX,CO2})$			$p<0.05$
	$F_{\mathrm{NFD}}(NFD \mid GHG,\ \mathrm{HFC,PFC,SF6,METH,NOX,CO2})$			$p<0.05$
Narayan (2005) critical value bounds of the F-statistic: intercept and no trend				
Significance level (%)		Lower bounds, I(0)		Upper bounds, I(1)
1		4.590		6.368
5		3.276		4.630
10		2.696		3.895
Diagnostic tests				
	South Asia	MENA	Sub-Saharan Africa	East Asia and Pacific
Adjusted R^2	Minimum of 0.612 and maximum of 0.972	Minimum of 0.528 and maximum of 0.817	Minimum of 0.728 and maximum of 0.981	Minimum of 0.559 and maximum of 0.702
F-statistics	$p<0>05$	$p<0.05$	$p<0.05$	$p<0.05$
JB (χ^2_{NORMAL})	$p>0.05$	$P<0.05$	$P<0.05$	$p>0.05$
LM (χ^2_{SERIAL})	$p<0.05$	$p>0.05$	$p>0.05$	$p>0.05$
ARCH (χ^2_{ARCH})	$p<0.05$	$p<0.05$	$p>0.05$	$p>0.05$
Rqmsey RESET (χ^2_{RESET})	$p>0.05$	$p>0.05$	$p>0.05$	$p<0.05$
CUSUM	Stable at 5 % level	Stable at 5 % level	Stable at 5 % level	Stable at 5 % level
CUSUM of squares	Stable at 5 % level	Stable at 5 % level	Stable at 5 % level	Stable at 5 % level

Denote significance at the 1 % level. The range of adjusted R^2 in all four regions of the World, i.e., minimum is 0.681 and maximum is 0.912

(2005); we find that the calculated F-statistic is greater than the 1 % upper bound critical values in majority of the World's regions. Hence, we reject the null hypothesis of no cointegration relationship among the variables. Since the suggestions of both cointegration tests are consistent, we conclude that the variables are cointegrated and have a long-run relationship between the variables.

Estimating the long-run and short-run relationship

In order to check the stability of the long-run and short-run relationship among climate change, tourism, and air pollution, we used the error correction model in Table 6.

The results show that there is a negative relationship between greenhouse gas (GHG) emissions and tourism

Table 6 Long-run and short-run elasticities [dependent variable: Δln(ITR)]

Variables	Coefficients (South Asia)	Coefficients (MENA)	Coefficients (sub-Saharan Africa)	Coefficients (East Asia and Pacific)
Long-run results				
GHG	Negative, <1**	Negative, <1*	Negative, <1**	Negative, <1
HFC	Positive, <1	Positive, >1	Negative, <1*	Positive, >1**
PFC	Negative, ≅1*	Positive, <1	Positive, <1*	Negative, <1**
SF6	Negative, <1*	Negative, <1*	Positive, <1*	Negative, <1**
METH	Positive, <1**	Negative, <1	Positive, >1*	Positive, <1**
NOX	Negative, <1**	Positive, <1	Positive, <1	Negative, <1*
CO_2	Negative, <1**	Negative, <1*	Positive, <1*	Positive, >1*
Short-run results				
GHG	Negative, <1	Negative, <1*	Positive, <1**	Negative, <1*
HFC	Negative, <1**	Positive, <1*	Negative, <1**	Negative, >1*
PFC	Positive, <1*	Negative, <1	Negative, <1*	Negative, <1*
SF6	Negative, >1*	Negative, <1	Negative, <1**	Negative, ≅1*
METH	Positive, <1*	Negative, ≅1*	Positive, <1	Negative, <1**
NOX	Positive, <1**	Negative, <1**	Positive, <1	Positive, >1*
CO_2	Positive, <1*	Negative, <1*	Negative, ≅1*	Positive, <1
Diagnostic tests				
Adjusted R^2 (minimum–maximum)	0.512–0.699	0.728–0.912	0.852–0.978	0.775–0.899
F-statistics (minimum–maximum)	7.258*–12.369*	4.699*–5.252*	6.958*–7.223*	2.125**–4.996*
JB (χ^2_{NORMAL})	$p>0.050$	$p>0.050$	$p>0.050$	$p<0.050$
LM (χ^2_{SERIAL})	$p>0.050$	$p<0.050$	$p<0.050$	$p>0.050$
ARCH (χ^2_{ARCH})	$p>0.050$	$p<0.050$	$p>0.050$	$p>0.050$
Ramsey RESET (χ^2_{RESET})	$p>0.050$	$p<0.050$	$p>0.050$	$p<0.050$
CUSUM	Stable at 5 % level	Stable at 5 % level	Stable at 5 % level	Stable at 5 % level
CUSUM of squares	Stable at 5 % level	Stable at 5 % level	Stable at 5 % level	Stable at 5 % level

Probability values are quoted in square brackets. LM (I) tests for the null of first-order serial correlation among the residuals; Het: a test based on regression of squared residuals on a constant and squares of the fitted values; ARCH: a test for first-order autoregressive conditional heteroscedasticity effects; RESET: Ramsey's Regression Specification Error/′-test with (m, n) degrees of freedom; and the Jarque–Bera $X2(2)$ LM test for normality of residuals

*p=0.01; **p=0.05; ***p=0.10 (denote statistical significance)

revenues; as in most of the World's regions, this relationship becomes less elastic; however, in some cases, the relationship is averted and has a more elastic relationship between the variables. There are few indications of positive relationship between the GHG emissions [other GHG emissions, i.e., HFC, PFC, and SF6] and international tourism receipts. In some cases, the results become one-to-one corresponding relationship between climatic factors and international tourism receipts. In the similar fashion, tourism industry is responsible to contribute air pollution, as air passenger transport contributed to global greenhouse gasses (GHGs) generated by visitors, with an estimated 2 % of tourism's global emissions (UNWTO 2009). Climate change illustrates the growing urgency for a paradigm shift in the tourism industry, including some to replace those threatened or disappearing due to global warming. In order to meet the challenge of ensuring that global warming remains below the unsafe threshold of 2° centigrade, every nation, every industry sector, and every human being are called to take on a fair share of the mitigation burden (ECOT 2010). Climate affects a wide range of the environmental resources that are critical attractions for tourism, such as wildlife productivity and biodiversity and water levels and quality. Climate has an important influence on environmental conditions than can deter tourism, including infectious disease, bushfires, insect and waterborne pests, and extreme weather events such as tropical cyclones (Safa and Hilmi 2012).

The value of R^2 adjusted indicates the range between a minimum of 51.2 % to a maximum of 97.8 %; variation in dependent variable has been explained by variations in independent variables. F value is higher than its critical value, suggesting a good overall significance of the estimated model. Therefore, fitness of the model is acceptable empirically. The model seems to be robust to various departures from standard regression assumptions in terms of residual correlation, like heteroscedasticity, autoregressive conditional heteroscedasticity (ARCH), misspecification of functional form, or non-normality of residuals. This result tends to suggest that, in majority of the World's regions, the impact of any structural change over the entire sample period does not appear to be significant at least in terms of model stability. Table 7 shows the short- and long-run elasticities between climate change, air pollution, and international tourism expenditures in different regions of the World.

The results show that in the short-run, there is a negative and one-to-one corresponding relationship between GHG emissions and ITE in the South Asian region, between PFC and ITE in the sub-Saharan Africa, and between SF6 and ITE in the East Asia and Pacific region. In the long-run, there is a negative and one-to-one corresponding relationship between nitrous oxide emissions and ITE in the MENA region. There are number of climatic factors and air pollution that have a significant and more elastic relationship with the international tourism expenditures, i.e., in the short-run, methane emissions have a negative and more elastic relationship with the ITE in the South Asian region; PFC have a more elastic relationship with the ITE in the MENA region, while GHG have an elastic relationship with ITE in East Asia and the Pacific region. In the long-run, carbon emissions in MENA region and nitrous oxide emission and methane emissions in the sub-Saharan African region have a negative and more elastic relationship with the ITE. In addition, there is a positive and more elastic relationship between methane emissions and ITE in the MENA region. The results conclude that climate change shifts international tourism flows toward higher altitudes and latitudes. The redistribution of tourism flows could negatively affect countries and regions that depend heavily on income from tourism (Bigano et al. 2007). Tourism activity involves

Table 7 Long-run and short-run Elasticities [dependent variable: $\Delta\ln(\text{ITE})$]

Variables	Coefficients (South Asia)	Coefficients (MENA)	Coefficients (sub-Saharan Africa)	Coefficients (East Asia and Pacific)
Long-run results				
GHG	Negative, <1*	Negative, <1	Negative, <1*	Negative, <1***
HFC	Negative, <1	Negative, <1	Negative, <1*	Positive, <1**
PFC	Positive, <1**	Negative, <1*	Negative, <1**	Negative, <1
SF6	Negative, <1	Negative, <1	Negative, <1	Negative, <1**
METH	Negative, <1**	Positive, >1*	Negative, >1*	Negative, <1
NOX	Negative, <1***	Negative, ≅1*	Negative, >1*	Positive, <1**
CO_2	Negative, <1*	Negative, >1*	Positive, <1**	Negative, <1*
Short-run results				
GHG	Negative, ≅1*	Negative, <1*	Negative, <1	Negative, >1*
HFC	Negative, <1***	Negative, <1*	Positive, <1*	Negative, <1
PFC	Negative, <1*	Negative, >1*	Negative, ≅1*	Positive, <1**
SF6	Positive, <1*	Negative, <1	Negative, <1	Negative, ≅1*
METH	Negative, >1*	Negative, <1***	Positive, <1**	Negative, <1***
NOX	Negative, <1	Negative, <1	Positive, <1*	Negative, <1*
CO_2	Positive, <1*	Negative, <1***	Negative, <1	Positive, <1
Diagnostic tests				
Adjusted R^2 (minimum–maximum)	0.559–0.701	0.725–0.912	0.667–0.938	0.552–0.789
F-statistics (minimum–maximum)	4.669*–7.895*	2.232**–4.012*	5.695*–7.996*	8.235*–11.369*
JB (χ^2_{NORMAL})	p>0.050	p>0.050	p>0.050	p>0.050
LM (χ^2_{SERIAL})	p>0.050	p>0.050	p>0.050	p>0.050
ARCH (χ^2_{ARCH})	p>0.050	p>0.050	p>0.050	p>0.050
Ramsey RESET (χ^2_{RESET})	p>0.050	p>0.050	p>0.050	p>0.050
CUSUM	Stable at 5 % level	Stable at 5 % level	Stable at 5 % level	Stable at 5 % level
CUSUM of squares	Stable at 5 % level	Stable at 5 % level	Stable at 5 % level	Stable at 5 % level

Probability values are quoted in square brackets. LM (I) tests for the null of first-order serial correlation among the residuals; Het: a test based on regression of squared residuals on a constant and squares of the fitted values; ARCH: a test for first-order autoregressive conditional heteroscedasticity effects; RESET: Ramsey's Regression Specification Error/′-test with (m, n) degrees of freedom; and the Jarque–Bera $X2(2)$ LM test for normality of residuals

*p=0.01; **p=0.05; ***p=0.10 (denote statistical significance)

Table 8 Long-run and short-run elasticities [dependent variable: Δln(NRD)]

Variables	Coefficients (South Asia)	Coefficients (MENA)	Coefficients (sub-Saharan Africa)	Coefficients (East Asia and Pacific)
Long-run results				
GHG	Negative, <1	Negative, <1	Positive, <1*	Positive, <1**
HFC	Positive, <1**	Positive, <1*	Negative, <1***	Positive, >1*
PFC	Positive, <1**	Negative, <1	Negative, <1	Negative, <1***
SF6	Negative, <1*	Positive, >1*	Positive, <1**	Negative, <1***
METH	Negative, >1*	Positive, ≅1*	Positive, <1	Positive, <1*
NOX	Negative, <1	Negative, <1**	Positive, <1***	Negative, <1
CO_2	Positive, <1*	Negative, <1	Positive, ≅1*	Negative, <1
Short-run results				
GHG	Positive, <1**	Negative, <1	Negative, <1***	Negative, <1
HFC	Positive, <1***	Negative, >1*	Positive, >1*	Positive, <1***
PFC	Negative, >1*	Negative, >1*	Positive, <1**	Positive, <1
SF6	Negative, >1*	Positive, <1**	Negative, <1*	Negative, >1*
METH	Negative, <1	Positive, <1***	Negative, >1*	Positive, >1*
NOX	Positive, <1	Negative, <1***	Positive, ≅1*	Positive, <1**
CO_2	Positive, ≅1*	Negative, <1	Negative, <1	Negative, <1
Diagnostic tests				
Adjusted R^2 (minimum–maximum)	0.452–0.517	0.612–0.779	0.551–0.625	0.712–0.898
F-statistics (minimum–maximum)	2.389**–4.458*	3.312**–4.114*	3.996*–4.969*	5.528*–6.012*
JB (χ^2_{NORMAL})	$p>0.050$	$p>0.050$	$p>0.050$	$p>0.050$
LM (χ^2_{SERIAL})	$p>0.050$	$p>0.050$	$p>0.050$	$p>0.050$
ARCH (χ^2_{ARCH})	$P>0.050$	$p>0.050$	$p>0.050$	$p>0.050$
Ramsey RESET (X^2_{RESET})	$p>0.050$	$p<0.050$	$p>0.050$	$p>0.050$
CUSUM	Stable at 5 % level	Stable at 5 % level	Stable at 5 % level	Stable at 5 % level
CUSUM of squares	Stable at 5 % level	Stable at 5 % level	Stable at 5 % level	Stable at 5 % level

Probability values are quoted in square brackets. LM (I) tests for the null of first order serial correlation among the residuals; Het: a test based on regression of squared residuals on a constant and squares of the fitted values; ARCH: a test for first-order autoregressive conditional heteroscedasticity effects; RESET: Ramsey's Regression Specification Error/′-test with (m, n) degrees of freedom; and the Jarque–Bera $X2(2)$ LM test for normality of residuals

*p=0.01; **p=0.05; ***p=0.10 (denote statistical significance)

economic costs, including the direct costs incurred by tourism businesses, government costs for infrastructure to better serve tourists, as well as congestion and related costs borne by individuals in the community. Tourism's economic impacts are therefore an important consideration in state, regional and community planning, and economic development. Economic impacts are also important factors in marketing and management decisions. Communities therefore need to understand the relative importance of tourism to their region, including tourism's contribution to economic activity in the area (Stynes 1997). Continuing growth may jeopardize the achievement of sustainable development and, unless properly managed, may affect the social conditions, cultures, and local environment of tourist areas. It also reduces the benefits of tourism to the local and wider economy (European Commission 2000). In terms of the diagnostic tests for the model, it appears to be robust to the various departures from standard regression assumptions in terms of residual correlation, misspecification of functional form, and non-normality of residuals. Table 8 shows the natural resource depletion, air pollution, and climate change nexus in the World's largest regions.

The results show that, in majority of the cases, climatic factors and air pollution have a significant and positive relationship with the natural resource depletion (NRD); however, the extent to deplete the natural resource varied region to region. As in the short-run, GHG emissions and HFC have a positive and less elastic relationship with the NRD in the South Asian region. However, carbon dioxide emissions have one-to-one negative corresponding relationship with the NRD in the South Asia. Similarly, HFC and NOX have a positive and less elastic relationship with the NRD in East Asia and the Pacific region. PFC has a positive and less elastic relationship with the NRD, while NOX has a one-to-one corresponding relationship with the NRD in the sub-Saharan Africa. Finally,

Table 9 Long-run and short-run elasticities [dependent variable: Δln(NFD)]

Variables	Coefficients (South Asia)	Coefficients (MENA)	Coefficients (sub-Saharan Africa)	Coefficients (East Asia and Pacific)
Long-run results				
GHG	Negative, <1***	Positive, <1	Negative, >1*	Negative, <1
HFC	Negative, <1	Negative, <1***	Negative, <1	Negative, >1*
PFC	Negative, <1**	Negative, ≅1*	Negative, <1*	Negative, <1**
SF6	Negative, <1***	Negative, <1	Positive, <1***	Positive, <1**
METH	Positive, >1*	Negative, <1	Negative, <1	Positive, <1
NOX	Negative, <1	Positive, <1*	Negative, >1*	Negative, ≅1*
CO_2	Negative, >1*	Negative, <1***	Negative, <1	Negative, <1***
Short-run results				
GHG	Positive, <1*	Negative, <1**	Negative, <1*	Negative, <1
HFC	Negative, <1**	Negative, <1***	Positive, <1**	Negative, <1**
PFC	Negative, <1	Negative, <1*	Negative, <1**	Negative, <1*
SF6	Negative, <1**	Negative, <1	Negative, <1***	Positive, >1**
METH	Positive, >1*	Negative, >1*	Negative, <1	Negative, <1***
NOX	Negative, <1	Negative, <1***	Negative, <1	Negative, <1
CO_2	Negative, <1*	Positive, <1*	Negative, <1**	Positive, <1*
Diagnostic tests				
Adjusted R^2 (minimum–maximum)	0.501–0.669	0.498–0.512	0.612–0.817	0.549–0.669
F-statistics (minimum–maximum)	2.525**–3.969*	5.526*–6.012*	4.336*–5.663*	5.969*–6.969*
JB (χ^2_{NORMAL})	$p>0.050$	$p>0.050$	$p>0.050$	$p<0.050$
LM (χ^2_{SERIAL})	$p>0.050$	$p>0.050$	$p>0.050$	$P<0.050$
ARCH (χ^2_{ARCH})	$p>0.050$	$p>0.050$	$p>0.050$	$p>0.050$
Ramsey RESET (χ^2_{RESET})	$p<0.050$	$p<0.050$	$p>0.050$	$p>0.050$
CUSUM	Stable at 5 % level	Stable at 5 % level	Stable at 5 % level	Stable at 5 % level
CUSUM of squares	Stable at 5 % level	Stable at 5 % level	Stable at 5 % level	Stable at 5 % level

Probability values are quoted in square brackets. LM (I) tests for the null of first-order serial correlation among the residuals; Het: a test based on regression of squared residuals on a constant and squares of the fitted values; ARCH: a test for first-order autoregressive conditional heteroscedasticity effects; RESET: Ramsey's Regression Specification Error/′-test with (m, n) degrees of freedom; and the Jarque–Bera *X*2(2) LM test for normality of residuals

*p=0.01; **p=0.05; ***p=0.10 (denote statistical significance)

SF6 and methane emissions have a positive and less elastic relationship with the NRD in the MENA region. The results infer that tourism development put pressure on natural resources when it increases consumption in areas where resources are already scarce. Water, and especially fresh water, is one of the most critical natural resources. The tourism industry generally overuses water resources for hotels, swimming pools, golf courses, and personal use of water by tourists. This can result in water shortages and degradation of water supplies, as well as generating a greater volume of wastewater (UNEP 1999). Conservation successes have been limited compared with the threats to biodiversity and other natural endowments resulting from expansion of agriculture, tourism, and production of hydropower (UNESCAP 2013). The environment, development, and institutions are fundamentally interrelated, within a general context of sustainable development. Overuse, mismanagement, and contamination of natural resources are often the negative unforeseen consequences of development efforts characterized by unclear property rights, perverse economic incentives, poor governance, and badly designed production processes (World Bank 2008). Table 9 shows the short- and long-run elasticities in relation with the climatic factors, air pollution, and net forest depletion.

Table 9 shows that on average, climatic factors and air pollution deplete the forest area; however, the intensity to deplete the forest area varied region to region. The more pronounced factors to affect forest depletion include HFC in East Asia and the Pacific region, PFC in the MENA region, NOX in the sub-Saharan Africa and East Asia and the Pacific, and carbon emissions in South Asia. The development of climate change-related policies, as well as the status and approaches to forest management in the context of climate change, vary

Table 10 Long-run Granger causality test—VECM (causality between climate change and tourism)

Variables	Causality (South Asia)	Causality (MENA)	Causality (sub-Saharan Africa)	Causality (East Asia and Pacific)
Greenhouse gas emissions (GHG) to tourism development indicators				
GHG ↔ ITR	→	→	→	→
GHG ↔ ITE	←	→	→	→
GHG ↔ NRD	≠	⇔	⇔	≠
GHG ↔ NFD	≠	←	⇔	≠
HFC to tourism development indicators				
HFC ↔ ITR	→	≠	⇔	≠
HFC ↔ ITE	→	⇔	→	≠
HFC ↔ NRD	→	→	≠	←
HFC ↔ NFD	→	≠	→	→
PFC to tourism development indicators				
PFC ↔ ITR	→	→	→	→
PFC ↔ ITE	≠	←	→	→
PFC ↔ NRD	⇔	≠	→	→
PFC ↔ NFD	≠	→	←	≠
SF6 to tourism development indicators				
SF6 ↔ ITR	→	⇔	≠	←
SF6 ↔ ITE	≠	←	→	←
SF6 ↔ NRD	≠	≠	→	←
SF6 ↔NFD	→	⇔	⇔	≠

widely region to region. Forest-based mitigation of climate change can be achieved in three direct ways, i.e., firstly, through the maintenance of existing forests, thus addressing the source of emissions from the forest sector; secondly, through the restoration of lost carbon stocks from degraded or cleared forests, rectifying the negative impact that the forest sector has had in terms of emissions in recent years; and finally, through the creation of new forest areas, thus increasing the potential of forests to act as a sink for greenhouse gasses (FAO 2010).

Table 11 Long-run Granger causality test [air pollution and tourism]

Variables	Causality (South Asia)	Causality (MENA)	Causality (sub-Saharan Africa)	Causality (East Asia and Pacific)
METH to tourism development indicators				
METH ↔ ITR	→	≠	≠	≠
METH ↔ ITE	≠	→	→	←
METH ↔ NRD	≠	→	→	≠
METH ↔NFD	→	≠	≠	→
NOX to tourism development indicators				
NOX ↔ ITR	≠	←	⇔	←
NOX ↔ ITE	≠	⇔	≠	→
NOC ↔NRD	≠	→	≠	⇔
NOX ↔ NFD	≠	≠	←	≠
CO_2 to Tourism development indicators				
CO_2 ↔ ITR	→		≠	≠
CO_2 ↔ ITE	≠	→	→	→
CO_2 ↔ NRD	⇔	→	→	→
CO_2 ↔ NFD	←	→	→	→

Results of granger causality analysis

As the variables are cointegrated, the study proceeds to examine the short- and the long-run Granger causality in the ECM framework. Table 10 presents the results of Granger causality among climatic factors, air pollution, and tourism development indicators. The overall results conclude that at large, there is a unidirectional causality running toward climatic factors to tourism indicators; however, there are some feedback relationship between the specific climatic factors and tourism indicators, i.e., GHG emissions Granger cause NRD in MENA and sub-Saharan Africa; GHG emissions cause NFD in sub-Saharan Africa; HFC Granger cause ITR and ITE in sub-Saharan Africa and MENA regions; PFC Granger cause NRD in South Asia; SF6 Granger cause ITR and NFD in MENA region; and finally, SF6 Granger cause NFD in sub-Saharan Africa. The remaining factors show no cause–effect relationship between the climatic factors and tourism indicators, i.e., GHG emissions and NRD in South Asia, GHG emissions and NFD in South Asia, HFC and ITR in MENA, HFC and ITE in East Asia and the Pacific, HFC and NRD in sub-Saharan Africa, HFC and NFD in MENA, PFC and ITE in South Asia, PFC and NRD in MENA, PFC and NFD in South Asia and East Asia and the Pacific regions, SF6 and ITR in sub-Saharan Africa, SF6 and ITE in South Asia, SF6 and NRD in South Asia and MENA regions, and finally, SF6 and NFD in East Asia and the Pacific region.

In the subsequent analysis, Table 11 shows the Granger causality between air pollution and tourism indicators in the World's largest regions. The results reveal that on average, air pollution Granger cause tourism indicators but not vice versa; however, there are some bidirectional causalities between the variables, i.e., NOX Granger cause ITR in sub-Saharan Africa; NOX Granger cause ITE in MENA region; NOX Granger cause NRD in East Asia and the Pacific region; and carbon dioxide emissions Granger cause BRD in South Asia.

There has been limited progress in the implementation of policies for more sustainable tourism, with minimal penetration of schemes such as eco-labeling within the tourism industry (European Commission 2000).

The issue of climate change is now firmly entrenched in the global agenda and critical negotiations for a greenhouse gas emissions framework continue (UNWTO 2009). The tourism industry faces a multitude of significant sustainability related challenges. Challenges that need to be resolved through the greening of the industry include (i) energy and greenhouse gas (GHG) emissions, (ii) water consumption, (iii) waste management, (iv) loss of biological diversity, and (v) effective management of cultural heritage (UNEP 2011).

Conclusion

Tourism destinations are gradually more concerned about global climate change and considering becoming involved in the adoption of mitigation policies that reduce global emissions (Araña et al. 2013). The objective of the study is to explore the relationship between climate change, air pollution, and tourism development indicators in the World's most promising regions, during the period of 1975–2012. The results indicate that on average, climatic factors and air pollution affect the tourism industry; however, the intensity to affect the tourism indicators varied region to region. These factors affect either less elastic, more elastic, or one-to-one corresponding relationship with the tourism indicators. The results further indicate that there are multiple channels to affect the climatic factors, air pollution, and tourism indicators; however, the direction of cause–effect relationship remains diverse and has strong policy implications. In general, there is a unidirectional causality running between climatic factors to tourism indicators on one the hand, while on the other side, air pollution Granger also causes tourism indicators, but this process is rarely opposite in some regions. In addition, there have been some bidirectional causalities between the climatic factors and air pollution and air pollution to tourism indicators in World's largest regions. This study also confirms the neutrality hypothesis between the variables in different regions. These results emerged with the following policy implications, i.e., to promote cross-country research, technical assistance and knowledge sharing on climate compatible development, and learning lessons locally to scale up nationally and regionally (CDKN 2013).

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