Science of the Total Environment 778 (2021) 146209

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

A step towards environmental mitigation: Do tourism, renewable energy and institutions really matter? A QARDL approach

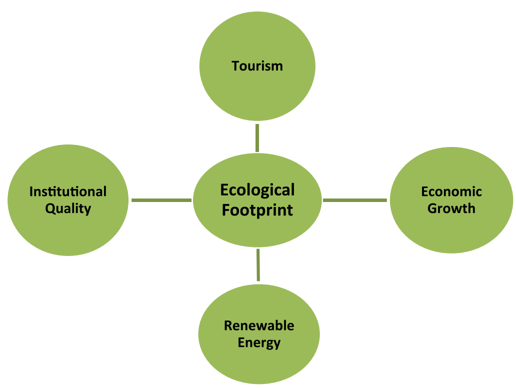
Zhan Zhan [a], Liaqat Ali [b], Salman Sarwat [c], Danish Iqbal Godil [d,*], Gheorghita Dinca [e], Muhammad Khalid Anser [f]

[a] *Wuchang University of Technology, Wuhan, Hubei, China*
[b] *Department of Management Studies, Bahria Business School, Bahria University, Karachi, Pakistan*
[c] *Benazir Bhutto Shaheed University Lyari, Karachi, Pakistan*
[d] *Department of Business Studies, Bahria Business School, Bahria University, Karachi, Pakistan*
[e] *Faculty of Economics and Business Administration, Universitatea Transilvania Brasov, Romania*
[f] *School of Public Administration, Xi'an University of Architecture and Technology, Xi'an, China*

HIGHLIGHTS

- We evaluated the impact of renewable energy, institutional quality, and tourism on the ecological footprint.
- We utilize the novel Quantile autoregressive distributed lag model to evaluate the nexus.
- Increased utilization of renewable energy and tourism improve the environment in Pakistan
- Institutional quality and GDP were found to be positive and significant at all quantiles.
- The presence of the Environmental Kuznets Curve was also validated.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 7 February 2021
Received in revised form 24 February 2021
Accepted 25 February 2021
Available online 3 March 2021

Editor: Huu Hao Ngo

Keywords:
Ecological footprint
Tourism
Renewable energy
Sustainability
QARDL

ABSTRACT

Adverse changes in environmental conditions due to unprecedented industrialization have been attracting the attention of policymakers, researchers, and activists. For developing nations like Pakistan, sustainability issues become even more severe because of unplanned growth and lack of resources. In this study, we have applied the QARDL model to analyze the impact of renewable energy, institutional quality, tourism, and GDP on the ecological footprint in Pakistan from 1995 to 2017. The results of this study suggest that increased utilization of renewable energy and tourism improve the environment in Pakistan, whereas institutional quality and GDP are positive and significant at all quantiles, revealing that upsurge in GDP and institutional quality are directly related to environmental conditions at all the quantiles. These results also validate the presence of the Environmental Kuznets Curve in Pakistan. The government of Pakistan can play a notable part in attaining sustainability by efficient management of the environment through promoting sustainable tourism, utilization of renewable energy, and enhancement of institutional quality.

* Corresponding author.
E-mail addresses: salman.sarwat@bbsul.edu.pk (S. Sarwat), research2526@gmail.com (D.I. Godil), gheorghita.dinca@unitbv.ro (G. Dinca), mkhalidrao@xauat.edu.cn (M.K. Anser).

https://doi.org/10.1016/j.scitotenv.2021.146209

1. Introduction

Environmental deterioration is one of today's world's major concerns. Greenhouse gases, the ozone layer's thinning, and global warming are serious threats for mankind. Air quality and water quality are declining day by day. Such a situation led various countries to take drastic measures to rescue the environment. Nevertheless, the efforts to protect the environment are considered to be inversely related to the economic output, which creates a tradeoff situation. There are also some theories supporting the view that economic growth can elevate environmental conditions as well, after a certain threshold point. In this regard, the Environmental Kuznets Curve (EKC) Hypothesis is a well-known theory. Based on Kuznets (1955) pioneering work, scholars such as Ozcan and Ari (2017), Istaiteyeh (2016), Grossman and Krueger (1991), and Dinda (2004) debated that countries' economic growth causes environmental damages via energy consumption in the initial stage of progress. As economic advancement reaches a particular threshold, environmental exploitation starts diminishing. This is the simplest explanation of Kuznets' environment curve (EKC) theory.

Building the argument further, several studies (Katircioglu, 2017; Kapusuzoğlu, 2014; Magnani, 2001) suggested economic growth is not the only determinant of EKC, hence the need to explore different dimensions and components. The environmental deterioration has gone to the edge in recent times for both developing and developed nations because of greenhouse gases (GHGs) emission, which caused a rise in the average temperature worldwide. Due to unprecedented industrialization during the last 200 years, the world has seen a rapid ascent in energy consumption, which created a trade-off between economic advancement and ecological effects. This in turn made it progressively hard to oversee and control the greenhouse effect. Using non-renewable energy sources to fulfill energy demand for transportation (Godil et al., 2021, 2021a, 2021b) and production further enhanced the greenhouse effect.

There is a herding behavior in the selection of CO_2 emission as a proxy for environmental degradation while observing its connection to GDP and environmental conditions (Wackernagel and Rees, 1996). Selecting CO_2 emission is at least partially flawed since it comprises data for absolute environmental degradation through energy consumption, whilst intermediary effects and broader aspects of environmental concerns are ignored (Al-Mulali et al., 2015b). The ecological footprint (ECF) is a distinctive measure for environmental conditions as it tracks the human economy's reliance upon natural capital; in other words, it gauges the social and technological impact upon Earth's ecosystem. There is a detailed literature discussion about the determination and selection of ecological footprint as a pointer of environmental condition (Kissinger and Haim, 2008; Moore et al., 2013; Galli, 2015). Data about natural resources (such as soil, water, and air) accessibility can be acquired through ECF.

The Earth's capacity to impound leftover is currently undermined because of population rise, tourism, local governments' institutional quality, and worldwide overrun (Hoekstra, 2009). A measure of Earth resources' consumption is indicative of Ecological Footprint's idea. The ECF concept was presented in the 1990s (Rees, 1992), as an instrument proposed to follow the social or economic impact on nature's reproductive capacity and man's dependability upon the environment (Wackernagel et al., 2002). There are six different footprint kinds, i.e. cropland, energy, built land, pasture, ocean, and forest. Nevertheless, for estimation, only the food, carbon, housing, goods, and services footprints' classes of the ECF are utilized.

The ecological footprint clarifies the range of the ecological system's aggregate territory to produce the resources devoured by economic procedures and demonstrates the capacity to ingest the formed waste (Wackernagel et al., 1999; Solis-Guzman and Marrero, 2015). There are two fundamental explanations behind choosing ECF as a pointer of ecological conditions. Firstly, it tells us the usufruct limits of natural settings; thus, a superior estimation tool for the natural environment's accessibility. As indicated by Sustainable Development Goals (SDGs), the ECF is the primary technique that takes the organic abilities of soil, water, and air for manageable social activities and economic advancement (Nazar et al., 2018; Pan et al., 2019). Secondly, it also captures natural resources' (minerals, wood, and other natural assets) extraction. In this way, if outflows are picked as environmental markers, ecological manageability can be tracked vis-à-vis the economic activity, which can harm the environment's maintainability (Li et al., 2019).

Because of its extensiveness, several researchers (e.g. Godil et al., 2020c; Wang et al., 2011; Mostafa, 2010; Caviglia-Harris et al., 2009; Sharif et al., 2020) prefer to utilize ECF as a pointer of ecological effect. Cornelia (2014) regards ECF for its comprehensiveness; Lenzen and Murray (2003), Niccolucci et al. (2012), and Wackernagel et al. (2004) consider its maintainability for a given population; Costanza (2000) found that it consolidates environmental information into a solitary measure. Besides ECF, the ecological footprint of consumption (EFC) indicates anthropogenic burden (pollution due to human activities) on the environment (Vačkář, 2012; Jorgenson, 2003; Jorgenson and Burns, 2007; Rosa et al., 2004; Rothman, 1998; York et al., 2009). Due to the aforementioned benefits, this study is also using ECF to measure the extent of environmental exploitation.

Research has highlighted different factors affecting ECF, for instance, economic growth (Tutulmaz, 2015), natural resources and tourism (Katircioglu et al., 2018b), and FDI (Solarin et al., 2018). Besides these factors, some examinations have inspected the role of financial growth on ECF, (for example Charfeddine and Khediri, 2016; Destek and Sarkodie, 2019), institutional quality, and trade openness (Ali et al., 2020). In these examinations, potential determinants of ecological footprint are consolidated, such as GDP, quality of institutions, energy consumption, and tourism.

Economic development derives its real impact from the relationship between various factors including energy consumption, ecological changes, tourism, GDP, and globalization of institutions. However, the concerns about the sustainable environment have pushed international organizations and local and national governments to use a conservationist approach to cope up with the growing global environment issues (Adedoyin and Zakari, 2020). However, the task of maintaining sustainable environmental policies contradicts the activity of large-scale manufacturing that needs energy consumption at a certain level to maintain a minimum level of production, especially in emerging economies such as Pakistan. The reason behind this is mainly the requirement of many countries to attend to the immediate need of energy consumption to increase production. Therefore, chasing the development projection while considering environmental sustainability is a daunting task for many countries. Resultantly, the international market integration through various avenues like trade agreements has put more stress on the energy consumption levels access to international markets through leverage of international trade. Various studies have revealed that there is an interconnectedness of GDP, energy consumption, tourism, ecological footprint and there is a possibility that the relation of these variables adversely affects the environment. However, more empirical evidence is needed to explore more in this direction.

The entirety of the chosen factors is extremely significant for nations like Pakistan. The country faces serious dangers from spontaneous unplanned inflating communities, it has 98% of the energy coming from non-renewable energy sources, and the development pattern of its economy significantly relies upon the vast scope of the industry, which utilizes obsolete systems, equipment, and machinery (Khan et al., 2019). Even though, in the literature, EKC theory was thoroughly tested, notwithstanding, few observational investigations have attempted to clarify the potential explanations behind the presence of EKC in the setting of Pakistan. Taking this scenario into account, this study looks back on environmental issues in Pakistan and explores the impact of factors such as renewable energy consumption, tourism, institutional quality, and economic growth with the ecological footprint.

Tourism is viewed as one of the rapidly developing industries on a global scale. It additionally represents a significant wellspring of economic growth, with respect to various aspects, for example, GDP growth (Kim and Chen, 2006), trade (Kulendran and Wilson, 2000), and investment (Dunning and Kundu, 1995). Moreover, there is a parallel expanding association between outbound footprint and ECF (Qureshi et al., 2019). The contribution of the tourism industry to global gross domestic product has expanded around twofold in the last 25 years and it has been a significant component in decreasing poverty (Blake et al., 2008). This industry is nevertheless a major cause of ecological disturbance. The tourism industry needs enormous outlay for infrastructural improvements, such as road networks, ports, and distinctive traveling services such as hotels, malls, and amusement parks, etc. So, it isn't astounding that the travel industry put huge pressure on natural resources, climate, and soil; subsequently, it challenged environmental sustainability.

The general development of interest in renewable energy sources is outlined by the noteworthy increment in the number of recent years' published research articles. However, only 7.6% of these articles were related to environmental effects, regardless of whether positive or negative and simply 4% have explicitly considered the biological ramifications of saddling any sustainable power source. Less than 1% of the articles considered the potential natural dangers of sustainable power source's misuse and none was explicitly identified with waterfront biology. Natural components are not being considered appropriate, and are underrepresented in any discussion of the issues and advantages of embracing seaward sustainable power sources (Gill, 2005). The nexus between the usage of renewable energy and ECF is also imperative. According to Danish et al. (2020) natural resource, REC, and urbanization have an indirect nexus with the ecological footprint because all of these have a favorable contribution towards the environment's quality. Owusu and Asumadu-Sarkodie (2016) stated the sources of renewable energy are ample and sustainable whereas, the case of fossil fuel is vice versa, i.e. it is unsustainable and limited, and its usage upsurges the ECF. Destek and Sarkodie (2019) discovered that energy usage reduces ECF.

In contrast with developed nations, institutional quality is poor in South Asia. The circumstances in Pakistan and Bangladesh are even poorer than in India and Sri Lanka. Considering all the four countries, Sri Lanka has a superior positioning than the other three nations. Weak institutional quality may lead to misallocation of foreign funds, hindering development. Along with poor institutional quality, there is also the absence of an ecological footprint in these nations. The biological Footprint of these four countries is greater than their bio-capacity. Regardless of foreign inflows, South Asia has not accomplished economic advancement. In the case of Pakistan, net reserve funds and foreign aid show an inverse relation. A similar picture is also exhibited by Sri Lanka, which likewise shows a reduction in net foreign aid received. Poor institutional quality and lack of environmental protection have diminished the volume of assistance received by South Asian nations.

The association of institutional quality with ecological conditions is another relevant yet multifaceted inquiry. The relationship between institutional quality and ecological conditions was studied by various researchers (Charfeddine and Mrabet, 2017; Bhattarai and Hammig, 2004). Results from these studies are diverse, with one possible reason being the differences in concepts' operationalization (Holmberg et al., 2009). Sønderskov (2009) found that people's trust in high-quality institutions will allow institutions to lead the people and this might help to solve the issues related to unsustainable use of natural resources. The effectiveness of environmental policies is contingent upon policy implementation along with institution performances, governing ideas, resources dispersal, and the structure of industries (Hughes and Lipscy, 2013; Meyer et al., 2003).

Considering the above contentions, the following research is based on the impact of renewable energy consumption, tourism, institutional quality, and economic growth on Pakistan's ECF. In the context of Pakistan, past studies cannot be viewed as conclusive because the aforementioned components were not considered in the nexus of ecological footprint. Examination of these factors' causal relationship would be helpful in prescribing policy recommendations. This study also explains the operational and potential ways to help the business network and course of future activities in accordance with grounded circumstances. It is observed that the studies were just considering the traditional research strategies, for example, exploring the causality among referenced factors while overlooking timelines. Even investigations that concentrated on these factors with an appropriate approach to address the gaps, cannot match the use of the QARDL method from the present examination, which is more comprehensive in exploring the relationship of the ecological footprint nexus. The use of the QARDL model refines and appropriates the analysis to extend the examination and understand ecological footprint in the context of renewable energy consumption, tourism, institutional quality, and economic growth.

The QARDL strategy is quite different and more comprehensive compared to conventional methodologies. QARDL approach is designed to test the relationship's dependability over the quantiles and conveys an appropriate statistical setting to examine the relationship. Even if the QARDL model originates from the straight ARDL model, however, it has the prevalence of acclimating abnormalities in the response of ECF to the impact of renewable energy, tourism, institutional quality, and GDP, with an ecological footprint under various viewpoints.

This approach contemplates locational asymmetry, where findings and the components might be unexpected to the dependent variable's circumstance for the analyzed situation. Secondly, the QARDL model simultaneously considers the drawn-out association of renewable energy, tourism, institutional quality, and GDP with the ECF, and its related momentary elements over the quantiles scopes of ecological footprint's contingent dispersal. Thirdly, the present investigation discovers indication of nonappearance of co-joining among these time arrangements, while applying standard econometric strategies, as the linear ARDL model and the Johansen co-incorporation test. The QARDL model additionally is prevalent over nonlinear models like Nonlinear ARDL created by Shin et al. (2011), where nonlinearly is delineated by setting it at zero; QARDL sets up dependents on the information-driven procedure. As such, the QARDL model turns out to be generally reasonable for the nonlinear and asymmetric relationship of renewable energy, tourism, institutional quality, and GDP with an ecological footprint in Pakistan.

The remaining portion of the paper is organized as: in the following section, related literature is expounded, the third section gives exhaustive QARDL technique's clarification, the fourth section exhibits analysis outcomes and discusses key findings, whereas the fifth section concludes the whole discussion, infers insights about investigated nexus and offers some policy recommendations.

2. Literature review

Climate changes' repercussions upon human beings and other living organisms are a major contemporary concern. Environment activists, policymakers, and regulators have been constantly searching for solutions to stop environmental degradation and ensure sustainable advancements on societal and economic fronts. In fact, this is a survival matter, as many researchers (such as Bilgili and Ulucak, 2018b), have emphasized the severity of environmental issues. Environmental manageability has been increasingly viewed as more conspicuous with the ever-deteriorating environment (Ulucak et al., 2019). In this regard, ECF is viewed as an appropriate pointer for environmental debasement and its maintainability

(Bilgili and Ulucak, 2018a; Lin et al., 2018; Ozcan et al., 2018; Ozcan et al., 2019; Solarin et al., 2018; Solarin et al., 2019).

Nevertheless, the literature has also inspected environmental degradation from different points of view; among them, the EKC theory (income and environmental degradation association) is one of the most approached. Destek et al. (2018) examined the EKC theory for the European nations utilizing an advanced panel data approach and endorsing the inverted U-shape connection between national income and ECF. Aydin et al. (2019) discovered, with the assistance of a recently developed panel smooth transition regression (PSTR) model that EKC doesn't hold for most of the 26 analyzed European nations, covering the 1990–2013 period. Further examination by Destek et al. (2018) suggested the same conventional EKC connection between income and ECF for EU nations.

This area also hosts studies on Asian and African regions as well. Ozcan et al. (2018) study has not confirmed EKC for Turkey. Besides, Uddin et al. (2019) analyzed the interdependency among growth and ECF in 14 Asian countries. The EKC hypothesis was confirmed for Malaysia, Pakistan, Nepal, and India. Danish and Wang (2019) connected economic development and ECF through human capital and bio-capacity in Pakistan. Studies have uncovered that economic development and bio-capacity expand ECF, while human capital's expansion does decrease ECF. Wang and Dong (2019) stated that economic growth has a positive influence on ECF for 14 African countries, applying the Augmented Mean Group (AMG) algorithm. Sarkodie (2018) also found the conventional U-type EKC curve between GDP and ECF for 17 African nations.

Besides region-specific studies, EKC has also been examined from other angles, as for instance, Uddin et al. (2017), which dissected the same connection for twenty-seven air polluted nations. DOLS *dynamic ordinary least square* method has been used in their study to check the impact of national income on ECF and found a positive relationship. Aşıcı and Acar (2016) have examined whether GDP has any link with ecological conditions. The study analyzed 116 nations for the 2004–2008 period and the results affirmed a modified *U*-shaped connection between income and environmental conditions. Ulucak and Bilgili (2018) reexamined EKC in lower, mid, and higher income-level nations and they affirmed EKC with ECF for all the strata of nations.

Determinants, other than economic growth or income, are also relevant to study ECF; as such Katircioglu et al. (2018a), and Ozturk et al. (2016) affirmed the EKC hypothesis for well-off and wealthy nations from the tourism industry. According to Katircioglu et al. (2018a), growth in tourism for major tourist destinations does not cause degradation in the environment; thus, tourism development for such a destination can be viewed as environmentally compatible. Raza et al. (2016) analyzed the role of the tourism industry on environmental degradation in the United States. Their results implied that the tourism industry has a huge transportation dependency, leading to significant carbon emissions. Transportation causes immense energy consumption; petrol and other fuel combustion have a denting impact on the environment (Godil et al., 2020a). Bakhat and Rosselló (2011) analyzed the relationship between tourism and ecological footprint via the transportation industry, because as tourism increases, transportation to different regions also increases, thus causing environmental degradation. Results of Gössling (2002) indicated that more than 90% of global warming from tourism's summative effect is accounted for by transportation itself.

Peeters et al. (2007) argued in their research that tourism increases air pollution by means of intercontinental and air transportation. Their research results showed that voyage via cruise ships is even more carbon-severe than air transportation. However, both means are accountable for enormous CO_2 emissions, thus reducing ecological resources. Byrnes and Warnken (2006) examined the relationship between total and per capita energy and greenhouse contribution as compared to tour boat operations. Their research depicted that tour boat operations accounted for 0.1% of Australia's transportation industry. Furthermore, Lin et al. (2018) argued that CO_2 emissions in five different national parks were extraordinary, and per capita, CO_2 emissions were different for each national park.

Al-Mulali et al. (2015a) performed a longitudinal study for the 1995–2009 period. They investigated the association between CO_2 and tourism for 48 different tourism destinations and found a long-term association of the two in Africa, the Americas, and the Middle East. Lee and Brahmasrene (2013) also revealed a long-run relationship between tourism and CO_2 emission. They analyzed a data panel for the 1988–2009 period for European countries. Results of Tovar and Lockwood (2008) suggested that tourism has severely affected the ecological conditions and environmental balance.

Solarin (2014), investigated the macroeconomic variables and tourist arrivals as determinants of Malaysia's CO_2 emission and found a long-term association between tourist arrivals and CO_2 emission. His research suggests that government should use alternative energy resources, especially renewable ones. Growing tourism also tends to increase the use of resources available in different regions. According to Katircioğlu (2014), there are empirical shreds of evidence for the causal association of tourism with ECF in Singapore; the author found a unidirectional causal relationship between tourism and the ecological footprint. Furthermore, his study revealed a negative effect of tourism development on the environment.

This whole scenario prompted researchers to investigate the travel industry's impact on environmental disturbance (Gössling, 2013). The greater part of these investigations used CO_2 emission as a proxy for environmental degradation. However, this proxy can only portray a fractional view of ecological degradation brought about via the travel industry. Thus, we need a more comprehensive measure. The ecological footprint is a much better indicator in this regard, the same used in our study. The ECF delineates the nation's effect on the environment from three perspectives: soil, water, and air; therefore, it provides comprehensive insights into the ecological conditions brought about by tourism. To the best of researchers' knowledge, there is a dearth of literature available on the nexus between tourism and ECF. We mention only part of them in what follows.

Hunter (2002) was among the pioneers attempting to associate tourism with ECF. He conceptualized the touristic EFC and provided an opportunity to enhance our insight about 'on the ground' facts regarding tourism's impact on the environment. Previously, and even afterward Hunter, most studies investigating the impact of tourism on the environment use CO_2 emissions as an indicator of ecological deterioration. Qureshi et al. (2019) have studied the role of inbound and outbound tourism on the environment revealing that shreds of evidence of Carbon Dioxide cannot be enough to substantiate the nature, direction, and magnitude of the association between tourism and the environment. They included ECF, NOx, CO_2, SO2, and GHG emissions to express environmental degradation, taking empirical evidence from panel data with 35 countries. Their results suggest there is a rebound effect of international tourism on the ecosystem and on air pollution, which is evident as a monotonic increasing relationship between outbound tourism and ECF; on the other hand, such a relationship cannot be captured for Nitrogen Oxide, Carbon Dioxide, Sulphur Dioxide, and Green House Gas emissions.

Katircioglu et al. (2018a, 2018b) have also tested the impact of the tourism industry on ECF quality; they performed their inquiry on the top ten tourists' destinations. According to their results, tourism development negatively affects ECF for the top ten tourist destinations. They have mentioned a few causes of this adverse effect, such as overusage of raw materials, freshwater waste, deforestation, etc. They have also justified the selection of ECF as a pointer of environment degradation and considered it as a unique proxy that tracks vital ecological information such as availability of water resources, forests, and fresh air, etc. The investigation suggested that renewable energy can diminish environmental deterioration.

Apergis et al. (2010), took a sample of 19 developed and developing nations for the 1984 to 2007 period and indicated a long-term inverse causal connection between green-energy utilization and CO_2 emissions, though green energy utilization has no impact over carbon outflow in the short-run. Azlina et al. (2014) contended unidirectional causal relation between green-energy utilization and CO_2 emission in Malaysia. Ajmi et al. (2015) examined the causality between energy consumption and CO_2 emission for the 7 most developed nations group; they found bidirectional causality in the USA and unidirectional causality in France. Menyah and Wolde-Rufael (2010) examined the causal linkage between renewable energy consumption, nuclear energy, and CO_2 emission in the USA. The results suggested no causal association between renewable energy and CO_2 emissions, leading to a conclusion that the use of renewable energy has not reached yet a breakeven point from where it could reduce CO_2 emanation in the United States.

The influence of energy consumption is country-specific and is dependent upon different factors (Godil et al., 2021, 2021a, 2021b). However, renewable energy plays a vital role in reducing ECF (Danish et al., 2020). Charfeddine (2017) found a positive relationship between ECF, financial development, and energy consumption. He stated that ECF is a comprehensive environment indicator, which can capture the effect of financial development and energy consumption at multiple levels. The results of his study indicate that a 1% increase in energy consumption in terms of electricity will cause a 0.227% increase in ECF. Bello et al. (2018) studied the use of alternative sources of energy like hydroelectricity, which tends to decrease ECF. Sharif et al. (2019) have researched the role of renewable and non-renewable energy utilization on ecological degradation from 74 most carbon-emitting nations sampled from 1990 to 2015.

Recent studies of Danish et al. (2020), respectively of Danish and Wang (2019) have further dug down the relationship between ECF and urbanization. Danish et al. (2020) have stated that increasing urbanization pushes up the industrialization process as well as transportation needs, which in turn causes non-renewable energy consumption to increase, and consequently, creates an impact on ECF. Danish and Wang (2019) have discussed the association of EFC and urbanization from another angle; they incorporated the role of scale economies, increased level of personal income, and other positive externalities, which ultimately enhance citizens and businesses' purchasing power. Enhanced purchasing power tends to switch people from non-renewable to renewable energy resources, which can positively impact ECF. Dogan et al. (2019) evaluated ECF with similar variables in MINT economies (i.e. Mexico, Indonesia, Nigeria, and Turkey), with export as an additional variable in their study. They concluded that financial development, fuel consumption, urbanization, and export were negatively influencing ECF. Nathaniel (2020) has also studied ECF in the context of energy and economic growth along with urbanization and trade for the Indonesian economy. His findings suggest that an increase in energy consumption, economic growth, and urbanization causes environmental degradation.

Opinions are divided on the role of institutional quality in addressing the environmental issue for both empirical and theoretical studies. One explanation might be the diversified nature and functions of concerned institutions in various countries. The effects of institutional quality have been discussed under different disciplines. The ecological aspects and environmental degradation might be a result of issues in achieving collective efforts in the context of institutions. To avoid the so-called social traps, coordination is required at several levels (Gärling et al., 2002). Social trust is the key that motivates people to willingly cooperate, whereas high-quality and reliable institutions seemingly can successfully develop social trust. Initially, Torras and Boyce (1998) found a positive influence of good governance and democracy on environmental quality. Institutional quality has also a political dimension (Fredriksson and Svensson, 2003). Bhattarai and Hammig (2001) studied the nexus between deforestation and the quality of institutions for 66 countries. They found a significant reduction in deforestation due to political institutions and good governance. Pellegrini and Gerlagh (2006) have found week institutional quality to strongly deter the implementation of environmental policy. Castiglione et al. (2013) detected that a stronger rule of law and pollution are negatively associated.

Sønderskov (2009) has discussed the association between institutional quality and environmental issues. He considers that institutional quality inculcates institutional trust, which leads to a better collective action as individuals are governed by the institutions. Better collective action offers organized use of natural resources, which can result in a sustainable environment. Duit et al. (2009) have also deliberated on the impact of institutional quality on environmental sustainability and found a negative association between the two variables. They further analyzed the causes of the negative relationship and concluded that quality institutions facilitate the swift and effective extraction of natural resources, which in turn hurts environmental sustainability. Another very important angle of institutional quality is the rule of law and level of corruption, which can affect the stringency of environmental policy. Damania et al. (2004), respectively Pellegrini and Gerlagh (2006) have covered this aspect of institutional quality, and both studies concluded that the corruption element has a strong negative impact on environmental sustainability, because it induces compromise on the strictness of environmental policy. Charfeddine and Mrabet (2017) have combined socio-political variables, such as institutional quality and economic variables, such as GDP per capita, to check their impact on ECF. They conducted their study on MENA (the Middle East & North Africa) economies. The findings of their study suggest that real GDP per capita has an inverted *U* shape association with ECF, whereas energy usage creates a negative impact on ECF. Institutional quality has been found neutral for ECF. Strand (2010) confirms the nexus between institutional quality and ECF. The research conducted by Bhattarai and Hammig (2004) revealed that institutional quality and forest resources preservation are positively and significantly associated. According to Duit (2005), high-quality institutions could result in easier access and utilization of natural resources, which helps environment sustainability. Ali et al. (2020) found a substantial yet negative nexus between ecological footprint and institutional performance.

3. Methodology

To review the association of our variables (REN, TOR, INQ, GDP, and ECF), we utilized the novel model introduced by Cho et al. (2015) i.e. QARDL. This novel model is an advanced version of the ARDL model. QARDL helps to explore the likely asymmetries and nonlinearities between REN, TOR, INQ, GDP, and ECF. It can be written as in Eq. (1) below.

$$\begin{aligned} ECF_t = \mu &+ \sum_{i=1}^{p}\sigma_{ECFi}ECF_{t-i} + \sum_{i=0}^{q}\sigma_{GDPi}GDP_{t-i} \\ &+ \sum_{i=0}^{r}\sigma_{GDP^2i}GDP^2{}_{t-i} + \sum_{i=0}^{s}\sigma_{\mathrm{REN}i}\mathrm{REN}_{t-i} \\ &+ \sum_{i=0}^{U}\sigma_{TORi}TOR_{t-i} + \sum_{i=0}^{v}\sigma_{INQi}\mathrm{INQ}_{t-i} + \varepsilon_t \end{aligned} \tag{1}$$

where ε_t is the sign of error term specified as $ECF_t - E\,[ECF_t/\omega_{t-1}]$ and ω_{t-1} is the smallest υ- field which is formed by. $ECF_t, GDP_t, GDP^2{}_t, REN_t, TOR_t, INQ_t, ECF_{t-1}, GDP_{t-1}, GDP^2{}_{t-1}, REN_{t-1}, TOR_{t-1}, INQ_{t-1}$ and *p, q, r, s u, and v* are lag orders identified by the Schwarz Information Criterion. Here *ECF, GDP, GDP^2, REN, TOR,* and *INQ* from Eq. (1) are ecological footprint, gross domestic product, its square, renewable energy consumption, tourism, and institutional quality.

The extended form of Eq. (1) as proposed by Cho et al. (2015) is given in Eq. (2), as a QARDL (*p,q,r,s,u,v*) framework:

$$\begin{aligned} Q_{\Delta ECF_t} = \mu(\tau) &+ \sum_{i=1}^{P}\sigma_{ECFi}(\tau)\, ECF_{t-i} + \sum_{i=0}^{q}\sigma_{GDPi}(\tau)GDP_{t-i} \\ &+ \sum_{i=0}^{r}\sigma_{GDP^2i}(\tau)GDP^2{}_{t-i} + \sum_{i=0}^{s}\sigma_{RENi}(\tau)REN_{t-i} \\ &+ \sum_{i=0}^{U}\sigma_{TORi}(\tau)TOR_{t-i} + \sum_{i=0}^{v}\sigma_{INQi}(\tau)INQ_{t-i} + \varepsilon_t(\tau) \end{aligned} \tag{2}$$

where, $\varepsilon_t(\tau) = ECF_t - Q_{ECFt}\,(\tau/\delta_{t-1})$ (Kim and White, 2003). Further $0 > \tau < 1$ indicates quantile. The QARDL model as depicted in Eq. (2). can be generalized as in Eq. (3) due to the likelihood of serial correlation in the error term.

$$
\begin{aligned}
Q_{\Delta ECF t} &= \mu + \rho ECF_{t-1} + \pi_{GDP} GDP_{t-1} + \pi_{GDP^2} GDP^2{}_{t-1} + \pi_{REN} REN_{t-1} \\
&+ \pi_{TOR} TOR_{t-1} + \pi_{INQ} INQ_{t-1} + \sum_{i=1}^{P} \sigma_{ECFi} \Delta ECF_{t-i} \\
&+ \sum_{i=0}^{q} \sigma_{GDPi} \Delta GDP_{t-i} + \sum_{i=0}^{r} \sigma_{GDP^2 i} \Delta GDP^2{}_{t-i} \\
&+ \sum_{i=0}^{s} \sigma_{RENi} \Delta REN_{t-i} + \sum_{i=0}^{U} \sigma_{TORi} \Delta TOR_{t-i} \\
&+ \sum_{i=0}^{v} \sigma_{INQ\,i} \Delta INQ_{t-i} + \varepsilon_t(\tau)
\end{aligned} \tag{3}
$$

According to Cho et al. (2015) Eq. (3) can be reformulated as given in Eq. (4), to develop the *ECM* of the QARDL model:

$$
\begin{aligned}
Q_{\Delta ECF t} &= \mu(\tau) + \rho(\tau)(ECF_{t-1} - \beta_{GDP}(\tau) GDP_{t-1} - \beta_{GDP^2}(\tau) GDP^2{}_{t-1} \\
&- \beta_{REN}(\tau) REN_{t-1} - \beta_{TOR}(\tau) TOR_{t-1} - \beta_{INQ}(\tau) INQ_{t-1}) \\
&+ \sum_{i=1}^{P} \omega_{ECFi}(\tau) \Delta ECF_{t-i} + \sum_{i=0}^{q} \omega_{GDPi}(\tau) \Delta GDP_{t-i} \\
&+ \sum_{i=0}^{r} \omega_{GDP^2 i}(\tau) \Delta GDP^2{}_{t-i} + \sum_{i=0}^{s} \omega_{RENi}(\tau) \Delta REN_{t-i} \\
&+ \sum_{i=0}^{U} \omega_{TORi}(\tau) \Delta TOR_{t-i} + \sum_{i=0}^{v} \omega_{INQ\,i}(\tau) \Delta INQ_{t-i} + \varepsilon_t(\tau)
\end{aligned} \tag{4}
$$

Delta method was applied to measure the short-run influence of former ECF on current ECF and it is gauged by $\omega_* = \sum_{i=1}^{P} \omega_{ECFi}$, whereas, the accumulated short-term effect of contemporary and preceding levels of *GDP, INQ, TOR, GDP*^{2,} and *REN* are measured by $\omega\sigma_{GDP*} = \sum_{i=1}^{q} \omega_{GDP*}$, $\omega_{INQ*} = \sum_{i=1}^{v} \omega_{INQi}$, $\sigma_{TOR*} = \sum_{i=1}^{u} \omega_{TORi}$, $\omega_{GDP^2{}_*} = \sum_{i=1}^{r} \omega_{GDP^2 i}$, $\omega_{REN*} = \sum_{i=1}^{s} \omega_{RENi}$. Furthermore, the long-run integrating parameter β for *GDP, INQ, TOR, GDP*^{2,} and *REN* is gauged as under:

$\beta_{GDP*} = -\frac{\beta_{GDP}}{\rho}, \beta_{INQ*} = -\frac{\beta_{INQ}}{\rho}, \beta_{TOR*} = -\frac{\beta_{TOR}}{\rho}, \beta_{GDP^2{}_*} = -\frac{\beta_{GDP2}}{\rho}, \beta_{REN*} = -\frac{\beta_{REN}}{\rho}$. Further, ρ denotes the *ECM* parameter and it needs to be negative. The Wald test was utilized to find out the short-run and long-run asymmetric effect of *REN, GDP, TOR, GDP*^{2}, and *INQ* on *ECF*. Supposing ρ, the parameter for speed of adjustment, the null hypothesis is, ρ_* (0.05) = ρ_* (0.10)………… ρ_* (0.95). Similar, are the hypothesis for β_{GDP}, β_{INQ}, β_{TOR}, β_{GDP^2} and β_{REN} parameters and for short term parameters of specific lags, i.e. $\omega_{\ ECF}$, $\omega_{\ GDP}$, $\omega_{\ INQ}$, $\omega_{\ TOR}$, $\omega_{\ GDP}^{\ 2}$ and $\omega_{\ REN}$.

4. Results & their interpretation

The results and explanations are presented in this section. Table 1 illustrates the descriptive statistics of the variables selected for this research i.e. *REN, TOR, INQ, GDP*, and *ECF* with respect to Pakistan for the 1995 to 2017 period. The data for all variables were collected from the World Bank, except for Institutional quality and Ecological footprint, which were collected from the Economic Freedom Index and Global Footprint Network websites. All mean values are positive. The average value of *REN* is 48.322 with minimum and maximum values of 44.276 and 53.123 respectively. The mean value for *TOR* is 758.714 with a range of 369.000 minimum and 1900.035 maximum values. The mean of *INQ* is 55.471 with the minimum and maximum values of 52.800 and 58.400 respectively. The mean *GDP* is 949.690 with 806.646 and 1196.594 as minimum and maximum values respectively. The mean of *ECF* is found to be 0.838, with 0.788 as a minimum and 0.926 as maximum values. Furthermore, the result of the Jarque-Bera test describes that *REN, TOR, INQ, GDP*, and *ECF* are not normally distributed at a 1% significance level, which provides us the rationale to go for the *QARDL* model for further analysis.

Table 1
Outcomes of descriptive statistics.

Variables	REN	TOR	INQ	GDP	ECF
Mean	48.322	758.714	55.471	949.690	0.838
Minimum	44.276	369.000	52.800	806.646	0.788
Maximum	53.123	1900.035	58.400	1196.594	0.926
Std. Dev.	2.549	397.681	1.502	121.010	0.038
Jarque-Bera	22.347	14.189	18.229	31.405	15.370
Probability	0.000	0.001	0.000	0.000	0.000

Source: Author Estimations.

Table 2
Results of unit root test.

Variable	REN	TOR	INQ	GDP	ECF
ADF (level)	−1.385	−0.382	0.115	0.892	−1.362
ADF (Δ)	−4.582***	−3.219***	−3.501***	−7.584***	−4.483***
ZA (level)	−1.173	−1.893	−0.093	0.361	−0.783
Year	2005 Q2	2015 Q4	1999 Q1	2009 Q4	2012 Q3
ZA (Δ)	−5.893***	−7.093***	−5.993***	−11.372***	−5.725***
Year	2015 Q1	2017 Q1	2003 Q4	2010 Q4	2007 Q2

Source: Authors Estimation.
Notes: The outcomes in this table depict the ZA and ADF tests for stationarity property. *, ** and *** shows a significance level at 10%, 5% and 1% respectively. The critical values for the ZA test are −4.82 (10%)., −5.08 (5%) and − 5.57(1%),

To check the stationarity, *ZA*, and *ADF* tests of unit root were applied. *ZA* refers to Zivot and Andrews (1992) unit root test, which allows a break at an unknown point either in intercept or in linear trend or both. In Table 2, both tests show all variables are non-stationary at level, but they are stationary at the first difference, meaning there are long-term relationships. Autoregressive type models are found appropriate to handle long-term relationships, and this is another justification for using the *QARDL* model in this study. In Table 2, the structural break shown by the *ZA* test is 2015 quarter 1 for *REN*, 2017 quarter 1 for *TOR*, 2003 quarter 4 for *INQ*, 2010 quarter 4 for *GDP*, and 2007 quarter 2 for *ECF*.

Table 3 demonstrates the result of the *QARDL* analysis estimation for Pakistan. The ρ parameter shows the dependency of the parameter and it indicates a significant nexus with the negative sign at all quantiles. Moreover, the results depict the long-term association between the independent variables (*REN, TOR, INQ, GDP*) and dependent variable (*ECF*) represented by β. The result for *GDP* shows it is highly significant and positive, while *GDP*^{2} is also significant, yet negative at all quantiles, i.e. from 0.05 to 0.95. This result tells us that at all intensities of ECF in Pakistan, an upsurge in *GDP* increases ECF. The results validate the presence of the *EKC* curve for Pakistan, which was also supported by earlier studies like (Godil et al., 2020b; Nazir et al., 2018; Godil et al., 2021; Zhang et al., 2021). The *REN* is significant and negative at quantiles ranges from (0.05–0.50). This outcome specifies that an upsurge in *REN* will diminish *ECF* in Pakistan at low to medium quantiles. These same outcomes were found out by preceding researchers, for instance, Destek et al. (2018), Destek and Sinha (2020), and Wang and Dong (2019). This emphasizes again the role of *REN* to reduce *ECF*. This also specifies that Pakistan is on the right track towards accomplishing sustainable development objectives via REN technologies.

TOR is negative and significant at low quantiles, i.e. from 0.05 to 0.30, and at uppermost quantiles, i.e. from 0.90 to 0.95. This outcome tells us that a rise in *TOR* at low or high intensities of *ECF* improves Pakistan's environment. Katircioglu et al. (2018a) found the same nexus between *TOR* and ECF. It says Pakistan is successful in managing tourism growth with respect to environmental preservation. Finally, we find that *INQ* is positive and significant at all quantiles, respectively institutional quality still has room for improvement in Pakistan. Welsch (2004) found a significant direct nexus between corruption and pollution. Additionally, short-term dynamics demonstrate present *ECF* changes to be positively and significantly affected for all quantiles, i.e. from 0.05–0.95, by their former levels for Pakistan. The recent and earlier changes in *GDP*, *GDP*^{2}, *REN*, and *INQ* do not affect the prevailing *ECF* at all quantiles, while previous and existing variations in *TOR* are significantly and positively affecting the present

Table 3
Outcomes of quantile autoregressive distributed lag (QARDL).

Quantiles	Constant	ECM	Long-run parameters					Short-run parameters					
(τ)	$\mu_*(\tau)$	$\rho_*(\tau)$	$\beta_{GDP}(\tau)$	$\beta^2_{GDP}(\tau)$	$\beta_{REN}(\tau)$	$\beta_{TOR}(\tau)$	$\beta_{INQ}(\tau)$	$\omega_{ECF1}(\tau)$	$\omega_{GDP0}(\tau)$	$\omega_{GDP^20}(\tau)$	$\omega_{REN0}(\tau)$	$\omega_{TOR0}(\tau)$	$\omega_{INQ0}(\tau)$
	0.057	−0.044***	0.418***	−0.054***	−0.327**	−0.281*	0.137*	0.582*	0.213	−0.036	0.014	−0.128***	0.080
0.05	(0.064)	(0.015)	(0.019)	(0.017)	(0.126)	(0.162)	(0.071)	(0.294)	(0.263)	(0.131)	(0.700)	(0.030)	(0.066)
	0.144***	−0.114***	0.378***	−0.065**	−0.327**	−0.256*	0.096**	0.543*	0.198	−0.057	0.017	−0.100***	0.040
0.10	(0.049)	(0.039)	(0.034)	(0.033)	(0.138)	(0.156)	(0.044)	(0.294)	(0.264)	(0.254)	(0.437)	(0.015)	(0.035)
	0.045	−0.134***	0.314***	−0.067***	−0.489**	−0.324**	0.079**	0.465***	0.192	−0.066	0.029	−0.006***	0.040
0.20	(0.033)	(0.026)	(0.036)	(0.022)	(0.220)	(0.156)	(0.040)	(0.143)	(0.228)	(0.123)	(0.379)	(0.002)	(0.036)
	0.049	−0.153***	0.289***	−0.075***	−0.463**	−0.150**	0.097*	0.426*	0.202	−0.057	0.014	−0.072***	0.063
0.30	(0.032)	(0.025)	(0.045)	(0.022)	(0.162)	(0.059)	(0.053)	(0.238)	(0.175)	(0.123)	(0.350)	(0.022)	(0.037)
	0.072**	−0.170***	0.248***	−0.073***	−0.327*	−0.008	0.106***	0.288**	0.177	−0.054	0.051	−0.005*	0.055
0.40	(0.034)	(0.027)	(0.040)	(0.020)	(0.186)	(0.099)	(0.036)	(0.119)	(0.263)	(0.123)	(0.300)	(0.003)	(0.038)
	0.079**	−0.185***	0.205***	−0.113***	−0.327*	−0.008	0.112**	0.310**	0.012	−0.050	0.073	−0.001	0.012
0.50	(0.036)	(0.029)	(0.027)	(0.019)	(0.193)	(0.116)	(0.046)	(0.138)	(0.175)	(0.167)	(0.268)	(0.003)	(0.249)
	0.017	−0.380***	0.136***	−0.103***	−0.149	−0.016	0.133**	0.464***	0.017	−0.017	0.005	−0.021***	0.040
0.60	(0.034)	(0.027)	(0.020)	(0.022)	(0.094)	(0.169)	(0.052)	(0.147)	(0.115)	(0.175)	(0.220)	(0.004)	(0.282)
	0.011	−0.216***	0.106***	−0.105***	−0.149	−0.008	0.236***	0.584***	0.004	−0.002	0.002	−0.002	0.040
0.70	(0.034)	(0.027)	(0.010)	(0.031)	(0.152)	(0.168)	(0.052)	(0.165)	(0.097)	(0.139)	(0.180)	(0.004)	(0.311)
	0.023	−0.215***	0.093***	−0.101**	−0.079	−0.033	0.200***	0.432**	0.010	−0.051	0.007	−0.005	0.164
0.80	(0.037)	(0.029)	(0.013)	(0.041)	(0.172)	(0.040)	(0.054)	(0.190)	(0.087)	(0.078)	(0.174)	(0.004)	(0.347)
	0.040	−0.242***	0.131***	−0.083***	−0.056	−0.091**	0.177***	0.557***	0.012	−0.063	0.052	−0.012**	0.259
0.90	(0.041)	(0.034)	(0.016)	(0.026)	(0.183)	(0.036)	(0.047)	(0.192)	(0.080)	(0.071)	(0.141)	(0.004)	(0.379)
	0.021	−0.271***	0.197***	−0.091***	−0.049	−0.098**	0.196***	0.582***	0.006	−0.072	0.081	−0.007	0.269
0.95	(0.041)	(0.033)	(0.020)	(0.028)	(0.187)	(0.040)	(0.052)	(0.203)	(0.078)	(0.076)	(0.138)	(0.004)	(0.414)

Source: Author Estimations.
Note: The matrix depicts the outcomes of quantile estimation. Brackets show the standard errors. *, ** and *** shows significance at the 10%, 5% and 1%, levels, respectively.

variations in *ECF* from low to moderate quantiles ranges, from 0.05 to 0.40, and at 0.60 and also at high quantile, i.e. at 0.90.

The outcome of the Wald test is depicted in Table 4; it assists in evaluating the parameter reliance of the quantiles. Wald test also examines the nonlinearities for assessing locational asymmetries. The acceptance of the null hypothesis means the relationship holds no asymmetries and nonlinearities. In our research, the null hypothesis was rejected in the long run (except for GDP^2) whereas, for the short run, the null hypothesis was rejected only in the case of *ECF* and *TOR*. The outcomes ascertain that variables of *ECF* and *TOR* present a nonlinear and asymmetric association.

The Granger causality test is presented in Table 5. It demonstrates the causality between the two variables at various quantiles. Here we have used three lag periods to evaluate the variables. The findings specify that bidirectional causality is present between each exogenous variable and ECF. However, in the case of *INQ*, a unidirectional causality running from *INQ* to ECF is present at all lags.

Table 4
Outcomes of the Wald test showing parameters constancy.

Variables	Wald-statistics [*P*-value]
ρ^*	11.538*** [0.000]
β_{GDP}	4.842*** [0.000]
β^2_{GDP}	0.382 [0.862]
β_{REN}	7.961*** [0.000]
β_{TOR}	5.009*** [0.000]
β_{INQ}	8.374*** [0.000]
ω_{ECF1}	2.685** [0.048]
ω_{GDP0}	0.201 [0.994]
ω_{GDP^20}	0.561 [0.793]
ω_{REN0}	1.201 [0.521]
ω_{TOR0}	3.893*** [0.001]
ω_{INQ0}	1.093 [0.592]

Source: Authors Estimation.

5. Conclusions and policy recommendations

In this study, we have selected ecological footprints (ECF) as a pointer for environmental conditions. The ecological footprint (ECF) is a distinctive measure for environmental conditions in the sense that it tracks the human economy's reliance on natural capital; in other words, it gauges the social and technological impact on Earth's ecosystem. Unprecedented energy demand due to rapid industrialization and urbanization, deforestation, large-scale fishing, air and water pollution, and untapped exploitation of natural resources are potential determinants of ECF. There are certain variables, such as economic growth, energy consumption, transportation, and tourists' activities as well as institutional setup, which are helpful in consolidating the determinants of *ECF*. Due to the aforementioned variables' relevance to the environment, this study has applied the *QARDL* model to analyze the impact of Renewable Energy, Institutional Quality, Tourism, and GDP on Ecological Footprint for the 1995 to 2017 period. The study results suggest that increased utilization of renewable energy and tourism improve Pakistan's environment, whereas institutional quality and GDP are positive and significant at all quantiles. This shows that GDP upsurge and institutional quality are directly related to environmental conditions at all the quantiles.

Taking all these concerns into account, our study has empirically validated most of these hypotheses. The results suggest that increased utilization of renewable energy diminish the environmental degradation in Pakistan for the low to medium quantiles, rise in tourism at low or high intensities of ECF improves Pakistan environment, institutional quality is positive and significant at all quantiles (meaning that institutional quality improvement is directly related to environmental conditions), and an upsurge in GDP increases ECF for all the quantiles. At the same time, the GDP square is negatively related to all the quantiles. Short-term dynamics demonstrate current ecological footprint changes are positively and significantly affected from low to high quantiles. The recent and earlier changes in economic growth, renewable energy, and institutional quality do not affect prevailing ECF at all quantiles, while

Table 5
Outcomes of granger causality in quantiles.

Quantiles	Lags	[0.05–0.95]	0.05	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	0.95
$\Delta GDP_t \rightarrow \Delta ECF_t$	1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
$\Delta GDP_t \leftarrow \Delta ECF_t$		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
$\Delta GDP_t \rightarrow \Delta ECF_t$	2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
$\Delta GDP_t \leftarrow \Delta ECF_t$		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
$\Delta GDP_t \rightarrow \Delta ECF_t$	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
$\Delta GDP_t \leftarrow \Delta ECF_t$		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
$\Delta REN_t \rightarrow \Delta ECF_t$	1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
$\Delta REN_t \leftarrow \Delta ECF_t$		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
$\Delta REN_t \rightarrow \Delta ECF_t$	2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
$\Delta REN_t \leftarrow \Delta ECF_t$		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
$\Delta REN_t \rightarrow \Delta ECF_t$	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
$\Delta REN_t \leftarrow \Delta ECF_t$		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
$\Delta TOR_t \rightarrow \Delta ECF_t$	1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
$\Delta TOR_t \leftarrow \Delta ECF_t$		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
$\Delta TOR_t \rightarrow \Delta ECF_t$	2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
$\Delta TOR_t \leftarrow \Delta ECF_t$		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
$\Delta TOR_t \rightarrow \Delta ECF_t$	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
$\Delta TOR_t \leftarrow \Delta ECF_t$		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
$\Delta INQ_t \rightarrow \Delta ECF_t$	1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
$\Delta INQ_t \leftarrow \Delta ECF_t$		0.276	0.195	0.281	0.335	0.401	0.577	0.391	0.288	0.201	0.185	0.110	0.005
$\Delta INQ_t \rightarrow \Delta ECF_t$	2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
$\Delta INQ_t \leftarrow \Delta ECF_t$		0.413	0.292	0.420	0.501	0.599	0.863	0.585	0.431	0.300	0.277	0.234	0.195
$\Delta INQ_t \rightarrow \Delta ECF_t$	3	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
$\Delta INQ_t \leftarrow \Delta ECF_t$		0.604	0.427	0.615	0.733	0.877	0.999	0.855	0.630	0.440	0.405	0.342	0.285

Source: Author Estimation.

previous and existing variations in tourism significantly and positively affect present ECF variations, from low to moderate quantiles ranges. ECF and tourism also have a nonlinear and asymmetric association. The findings further specify that bidirectional causality is present between each exogenous variable and ECF, with the exception of institutional quality, which has a unidirectional causality at all lags.

Deteriorating environmental conditions is one of the contemporary issues which equally affects developed and developing nations. Various countries are actively working on policies and programs for environmental protection. The issue of environmental degradation becomes even more severe in the context of economic growth and development as economic growth can adversely affect the environment. EKC hypothesis is an important theory, which explains the environment-economy nexus. The results also validate the presence of the Environmental Kuznets Curve in Pakistan. According to the Environmental Kuznets Curve, economic growth initially causes an ecological disturbance, but after a certain threshold of economic development, it starts contributing to the betterment of the environment.

Developing nations such as Pakistan are facing consequences of spontaneous unplanned inflating communities, which demands quality institutions to address the environmental issue. Likewise, developing nations' energy consumption should include non-renewable energy resources and a gradual shift towards renewable energy for ecological betterment. The tourism industry is viewed as one of the rapidly developing industries on a global scale, and developing nations are lacking behind in this field. Pakistan was recently designated as one of most favorite tourist destinations, yet the tourism industry needs enormous outlays for infrastructural improvement (road networks, ports), and distinctive traveling services, such as hoteling, malls, and amusement parks, etc. All these facilities put pressure on environmental resources. Finally, being in the developing phase, general economic growth has its repercussions on Pakistan's environmental conditions.

The government of Pakistan should focus on increasing the efficiency of using its natural resources, thus more spending plans ought to be designated for developing renewable energy ventures. The incorporation of renewable energy at a higher rate in the energy mix would be beneficial for diminishing the ECF scenario in Pakistan, as demonstrated by the results of this study. Previous studies, such as Munasinghe (2002) and Ulucak et al. (2019), have also endorsed renewable energy as a legitimate response for the accomplishment of societal, economic, and environmental sustainability. Likewise, the government can play a noteworthy part in an efficient management environment through enhancement of institutional quality, as government writ and authority can be channelized against fighting atmospheric changes in Pakistan.

This is a country-specific study considering only a developing country scenario i.e. Pakistan which has limitations from the generalizability aspect. Further, for future researches, a penal study that includes developing countries will produce more noteworthy findings and can address the issue of generalization.

CRediT authorship contribution statement

Zhan Zhan: Supervision. **Liaqat Ali:** Review & Editing. **Salman Sarwat:** Writing – Original Draft. **Danish Iqbal Godil:** Conceptualization, Writing – Original Draft. **Gheorghita Dinca:** Proof read. **Muhammad Khalid Anser:** Review & Editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

Adedoyin, F.F., Zakari, A., 2020. Energy consumption, economic expansion, and CO2 emission in the UK: the role of economic policy uncertainty. Sci. Total Environ. 738, 140014. https://doi.org/10.1016/j.scitotenv.2020.140014.

Ajmi, A.N., Hammoudeh, S., Nguyen, D.K., Sato, J.R., 2015. On the relationships between CO_2 emissions, energy consumption and income: the importance of time variation. Energy Econ. 49, 629–638.

Ali, S., Yusop, Z., Kaliappan, S. R., & Chin, L. (2020). Dynamic common correlated effects of trade openness, FDI, and institutional performance on environmental quality: evidence from OIC countries. *Environmental Science and Pollution Research*, 1-12.

Al-Mulali, U., Fereidouni, H.G., Mohammed, A.H., 2015a. The effect of tourism arrival on CO_2 emissions from transportation sector. Anatolia 26 (2), 230–243.

Al-Mulali, U., Saboori, B., Ozturk, I., 2015b. Investigating the environmental Kuznets curve hypothesis in Vietnam. Energy Policy 76, 123–131.

Apergis, N., Payne, J.E., Menyah, K., Wolde-Rufael, Y., 2010. On the causal dynamics between emissions, nuclear energy, renewable energy, and economic growth. Ecol. Econ. 69 (11), 2255–2260.

Aşıcı, A.A., Acar, S., 2016. Does income growth relocate ecological footprint? Ecol. Indic. 61, 707–714.

Aydin, C., Esen, Ö., Aydin, R., 2019. Is the ecological footprint related to the Kuznets curve a real process or rationalizing the ecological consequences of the affluence? Evidence from PSTR approach. Ecol. Indic. 98, 543–555.
Azlina, A.A., Law, S.H., Mustapha, N.H.N., 2014. Dynamic linkages among transport energy consumption, income and CO_2 emission in Malaysia. Energy Policy 73, 598–606.
Bakhat, M., Rosselló, J., 2011. Estimation of tourism-induced electricity consumption: the case study of Balearics Islands, Spain. Energy Econ. 33 (3), 437–444.
Bello, M.O., Solarin, S.A., Yen, Y.Y., 2018. The impact of electricity consumption on CO_2 emission, carbon footprint, water footprint and ecological footprint: the role of hydropower in an emerging economy. J. Environ. Manag. 219, 218–230.
Bhattarai, M., Hammig, M., 2001. Institutions and the environmental Kuznets curve for deforestation: a crosscountry analysis for Latin America, Africa and Asia. World Dev. 29 (6), 995–1010.
Bhattarai, M., Hammig, M., 2004. Governance, economic policy and the environmental Kuznets curve for natural tropical forest. Environ. Dev. Econ. 9 (3), 367–382.
Bilgili, F., Ulucak, R., 2018a. Is there deterministic, stochastic, and/or club convergence in ecological footprint indicator among G20 countries? Environ. Sci. Pollut. Res. 25 (35), 35404–35419.
Bilgili, F., Ulucak, R., 2018b. The nexus between biomass–footprint and sustainable development. Elsevier, Reference Module in Materials Science and Materials Engineering.
Blake, A., Arbache, J.S., Sinclair, M.T., Teles, V., 2008. Tourism and poverty relief. Ann. Tour. Res. 35 (1), 107–126.
Byrnes, T.A., Warnken, J., 2006. Greenhouse gas emissions from marine tours: a case study of Australian tour boat operators. J. Sustain. Tour. 14 (3), 255–270.
Castiglione, C., Infante, D., Smirnova, J., 2013. Institutional enforcement, environmental quality and economic development. A panel VAR approach. In Proceedings of the IV CICSE Conference on Structural Change, Dynamics and Economic GrowthLivorno, Italy.
Caviglia-Harris, J.L., Chambers, D., Kahn, J.R., 2009. Taking the "U" out of Kuznets: a comprehensive analysis of the EKC and environmental degradation. Ecol. Econ. 68 (4), 1149–1159.
Charfeddine, L., 2017. The impact of energy consumption and economic development on ecological footprint and CO_2 emissions: evidence from a Markov Switching Equilibrium Correction Model. Energy Econ. 65, 355–374.
Charfeddine, L., Khediri, K.B., 2016. Financial development and environmental quality in UAE: cointegration with structural breaks. Renew. Sust. Energ. Rev. 55, 1322–1335.
Charfeddine, L., Mrabet, Z., 2017. The impact of economic development and social-political factors on ecological footprint: a panel data analysis for 15 MENA countries. Renew. Sust. Energ. Rev. 76, 138–154.
Cho, J.S., Kim, T.H., Shin, Y., 2015. Quantile cointegration in the autoregressive distributed-lag modeling framework. J. Econ. 188 (1), 281–300.
Cornelia, P.G., 2014. True cost economics: ecological footprint. Procedia Economics and Finance 8, 550–555.
Costanza, R., 2000. The dynamics of the ecological footprint concept. Ecol. Econ. 32 (3), 341–345.
Damania, R., Fredriksson, P.G., Mani, M., 2004. The persistence of corruption and regulatory compliance failures: theory and evidence. Public Choice 121 (3–4), 363–390.
Danish, Wang, Z., 2019. Investigation of the ecological footprint's driving factors: what we learn from the experience of emerging economies. Sustain. Cities Soc. 49.
Danish, Ulucak, R., Khan, S.U.-D., 2020. Determinants of the ecological footprint: role of renewable energy, natural resources, and urbanization. Sustain. Cities Soc. 54, 101996.
Destek, M.A., Sarkodie, S.A., 2019. Investigation of environmental Kuznets curve for ecological footprint: the role of energy and financial development. Sci. Total Environ. 650, 2483–2489.
Destek, M.A., Sinha, A., 2020. Renewable, non-renewable energy consumption, economic growth, trade openness and ecological footprint: evidence from organisation for economic co-operation and development countries. J. Clean. Prod. 242, 118537.
Destek, M.A., Ulucak, R., Dogan, E., 2018. Analyzing the environmental Kuznets curve for the EU countries: the role of ecological footprint. Environ. Sci. Pollut. Res. 25 (29), 29387–29396.
Dinda, S., 2004. Environmental Kuznets curve hypothesis: a survey. Ecol. Econ. 49 (4), 431–455.
Dogan, E., Taspinar, N., & Gokmenoglu, K. K. (2019). Determinants of ecological footprint in MINT countries. *Energy & Environment*, *30*(6), 1065–1086.
Duit, A., Hall, O., Mikusinski, G., Angelstam, P., 2009. Saving the woodpeckers: social capital, governance, and policy performance. J. Environ. Dev. 18 (1), 42–61.
Duit, Andreas, (2005). Understanding environmental performance of states: an Institution-centered approach and some difficulties. Qog Working Paper Series. 7.
Dunning, J.H., Kundu, S.K., 1995. The internationalization of the hotel industry: some new findings from a field study. MIR, Management International Review, pp. 101–133.
Fredriksson, P.G., Svensson, J., 2003. Political instability, corruption and policy formation: the case of environmental policy. J. Public Econ. 87 (7–8), 1383–1405.
Galli, A., 2015. On the rationale and policy usefulness of ecological footprint accounting: the case of Morocco. Environ. Sci. Pol. 48, 210–224.
Gärling, T., Biel, A., Gustafsson, M., 2002. The new environmental psychology: the human interdependence paradigm. Handbook of environmental psychology 85–94.
Gill, A.B., 2005. Offshore renewable energy: ecological implications of generating electricity in the coastal zone. J. Appl. Ecol. 42 (4), 605–615.
Godil, Danish I., Yu, Z., Sharif, A., Usman, R., & Khan, S. A. R. (2021). Investigate the role of technology innovation and renewable energy in reducing transport sector CO_2 emission in China: a path toward sustainable development. *Sustainable Development*, sd.2167. doi:https://doi.org/10.1002/sd.2167
Godil, Danish Iqbal, Sharif, A., Afshan, S., Yousuf, A., Khan, S.A.R., 2020a. The asymmetric role of freight and passenger transportation in testing EKC in the US economy: evidence from QARDL approach. Environ. Sci. Pollut. Res. 27 (24), 30108–30117. https://doi.org/10.1007/s11356-020-09299-7.
Godil, Danish Iqbal, Sharif, A., Agha, H., Jermsittiparsert, K., 2020b. The dynamic nonlinear influence of ICT, financial development, and institutional quality on CO2 emission in Pakistan: new insights from QARDL approach. Environ. Sci. Pollut. Res. 27 (19), 24190–24200. https://doi.org/10.1007/s11356-020-08619-1.
Godil, Danish Iqbal, Sharif, A., Rafique, S., Jermsittiparsert, K., 2020c. The asymmetric effect of tourism, financial development, and globalization on ecological footprint in Turkey. Environ. Sci. Pollut. Res. 27 (32), 40109–40120. https://doi.org/10.1007/s11356-020-09937-0.
Godil, Danish Iqbal, Ahmad, P., Ashraf, M.S., Sarwat, S., Sharif, A., Shabib-ul-Hasan, S., Jermsittiparsert, K., 2021a. The step towards environmental mitigation in Pakistan: do transportation services, urbanization, and financial development matter? Environ. Sci. Pollut. Res. https://doi.org/10.1007/s11356-020-11839-0.
Godil, Danish Iqbal, Sharif, A., Ali, M.I., Ozturk, I., Usman, R., 2021b. The role of financial development, R&D expenditure, globalization and institutional quality in energy consumption in India: new evidence from the QARDL approach. J. Environ. Manag. 285, 112208. https://doi.org/10.1016/j.jenvman.2021.112208.
Gössling, S., 2002. Global environmental consequences of tourism. Glob. Environ. Chang. 12 (4), 283–302.
Gössling, S., 2013. National emissions from tourism: an overlooked policy challenge? Energy Policy 59, 433–442.
Grossman, G. M., & Krueger, A. B. (1991). *Environmental impacts of a North American free trade agreement* (no. w3914). National Bureau of Economic Research.
Hoekstra, A.Y., 2009. Human appropriation of natural capital: a comparison of ecological footprint and water footprint analysis. Ecol. Econ. 68 (7), 1963–1974.
Holmberg, S., Rothstein, B., Nasiritousi, N., 2009. Quality of government: what you get. Annu. Rev. Polit. Sci. 12, 135–161.
Hughes, L., Lipscy, P.Y., 2013. The politics of energy. Annu. Rev. Polit. Sci. 16 (1), 449–469.
Hunter, C., 2002. Sustainable tourism and the touristic ecological footprint. Environ. Dev. Sustain. 4 (1), 7–20.
Istaiteyeh, R.M., 2016. Causality analysis between electricity consumption and real GDP: evidence from Jordan. Int J Econ Perspect 10 (4), 526–540.
Jorgenson, A.K., 2003. Consumption and environmental degradation: a cross-national analysis of the ecological footprint. Soc. Probl. 50 (3), 374–394.
Jorgenson, A.K., Burns, T.J., 2007. The political-economic causes of change in the ecological footprints of nations, 1991–2001: a quantitative investigation. Soc. Sci. Res. 36 (2), 834–853.
Kapusuzoğlu, A., 2014. Causality relationships between carbon dioxide emissions and economic growth: results from a multi-country study. International Journal of Economic Perspectives 8 (2).
Katircioglu, S., 2017. Investigating the role of oil prices in the conventional EKC model: evidence from Turkey. Asian Economic and Financial Review 7 (5), 498–508.
Katircioglu, S., Gokmenoglu, K.K., Eren, B.M., 2018a. Testing the role of tourism development in ecological footprint quality: evidence from top 10 tourist destinations. Environ. Sci. Pollut. Res. 25 (33), 33611–33619.
Katircioglu, S., Katircioglu, S.T., Altinay, M., 2018b. Interactions between tourism development and financial development. Serv. Ind. J. 38 (9–10), 519–542.
Katircioğlu, S.T., 2014. Testing the tourism-induced EKC hypothesis: the case of Singapore. Econ. Model. 41, 383–391.
Khan, I., Khan, N., Yaqub, A., Sabir, M., 2019. An empirical investigation of the determinants of CO_2 emissions: evidence from Pakistan. Environ. Sci. Pollut. Res. 26 (9), 9099–9112. https://doi.org/10.1007/s11356-019-04342-8.
Kim, H.J., Chen, M.H., 2006. Tourism expansion and economic development: the case of Taiwan. Tour. Manag. 27 (5), 925–933.
Kim, T.H., White, H., 2003. Estimation, inference, and specification testing for possibly misspecified quantile regression. Maximum Likelihood Estimation of Misspecified Models: Twenty Years Later. Emerald Group Publishing Limited, pp. 107–132.
Kissinger, M., Haim, A., 2008. Urban hinterlands—the case of an Israeli town ecological footprint. Environ. Dev. Sustain. 10 (4), 391–405.
Kulendran, N., Wilson, K., 2000. Is there a relationship between international trade and international travel? Appl. Econ. 32 (8), 1001–1009.
Kuznets, S., 1955. Economic growth and income inequality. Am. Econ. Rev. 45 (1), 1–28.
Lee, J.W., Brahmasrene, T., 2013. Investigating the influence of tourism on economic growth and carbon emissions: evidence from panel analysis of the European Union. Tour. Manag. 38, 69–76.
Lenzen, M., Murray, S.A., 2003. The ecological footprint–issues and trends. ISA research paper 1 (3).
Li, J.X., Chen, Y.N., Xu, C.C., Li, Z., 2019. Evaluation and analysis of ecological security in arid areas of Central Asia based on the emergy ecological footprint (EEF) model. J. Clean. Prod. 235, 664–677.
Lin, W., Li, Y., Li, X., Xu, D., 2018. The dynamic analysis and evaluation on tourist ecological footprint of city: take Shanghai as an instance. Sustain. Cities Soc. 37, 541–549.
Magnani, E., 2001. The Environmental Kuznets Curve: development path or policy result? Environ. Model Softw. 16 (2), 157–165.
Menyah, K., Wolde-Rufael, Y., 2010. CO_2 emissions, nuclear energy, renewable energy and economic growth in the US. Energy Policy 38 (6), 2911–2915.
Meyer, A.L., Van Kooten, G.C., Wang, S., 2003. Institutional, social and economic roots of deforestation: a cross-country comparison. Int. For. Rev. 5 (1), 29–37.
Moore, J., Kissinger, M., Rees, W.E., 2013. An urban metabolism and ecological footprint assessment of Metro Vancouver. J. Environ. Manag. 124, 51–61.
Mostafa, M.M., 2010. Clustering the ecological footprint of nations using Kohonen's self-organizing maps. Expert Syst. Appl. 37 (4), 2747–2755.
Munasinghe, M., 2002. The sustainomics trans-disciplinary meta-framework for making development more sustainable: applications to energy issues. Int. J. Sustain. Dev. 5 (1–2), 125–182.
Nathaniel, S.P., 2020. Ecological footprint, energy use, trade, and urbanization linkage in Indonesia. GeoJournal 1–14.

Nazar, R., Chaudhry, I.S., Ali, S., Faheem, M., 2018. Role of quality education for sustainable development goals (SDGS). PEOPLE: International Journal of Social Sciences 4 (2).
Nazir, M.I., Nazir, M.R., Hashmi, S.H., Ali, Z., 2018. Environmental Kuznets Curve hypothesis for Pakistan: empirical evidence form ARDL bound testing and causality approach. International journal of green energy 15 (14–15), 947–957.
Niccolucci, V., Tiezzi, E., Pulselli, F.M., Capineri, C., 2012. Biocapacity vs ecological footprint of world regions: a geopolitical interpretation. Ecol. Indic. 16, 23–30.
Owusu, P.A., Asumadu-Sarkodie, S., 2016. A review of renewable energy sources, sustainability issues and climate change mitigation. Cogent Engineering 3 (1), 1–14. https://doi.org/10.1080/23311916.2016.1167990.
Ozcan, B., Ari, A., 2017. Nuclear energy-economic growth nexus in OECD countries: a panel data analysis. Journal of Economic & Management Perspectives 11 (1), 138–154.
Ozcan, B., Apergis, N., Shahbaz, M., 2018. A revisit of the environmental Kuznets curve hypothesis for Turkey: new evidence from bootstrap rolling window causality. Environ. Sci. Pollut. Res. 25 (32), 32381–32394.
Ozcan, B., Ulucak, R., Dogan, E., 2019. Analyzing long lasting effects of environmental policies: evidence from low, middle and high income economies. Sustain. Cities Soc. 44, 130–143.
Ozturk, I., Al-Mulali, U., Saboori, B., 2016. Investigating the environmental Kuznets curve hypothesis: the role of tourism and ecological footprint. Environ. Sci. Pollut. Res. 23 (2), 1916–1928.
Pan, H., Zhuang, M., Geng, Y., Wu, F., Dong, H., 2019. Emergy-based ecological footprint analysis for a mega-city: the dynamic changes of Shanghai. J. Clean. Prod. 210, 552–562.
Peeters, P., Szimba, E., Duijnisveld, M., 2007. Major environmental impacts of European tourist transport. J. Transp. Geogr. 15 (2), 83–93.
Pellegrini, L., Gerlagh, R., 2006. Corruption, democracy, and environmental policy. J. Environ. Dev. 15 (3), 332–354. https://doi.org/10.1177/1070496506290960.
Qureshi, M.I., Elashkar, E.E., Shoukry, A.M., Aamir, A., Mahmood, N.H.N., Rasli, A.M., Zaman, K., 2019. Measuring the ecological footprint of inbound and outbound tourists: evidence from a panel of 35 countries. Clean Techn. Environ. Policy 21 (10), 1949–1967.
Raza, S.A., Sharif, A., Wong, W.K., Karim, M.Z.A., 2016. Tourism development and environmental degradation in the United States: evidence from wavelet-based analysis. Curr. Issue Tour. 20 (16), 1768–1790.
Rees, W.E., 1992. Ecological footprints and appropriated carrying capacity: what urban economics leaves out. Environ. Urban. 4 (2), 121–130.
Rosa, E.A., York, R., Dietz, T., 2004. Tracking the anthropogenic drivers of ecological impacts. AMBIO: A Journal of the Human Environment 33 (8), 509–512.
Rothman, D.S., 1998. Environmental Kuznets curves—real progress or passing the buck?: a case for consumption-based approaches. Ecol. Econ. 25 (2), 177–194.
Sarkodie, S.A., 2018. The invisible hand and EKC hypothesis: what are the drivers of environmental degradation and pollution in Africa? Environ. Sci. Pollut. Res. 25 (22), 21993–22022.
Sharif, A., Raza, S.A., Ozturk, I., Afshan, S., 2019. The dynamic relationship of renewable and nonrenewable energy consumption with carbon emission: a global study with the application of heterogeneous panel estimations. Renew. Energy 133, 685–691.
Sharif, A., Godil, D.I., Xu, B., Sinha, A., Rehman Khan, S.A., Jermsittiparsert, K., 2020. Revisiting the role of tourism and globalization in environmental degradation in China: fresh insights from the quantile ARDL approach. J. Clean. Prod. 272, 122906. https://doi.org/10.1016/j.jclepro.2020.122906.
Shin, Y., Yu, B., Greenwood-Nimmo, M., 2011. Modelling Asymmetric Cointegration and Dynamic Multiplier in a Nonlinear ARDL Framework (Mimeo).
Solarin, S.A., 2014. Tourist arrivals and macroeconomic determinants of CO_2 emissions in Malaysia. Anatolia 25 (2), 228–241.
Solarin, S.A., Al-Mulali, U., Ozturk, I., 2018. Determinants of pollution and the role of the military sector: evidence from a maximum likelihood approach with two structural breaks in the USA. Environ. Sci. Pollut. Res. 25 (31), 30949–30961.
Solarin, S.A., Tiwari, A.K., Bello, M.O., 2019. A multi-country convergence analysis of ecological footprint and its components. Sustain. Cities Soc. 46, 101422.
Solis-Guzman, J., Marrero, M., 2015. Ecological Footprint Assessment of Building Construction. Bentham Science Publishers.
Sønderskov, K.M., 2009. Different goods, different effects: exploring the effects of generalized social trust in large-N collective action. Public Choice 140 (1), 145–160.
Torras, M., Boyce, J.K., (1998). Income, inequality, and pollution: a reassessment of the environmental Kuznets curve, *Ecological Economics*, 25, 147–160.
Tovar, C., Lockwood, M., 2008. Social impacts of tourism: an Australian regional case study. Int. J. Tour. Res. 10 (4), 365–378.
Tutulmaz, O., 2015. Environmental Kuznets curve time series application for Turkey: why controversial results exist for similar models? Renew. Sust. Energ. Rev. 50, 73–81.
Uddin, G.A., Salahuddin, M., Alam, K., Gow, J., 2017. Ecological footprint and real income: panel data evidence from the 27 highest emitting countries. Ecol. Indic. 77, 166–175.
Uddin, G.A., Alam, K., Gow, J., 2019. Ecological and economic growth interdependency in the Asian economies: an empirical analysis. Environ. Sci. Pollut. Res. 26 (13), 13159–13172.
Ulucak, R., Bilgili, F., 2018. A reinvestigation of EKC model by ecological footprint measurement for high, middle and low income countries. J. Clean. Prod. 188, 144–157.
Ulucak, R., Yücel, A. G., & Koçak, E. (2019). The process of sustainability: from past to present. In *Environmental Kuznets Curve (EKC)* (pp. 37-53). Academic Press.
Vačkář, D., 2012. Ecological footprint, environmental performance and biodiversity: a cross-national comparison. Ecol. Indic. 16, 40–46.
Wackernagel, M., & Rees, W. (1996). *Our Ecological Footprint: Reducing Human Impact on the Earth* (Vol. 9). New society publishers.
Wackernagel, M., Onisto, L., Bello, P., Linares, A. C., Falfán, I. S. L., Garćia, J. M., ... & Guerrero, M. G. S. (1999). National natural capital accounting with the ecological footprint concept. Ecol. Econ., 29(3), 375–390.
Wackernagel, M., Schulz, N.B., Deumling, D., Linares, A.C., Jenkins, M., Kapos, V., ... Randers, J., 2002. Tracking the ecological overshoot of the human economy. Proc. Natl. Acad. Sci. 99 (14), 9266–9271.
Wackernagel, M., Monfreda, C., Schulz, N.B., Erb, K.H., Haberl, H., Krausmann, F., 2004. Calculating national and global ecological footprint time series: resolving conceptual challenges. Land Use Policy 21 (3), 271–278.
Wang, J., Dong, K., 2019. What drives environmental degradation? Evidence from 14 Sub-Saharan African countries. Sci. Total Environ. 656, 165–173.
Wang, S.S., Zhou, D.Q., Zhou, P., Wang, Q.W., 2011. CO_2 emissions, energy consumption and economic growth in China: a panel data analysis. Energy Policy 39 (9), 4870–4875.
Welsch, H., 2004. Corruption, growth, and the environment: a cross-country analysis. Environ. Dev. Econ. 9 (5), 663–693.
York, R., Rosa, E.A., Dietz, T., 2009. A tale of contrasting trends: three measures of the ecological footprint in China, India, Japan, and the United States, 1961-2003. Journal of World-Systems Research 15 (2), 134–146.
Zhang, L., Godil, D.I., Bibi, M., Khan, M.K., Sarwat, S., Anser, M.K., 2021. Caring for the environment: how human capital, natural resources, and economic growth interact with environmental degradation in Pakistan? A dynamic ARDL approach. Science of The Total Environment 145553. https://doi.org/10.1016/j.scitotenv.2021.145553.
Zivot, E., Andrews, D., 1992. Further evidence on the great crash, oil prices shock and the unit root hypothesis. J. Bus. Econ. Stat. (10), 5–17.