**DOĞUŞ ÜNİVERSİTESİ DERGİSİ**
**DOGUS UNIVERSITY JOURNAL**
**e-ISSN: 1308-6979**
https://dergipark.org.tr/tr/pub/doujournal

# EVALUATING THE INTERPLAY BETWEEN AIR TRANSPORT, ECONOMY, TOURISM, AND POLLUTION IN THE BALKANS

## *BALKAN ÜLKELERİNDE HAVA TAŞIMACILIĞI, EKONOMİK BÜYÜME VE TURİZMİN HAVA KİRLİLİĞİ ÜZERİNDEKİ ETKİSİ*

Erkam Emin AYVAZ[(1)], Mevlüt ÜZÜLMEZ[(2)], Hicran ERGEN[(3)], Didem ERŞEN[(4)]

**Abstract:** This study aims to investigate the effect of air transportation, tourism, and economic growth on environmental pollution. The impact of tourism, economic growth, air transportation, and carbon emissions (as a surrogate for air pollution) on ten Balkan nations from 1995 to 2020 is investigated in this study. Long-term panel autoregressive distributed lag (ARDL) projections reveal that CO2 emissions are affected by 0.22%, 0.32%, and -0.34% for every 1% increase in air transportation, economic growth, and tourism. Granger causality analysis identifies four significant causal pathways: (1) a unilateral relationship between CO2 emissions and air transportation; (2) a unilateral relationship between CO2 emissions and economic growth; (3) a unilateral relationship between tourism and air transportation; and (4) a unilateral relationship between economic growth and tourism. These findings shape climate policy in the countries investigated and affect people worldwide. Policymakers should incentivize eco-friendly housing and litter-free tourists to reduce tourism's environmental impact. Infrastructure expenditures should also prioritize low-carbon aviation and renewable energy. Strategic economic planning requires that growth and decarbonization targets match. Renewable energy and circular economic ideas will promote green growth. These initiatives may balance prosperity and environmental protection, putting the Balkans and other regions on the path to strong, low-carbon economies.

**Keywords:** Air Pollution, Air Transportation, Economic Growth, Tourism, ARDL

***JEL:*** *L93, Q53, F63, L83*

***Öz:*** *Bu çalışma, hava taşımacılığı, turizm ve ekonomik büyümenin çevre kirliliği üzerindeki etkisini araştırmayı amaçlamaktadır. Hava kirliliği için bir ölçüt olarak CO2 emisyonlarını kullanarak 1995-2020 yılları arasında 10 Balkan ülkesinde turizm, ekonomik büyüme, hava ulaşımı ve karbon emisyonlarının uzun vadeli etkilerini incelemektedir. Uzun vadeli panel otoregresif dağıtılmış gecikme (ARDL) tahminleri, hava yolculuğu, ekonomik büyüme ve turizmdeki her %1'lik etki için CO2 emisyonlarının %0,22, %0,32 ve -%0,34 oranında değişim gösterdiğini ortaya*

(*) This study is conducted from the study presented as "Impact of Air Transportation, Economic Growth, And Tourism on Air Pollution in Balkan Countries Based on A Panel ARDL Approach" at I. International Energy Congress.

(1) Erciyes Üniversitesi, Havacılık ve Uzay Bilimleri Fakültesi, Havacılık Yönetimi Bölümü; erkameminayvaz@erciyes.edu.tr, ORCID: 0000-0001-8213-5117
(2) Erciyes Üniversitesi, Havacılık ve Uzay Bilimleri Fakültesi, Havacılık Yönetimi; mevlutuzulmez@erciyes.edu.tr, ORCID: 0000-0002-4606-7468
(3) Antalya Bilim Üniversitesi, Meslek Yüksekokulu, Uçuş Harekat Yöneticiliği Bölümü; hicran.ergen@antalya.edu.tr, ORCID: 0000-0003-2449-8918
(4) Erciyes Üniversitesi, Havacılık ve Uzay Bilimleri Fakültesi, Havacılık Yönetimi Bölümü; didemover@erciyes.edu.tr, ORCID: 0000-0001-6349-7796
Geliş/Received: 20-03-2025; Kabul/Accepted: 26-06-2025

**Atıf bilgisi:** Ayvaz, E. E. Üzülmez, M. Ergen, H. Erşen, D. (2026). Evaluating the interplay between air transport, economy, tourism, and pollution in the Balkans. *Doğuş Üniversitesi Dergisi*, *27*(1), 270-293, DOI: 10.31671/doujournal.1661870.

*koymaktadır. Granger nedensellik analizi ayrıca dört önemli nedensel yol bulmuştur: (1) CO2 emisyonları ile hava yolculuğu arasında tek yönlü bir bağlantı; (2) CO2 emisyonları ile ekonomik büyüme arasında tek yönlü bir bağlantı; (3) turizm ile hava yolculuğu arasında tek yönlü bir bağlantı ve (4) ekonomik büyüme ile turizm arasında tek yönlü bir bağlantı. Bu bulgular, incelenen ülkelerdeki iklim politikalarını şekillendirmekte ve dünya genelindeki insanları etkilemektedir. Politika yapıcılar, turizmin çevresel etkisini azaltmak için çevre dostu konutları ve çöp atmayan turistleri teşvik etmelidir. Altyapı harcamalarında da düşük karbonlu havacılık ve yenilenebilir enerjiye öncelik verilmelidir. Stratejik ekonomik planlama, büyüme ve de-karbonizasyon hedeflerinin eşleştirilmesini gerektirir. Yenilenebilir enerji ve döngüsel ekonomi fikirleri yeşil büyümeyi teşvik edecektir. Bu girişimler refah ve çevrenin korunması arasında denge kurarak Balkanlar ve diğer bölgeleri güçlü, düşük karbonlu ekonomilere giden yola sokabilecektir.*

***Anahtar Kelimeler:*** *Hava Kirliliği, Hava Taşımacılığı, Ekonomik Büyüme, Turizm, ARDL*

## 1. Introduction

Air transport has emerged as a vital catalyst for economic growth and tourism development (Muthalib, 2024; Yarde & Zhang, 2024), particularly in regions with increasing globalization and cross-border mobility. The Balkan countries, positioned at the intersection of Europe and Asia, have experienced significant transformations in their aviation and tourism sectors (Bieber & Tzifakis, 2019; Curley, 2023; Huskić, 2023), driven by economic liberalization, infrastructure investments, and rising international visitor flows. However, while these developments contribute to regional prosperity, they pose considerable environmental challenges, particularly concerning air pollution and carbon emissions. The interplay between air transport, economic expansion, and tourism is inherently complex (Milne & Ateljevic, 2001; Sinclair, 1998). Aviation facilitates economic integration and enhances accessibility to tourism destinations, boosting employment, trade, and foreign direct investment. Simultaneously, the growing demand for air travel and the rapid expansion of tourism-related activities leads to increased fossil fuel consumption, greenhouse gas emissions, and environmental degradation. The Balkan region, where tourism is a key economic driver, faces balancing economic benefits with environmental sustainability (Porfido, 2020; Vladi, 2014).

Despite the increasing importance of air transport and tourism in the Balkans, limited research has examined their collective impact on air pollution in a regional context. An empirical study analyzing the impact of tourism on economic growth in the Western Balkan countries (Albania, Bosnia and Herzegovina, Croatia, North Macedonia, Montenegro, and Serbia) found that tourism has a positive and statistically significant effect on economic growth. Specifically, a 1% increase in tourists was associated with an approximately 0.08% increase in income (Selimi et al., 2017). In another study with similar objectives, which utilized panel data from the 2007–2018 period, it was found that a 1% increase in tourism share in gross domestic product led to a 0.22% increase in economic growth. Similarly, a 1% increase in international tourism receipts contributed to a 0.21% rise in economic growth, while a 1% increase in ITA (international tourism arrivals) resulted in a 0.09% increase in economic growth (Mirović et al., 2020). Studies conducted in the field indicate that current measures are insufficient to mitigate the health impacts of air pollution, based on projections for 2030 and 2050. Forecasts suggest that by 2030, approximately 75%

of the EU population will still be exposed to PM2.5 levels exceeding the WHO guideline values (Denby et al., 2024). In another study, during the heating season, the highest daily average concentrations were recorded as 87.1 μg/m³ for PM10 and 65.6 μg/m³ for PM2.5, with the maximum cumulative exceedance reaching approximately 7600 μg/m³ for PM10 and 5000 μg/m³ for PM2.5 (Stanojević et al., 2024). Another study focusing on the direct health impacts of air pollution estimated the mortality cost attributed to PM2.5 exposure to be €7.8 billion according to the Integrated Exposure-Response (IER) method and €9.0 billion according to the Concentration-Response Functions (CRF) method (Belis et al., 2023). Understanding these interdependencies is crucial for policymakers and stakeholders aiming to develop sustainable aviation strategies and eco-friendly tourism models. Setting itself apart from others, this study seeks to analyze the effects of air transport, economic growth, and tourism on air pollution in Balkan countries, offering insights into policy measures that can mitigate environmental harm while sustaining economic progress. This research contributes to the ongoing discourse on sustainable development and environmental stewardship in aviation and tourism by evaluating empirical data and regulatory frameworks.

This study makes several significant contributions to the existing body of literature. *First and foremost*, to the best of our knowledge, it is the first empirical investigation that systematically examines the environmental impacts of air transportation and tourism within the context of Balkan countries. While previous studies have addressed these relationships in broader regional or global frameworks, the present research offers a focused and region-specific analysis that fills a notable gap. *Second*, the study employs the panel Autoregressive Distributed Lag (ARDL) approach, which stands out as a robust and flexible econometric technique capable of capturing both short- and long-run dynamics among the variables of interest. This methodological advancement not only enhances the analytical rigor of the research but also provides more reliable and nuanced insights into the temporal relationships involved. *Third*, by addressing the underexplored issue of aviation-related environmental pollution in the Balkans through an econometric lens, the study responds to a clear void in the literature and opens avenues for further empirical inquiry and policy discussion on sustainable air transport development in the region.

Following this introduction and statement of contributions, the study proceeds with a detailed literature review, methodology, empirical findings, and finally, conclusion and discussion sections, respectively.

## 2. Literature Review

Air pollution refers to the increase in the concentration of harmful substances such as gases, particulate matter (PM), and biological agents in the atmosphere due to the accumulation of pollutants from various anthropogenic and natural sources (Brunekreef & Holgate, 2002; Stern, 1977; Wadden & Scheff, 1983). Pollutants are classified into two categories: primary and secondary. Primary pollutants, such as $SO_2$, $NO_x$, and $CO_2$, are directly discharged into the atmosphere from their sources. In contrast, secondary pollutants are formed through chemical reactions in the atmosphere, resulting in components such as ozone ($O_3$) and secondary particulate matter (Boubel et al., 2013). Air pollution can be classified based on its sources as either natural or anthropogenic (Holman, 1999). Anthropogenic sources, including industrial operations, consumption of fossil fuels, and tourism, are the main emphasis

of this study, while natural sources include dust storms, wildfires, and volcanic eruptions (Popescu & Ionel, 2010). Also, carbon dioxide ($CO_2$) emissions significantly contribute to air pollution, particularly as a result of fossil fuel combustion in sectors such as transportation, energy production, and industry (Quadrelli and Peterson, 2007). While $CO_2$ itself is a colorless and non-toxic gas at typical atmospheric concentrations, its accumulation in the atmosphere intensifies the greenhouse effect, indirectly exacerbating other forms of air pollution by altering climate patterns and increasing the frequency of extreme weather events (Nunes, 2023).

Air pollution poses severe risks to human health and harms ecosystems and economic activities (Folinsbee, 1993; Kampa & Castanas, 2008). Additionally, healthcare expenditures and productivity losses resulting from air pollution impose an annual financial burden of billions of dollars on the global economy (Mannucci & Franchini, 2017). Consequently, various policies and regulations have been developed at both international and national levels to mitigate air pollution. The EU's "Clean Air Policy Package," the EPA's Air Quality Standards, and the WHO's air pollution guidelines establish frameworks for reducing global air pollution (Ringquist, 1993; Walters, 2010).

Air pollution directly and indirectly affects air transportation, economic growth, and tourism. This section will examine these relationships within the scope of the literature.

### 2.1. Air Pollution and Air Transportation

Although the aviation sector is a critical mode of transportation that supports global economic and social development, it has been increasingly scrutinized due to its environmental impacts (Ovdiienko et al., 2021). Air transportation significantly contributes to air pollution due to fossil fuel consumption, particularly high-altitude emissions, which create distinct effects compared to other modes of transport (Harrison et al., 2015). The aviation sector increases air pollution through two main categories: exhaust gases from aircraft engines and ground emissions from airport operations (Masiol & Harrison, 2014; Ovdiienko et al., 2021).

Air pollution from commercial jet engines includes $CO_2$, $H_2O$, $NO_x$, CO, $SO_2$, VOCs, and PM. (Harrison et al., 2015; Peeters, 1998). These pollutants contribute to ground-level air pollution and persist in the stratosphere for extended periods, exacerbating global climate change. Ground emissions at airports stem from aircraft movements, ground support vehicles, airport terminal operations, and land transportation. In particular, the accumulation of exhaust gases on aprons and taxiways negatively impacts local air quality (Arifin et al., 2024; Çiçek, 2024; Saria & Wan Mohamed, 2022)—all these emissions from aircraft account for approximately 5% of global greenhouse gas emissions. Furthermore, $NO_x$ emissions increase ozone formation in the atmosphere, triggering global warming (Vedantham & Oppenheimer, 1998).

Various strategies have been developed to mitigate the aviation sector's impact on air pollution, ranging from sustainable aviation fuels to low-emission aircraft designs (Brooker, 2006; Dhara et al., 2021). Within these strategies, using biofuels and synthetic fuels as alternatives to conventional jet fuels is projected to reduce emission levels by up to 50% (Hari et al., 2015; Kousoulidou & Lonza, 2016). In addition, efforts to minimize the sector's environmental footprint include advancements in next-

generation engine technologies, more efficient aerodynamic structures, and the development of electric/hybrid aircraft (Thonemann et al., 2024; Zhang et al., 2023). Another key strategy in this context is optimizing air traffic management, which enables shorter flight routes, thereby reducing fuel consumption and emissions (Kale et al., 2021; Płanda & Skorupski, 2017). Projects such as SESAR in Europe and NextGen in the United States aim to make air traffic management more environmentally sustainable (Castell, 2014; El Asri & Tsiakalos, 2024). To decrease ground-level emissions from air transportation, various initiatives are being implemented at airports, including the adoption of electric ground support equipment, improvements in energy efficiency within terminal buildings, and the transition to renewable energy sources (Fregnani & Mattos, 2016; Saria & Wan Mohamed, 2022). While these efforts are underway, it is crucial to acknowledge that despite the aviation industry's commitment to reducing air pollution, the continuous growth of global air traffic necessitates more rapid and effective emission reduction measures.

Lo et al. (2020) examined $CO_2$ emissions in the aviation sector using panel data from flights in Italy's Lombardy region (1997–2011). Analyzing total and per seat-kilometer (SKL) emissions, they found that while aircraft size and route length increase total emissions, they reduce emissions per SKL, indicating greater efficiency in long-haul and large-aircraft operations. Technological advancements and EU market liberalization, particularly the rise of low-cost carriers, further improved emissions efficiency. Gürçam et al. (2021) studied the environmental impact of air transport in Iğdır, Türkiye's most polluted province with the smallest population. Through a six-stage methodology involving airport selection, flight data, and emission calculations, they concluded that rail integration should be prioritized due to the region's agricultural profile. The study also highlighted the need for emission taxes and regulatory measures for aircraft engines to safeguard public health. Habib et al. (2022) used panel quantile regression to assess the effects of air transport activity on $CO_2$ emissions across G20 countries (1990–2016). They found that emissions increase with economic growth, urbanization, and tourism but decrease with rising crude oil prices. Effects varied across quantiles, and bidirectional causality was observed between air transport intensity and emissions. Aksoy et al. (2025) compared the environmental impacts of sustainable aviation fuels (SAF) and conventional fuels on the Stockholm–Bordeaux route using SF2 and EC-SF2. The EC-SF2 method, incorporating SAF-specific adjustments, provided more balanced and reliable emission estimates. Conesa and Mortes (2025) assessed aviation's environmental footprint compared to road and maritime transport. While dioxin emissions were minimal, aviation's contribution to $CO_2$, $NO_x$, and ultrafine particles remains significant. The study also reviewed emission reduction strategies, including SAF, CORSIA regulations, and technological advancements.

### 2.2. Air pollution and economic growth

In the field of environmental economics and sustainable development, the correlation between increasing economic activity and air pollution is of paramount importance. While industrialization, urbanization, and increasing energy consumption are key drivers of economic growth, they also contribute to environmental degradation (Chen & Chen, 2021; Jiang et al., 2020). However, there are differing theoretical perspectives and empirical studies on whether this relationship is linear (Adebanjo & Shakiru, 2022; Magazzino et al., 2021; Ouyang et al., 2019). Energy consumption, industrial output, and transportation are among the factors that affect the correlation

between economic growth and air pollution. For instance, the rapid increase in economic activities, industrialization (Cole, 2000), and urbanization (Xu et al., 2019) within a country can lead to higher fossil fuel-based energy consumption due to rising factory emissions (Fujii & Managi, 2016) and increased use of motor vehicles (Faiz et al., 1996).

The EKC hypothesis is one of the most widely recognized explanations for the interactions between economic growth and air pollution (Bruvoll & Medin, 2003; Roca et al., 2001). The seminal study by Grossman and Krueger (1995) was the first to examine the linkage between economic growth and environmental pollution. According to the EKC hypothesis, environmental pollution is hypothesised to be worse at the initial stage of economic development. It is an established fact that, upon attaining a certain level of economic growth, there is a concomitant improvement in environmental quality, attributable to an increased level of environmental awareness (Ekins, 1997; Lau et al., 2025). However, the EKC hypothesis may not universally apply to all countries and types of pollutants. Some studies have shown that, particularly in developing countries, economic growth continuously leads to environmental deterioration (Farhani & Balsalobre-Lorente, 2020; Farhani & Rejeb, 2012; Özokcu & Özdemir, 2017). Developed economies such as the EU member states, the US, and Japan have generally experienced reductions in air pollution levels due to stringent investments and environmental regulations in clean energy. Conversely, rapidly growing economies such as China, India, and Brazil have witnessed rising industrial and transportation-related emissions (Ouyang et al., 2019; Sarkodie, 2020). In less developed countries, air pollution levels may remain relatively low due to insufficient economic growth. However, lacking environmental infrastructure increases the likelihood of localized air pollution issues (Dinda et al., 2000; Kukla-Gryz, 2009). These findings suggest that models solely based on the interplay across air pollution and economic growth may be insufficient for comprehensive analysis.

To mitigate the adverse interplay between economic growth and air pollution, various policy instruments have been developed, including carbon taxation and emissions trading, renewable energy investments, urban planning, and transportation strategies, as well as industrial and technological policies (Chen & Chen, 2021; Ouyang et al., 2019). Incentives for electric vehicles, the expansion of public transportation, and investments in hydroelectric energy contribute not only to a more environmentally friendly production and service process but also to the creation of more sustainable living spaces (Li et al., 2021; Urhie et al., 2017). Consequently, the widespread adoption of green economic policies and environmentally friendly technologies may soon help minimize economic growth's negative impacts on air pollution.

Hussain et al. (2023) examined how wind and solar energy generation and economic development impacted environmental quality in 43 nations from 1990 to 2017 using CCE-MG, CS-DL, and CS-ARDL. Environmental footprint is the dependent variable, and real GDP, international trade, energy intensity, urbanization, FDI, wind, and solar energy output are independent factors. Wind and solar energy generation improves the environment; 1% reduces ecological footprint by 3.1% and 2.9%. International trade improves the environment, whereas economic growth and energy intensity harm it. Islam et al. (2021) tested the Environmental Kuznets Curve (EKC) hypothesis in Bangladesh using data from 1976 to 2014. The study analyzed per capita emissions of $CO_2$, $CH_4$, and $N_2O$ as dependent variables, with GDP per capita, trade openness

(CTI), financial openness (KAOPEN), and urbanization rate (URB) as independent variables. Employing ADF, PP, and ERS unit root tests, the ARDL bounds testing approach was used due to mixed integration orders. Results indicated that GDP positively influenced $CO_2$ and $CH_4$ emissions in the long run, rejecting the EKC hypothesis for these pollutants. However, $N_2O$ emissions supported the EKC hypothesis.

Additionally, trade openness reduced $CO_2$ emissions, whereas urbanization and financial openness increased long-run emissions. Saleem et al. (2023) investigated the role of ICT, GDP per capita, population, and globalization on environmental quality in 31 Asian countries from 1990 to 2018. Utilizing ecological footprint as an environmental indicator and the CS-ARDL estimator under an extended STIRPAT framework, the study found that ICT significantly reduces ecological footprints across all income groups. Robustness was confirmed using the AMG test, and long-term relationships were established. Gao et al. (2022) explored the interlinkages among green finance, environmental pollution, and high-quality economic growth across 30 Chinese provinces (2010–2019). Spatial econometric models showed that green finance enhances economic quality while mitigating the adverse effects of pollution by restructuring industries and fostering innovation. Threshold effects indicated a nonlinear relationship. Han et al. (2023) analyzed industrial agglomeration, air pollution, and sustainable economic development across 273 Chinese cities (2015–2018). Using a spatial Durbin model, the study found U-shaped nonlinearities between agglomeration, pollution, and development. Air pollution also moderated the agglomeration–development nexus, weakening its positive impact.

### 2.3. Air Pollution and Tourism

The tourism sector serves as a significant driver of global economic growth and plays a crucial role in environmental sustainability. Since tourism activities encompass various industries such as food, accommodation, transportation, beverage services, and recreation, they impact air pollution directly (through transportation emissions and energy consumption) and indirectly (through infrastructure development and resource use). When analyzing transportation-related emissions, it becomes evident that the most substantial environmental impact of tourism arises from the aviation sector. In addition to international tourism, domestic travel preferences have shifted dramatically toward air transportation in recent years.

Gao and Zhang (2021) investigated the environmental impact of tourism in Mediterranean countries by examining multiple pollutants ($CO_2$, CO, $NO_x$, $SO_2$, PM2.5, PM10). Their panel cointegration analysis confirmed a long-term equilibrium between environmental pollution, energy use, growth, and tourism. The Environmental Kuznets Curve (EKC) hypothesis was held for Southern Mediterranean countries across four pollutants but was not supported in the North. Results showed that the environmental impact of tourism varies by region and pollutant type. Ahmad and Ma (2022) explored the potential of tourism to reduce environmental pollution in the Asian Tigers via industrial and energy substitution. Their econometric results indicated that a 1% rise in tourism can reduce carbon emissions by approximately 0.386%, suggesting tourism may support sustainability when managed strategically. Amin et al. (2024) examined the effects of tourism (TOU), GDP, foreign trade openness (TOP), and foreign direct investment (FDI) on

$CO_2$ emissions in major ASEAN tourism destinations (2000–2020). Using the panel ARDL model and Granger causality tests, they found TOU, GDP, and TOP positively correlated with emissions, while FDI had a mitigating effect, particularly in the long run. Idroes et al. (2024) analyzed $CO_2$ determinants in North Africa (1995–2021), focusing on economic growth, military spending, globalization, renewable energy, production, tourism, capital, and labor. Long-term ARDL findings showed that globalization, renewables, and capital formation reduce emissions while tourism, growth, and production increase them. Granger tests revealed unidirectional causality from most variables to emissions. Raihan (2024) studied Malaysia's tourism–emission nexus (1990–2019) using the ARDL model. The study found that tourism, fossil fuels, GDP, population, and capital formation increased emissions while renewable energy use lowered them. Findings were validated by CCR, DOLS, and FMOLS estimators. Sadullayeva (2025) assessed the impact of air pollution (PM2.5) on international tourism in Uzbekistan (1995–2023). Using fixed-effects regression on city-level data, the study found that higher PM2.5 levels significantly reduced tourist arrivals, while higher GDP per capita boosted tourism demand. Zhong et al. (2025) evaluated how the pandemic-induced drop in tourism in Bayanbulak, China, influenced air pollutants. Comparing the 2019 and 2020 tourist seasons, significant reductions were observed in PAHs (–54.37%), OC (–25.16%), and EC (–9.54%). Positive matrix factorization showed that the share of tourism and fuel use emissions declined notably while dust and biomass contributions rose. The study underscores the role of tourism in regional air quality. Musah et al. (2025) focused on the short-term greenhouse gas impacts of China's tourism boom, specifically $CH_4$ and $N_2O$. Using the Dynamic ARDL model, they found that tourism and financial development increased emissions. However, while initially environmentally burdensome, technological innovation helped mitigate emissions when synergized with tourism and finance. Hussain et al. (2025) analyzed the long-run relationship between tourism, corruption, and $CO_2$ emissions in 59 Belt and Road Initiative (BRI) countries (2002–2020). Using DOLS, FMOLS, and robustness techniques (CCE and DCCE), they found that both rising tourist numbers and corruption levels were positively associated with higher emissions in the long term. Zhong et al. (2025) conducted a spatial and temporal analysis of tourism-related $CO_2$ emissions in China (2001–2022). According to the Theil index, emissions displayed uneven spatial patterns, with disparities greater within regions than between them. Emissions were highest in the economically developed eastern region, moderate in the central region, and lowest in the west. Spatial clustering showed that high-emission areas coincided with dense, developed regions, indicating regional economic disparities significantly affect tourism-related environmental outcomes.

## 3. Methodology

The following model, which was inspired by, is utilized in this study to investigate the relationship between air transportation, economic growth, tourism, and CO2 emissions (Dogan & Aslan, 2017; Dursun, 2022):

$$CO_{2it} = f(AIR, GDP, TOUR) \quad (1)$$

The study uses data between 1995 and 2020 from 10 Balkan countries[1]. CO2 emissions are used as a dependent variable for the degradation of the environment. We employ AIR, GDP, and TOUR as independent variables to study the possible effect of aviation, GDP, and tourism on carbon dioxide emissions. Air passengers are used as a proxy for air transportation, with GDP constant US$ 2015 for economic growth and tourism receipts for tourism variables. All variables are collected from the World Bank (WDI, 2023). Table 1 shows the detailed information about variables.

Primarily, the analysis is informed by the Environmental Kuznets Curve (EKC) hypothesis, which posits an inverted U-shaped relationship between economic growth and environmental degradation (Barak et al., 2024; Balcı İzgi, 2020). According to this hypothesis, in the early stages of economic development, environmental pressure increases due to industrialization and fossil fuel consumption; however, after reaching a certain income threshold, societies tend to invest more in cleaner technologies, environmental regulation, and sustainable practices, thereby reducing emissions. This study also draws upon the tourism-induced EKC hypothesis, which extends the traditional EKC framework by integrating the role of tourism as a sector that may initially exacerbate environmental degradation through increased resource consumption and transportation-related emissions but eventually contribute to environmental improvements through green investments, ecotourism, and policy-driven sustainability efforts (Canpolat Gökçe and Kızılkaya, 2022; Zhang and Gao, 2016). The transport-induced emissions literature also supports the inclusion of air transportation in the model (Ergen et al., 2024; Alonso et al., 2014), which identifies aviation as a significant and growing contributor to global carbon emissions, particularly in service-oriented and tourism-dependent economies. Thus, the theoretical underpinnings of the EKC and its tourism-augmented variants provide a solid conceptual basis for selecting variables and interpreting the study's empirical findings, enhancing the objectivity and scientific coherence of the analysis.

**Table 1. List of Variables**

| Variables | Time | Abbreviation | Source |
|---|---|---|---|
| $CO_2$ Emission (kt) | 1995-2020 | $CO_2$ | WDI |
| Air Transportation (Air Passengers) | 1995-2020 | AIR | WDI |
| GDP (constant US$ 2015) | 1995-2020 | GDP | WDI |
| Tourism (Tourism Receipts) | 1995-2020 | TOUR | WDI |

Based on time series data, the following econometric model was created using Equation (1):

$$lnCO2_{it} = \beta_0 + \beta_1 lnAIR_{it} + \beta_2 lnGDP_{it} + \beta_3 lnTOUR_{it} + \mu_{it} \quad (2)$$

The analysis commences with an examination of the existence of the unit root. The LLC and IPS unit root tests assess the series' stability. When analyzing panel data for econometric purposes, the unit root tests developed by Levin-Lin-Chu (LLC) and Im-

[1] Albania, Bosnia & Herzegovina, Bulgaria, Croatia, North Macedonia, Romania, Serbia, Slovenia, Türkiye, Greece

Pesaran-Shin (IPS) are indispensable, particularly when testing for time series stationarity (Levin et al., 2002) created the LLC test, which, in a balanced panel framework, increases its power by assuming a standard unit root process across cross-sections. It works well for data with low cross-sectional dependence since it assumes mistakes are independent across series. However, the IPS (Im et al., 2003) test supports heterogeneous dynamics across series, making it relevant to scenarios with varied underlying processes (Hadri, 2000; Liang, 2017). A new research synthesis shows that both methods commonly prove economic series non-stationarity. Many studies on macroeconomic variables, including investment and savings, have used LLC and IPS tests to confirm non-stationarity in the data (Dumrul & Kılıçarslan, 2018; Wahid et al., 2010). Liang (2017) and Dumrul & Kılıçarslan (2018) suggest that unit root tests are essential before more complicated analyses like cointegration, as they provide a foundational understanding of the data's features. The IPS test excels as cross-sectional dependence becomes more widespread in economic data (Burger & Rensburg, 2008). Panel data diagnostics in economic research require a detailed understanding of data structure and hypothesis, as LLC and IPS tests depend on the data structure and hypothesis (Carvalho et al., 2004).

Secondly, we applied the cointegration test created by Pedroni (1999). This technique, developed by Pedroni, extends traditional cointegration test approaches to accommodate heterogeneous panels, allowing for variations in the long-run relationships among different cross-sectional entities (Mentel et al., 2022; Romano & Scandurra, 2011). Pedroni offers a variety of test statistics, including parametric and nonparametric approaches, that test for the absence of cointegration and account for the fact that the intercepts and slopes of the cointegrating equations can vary from one individual to the next (Kumari & Singh, 2022; Petrova, 2019). Such flexibility makes Pedroni cointegration suitable for diverse applications across economic studies, including investigating dynamics between economic growth and renewable energy in various countries in the long term (Hechmy, 2019), as well as assessing the interaction among economic growth and foreign direct investment in regional contexts (Bahizi et al., 2021; Mehrara et al., 2014). The method's robustness is evident in numerous studies, where it has effectively identified significant long-run relationships in datasets that encompass a wide variety of economic conditions (Anser et al., 2024; Boussiga & Ghdamsi, 2016; Sahoo et al., 2021).

After the cointegration test, the ARDL long-run coefficient estimation test is applied. For time-series data, the ARDL test provides a solid econometric framework for investigating the long- and short-term correlations between variables. In contrast to conventional cointegration methods, the ARDL approach can handle variables with differing integration orders (I(0) or I(1)), which is a significant strength of the method (Kırıkkaleli & Sofuoğlu, 2023; Sumarni, 2019). This feature makes ARDL particularly appealing in studies utilizing limited sample sizes, as it facilitates the estimation of valid results even when the data series exhibit differing integration levels (Kueh & Wei, 2018; Saleem & Ahmed, 2023). The method functions within the parameters of an unrestricted-error-correction-model(UECM), enabling researchers to effectively examine dynamic interactions (Ekesiobi et al., 2022; James et al., 2024). Moreover, the ARDL bounds test has gained widespread acclaim due to its ability to provide consistent and efficient estimations, making it a preferred choice in various fields, including economics, environmental studies, and finance (Amin & Rahman, 2024; Nkengfack & Fotio, 2014; Keho, 2017).

Finally, the Granger causality test (Granger, 1969) is conducted to reveal causalities between variables. Statistically, the Granger causality test is frequently used to determine if one time series may forecast another temporal process. At its core, it is based on the idea that X can be said to Granger because Y if its past values can enhance the prediction of Y beyond what Y's past values alone can accomplish (Graf, 2018; Maisonnave et al., 2020). This method has become prevalent in various fields, including economics, neuroscience, and environmental science, due to its ability to identify causal relationships without the direct assumption of causation that other techniques might require (Pourzanjani et al., 2015; Schmidt et al., 2016; Seth et al., 2015).

## 4. Empirical Results and Discussion

We first used the unit root test to establish stationarity. Finding the proper order of integrations and avoiding misleading regression results are statistically significant. We use the LLC and IPS unit root tests when checking for stationarity. A summary of the LLC and IPS test results can be found in this table. Table 2 shows that the variables are not all equally integrated. While the LLC test found that all variables were stationary at the intercept level, only CO2, AIR, and GDP were stationary at the first difference. Whether the variables are at their levels or their first differences, the results of the IPS test show that they are all stationary. We examine the interplay between the variables by employing the ARDL approach, which permits mixed integration orders.

**Table 2. Unit Root Test Results**

| Levin, Lin and Chu (LLC) | | | | |
|---|---|---|---|---|
| | Level | | First Difference | |
| Variables | With Intercept | With Intercept and Trend | With Intercept | With Intercept and Trend |
| $CO_2$ Emissions | -5.41754*** | -3.44319*** | -9.18299*** | -9.39203*** |
| Air Transportation | -10.1506*** | -11.9157*** | -21.0990*** | -19.9557*** |
| Economic Growth | -5.82289*** | -10.5197*** | -12.6509*** | -9.98442*** |
| Tourism | -4.32294*** | 3.91047 | -0.11033 | -0.20690 |
| **Im, Pesaran and Shin (IPS)** | | | | |
| | Level | | First Difference | |
| Variables | With Intercept | With Intercept and Trend | With Intercept | With Intercept and Trend |
| $CO_2$ Emissions | -3.48103*** | -2.62027*** | -9.11176*** | -9.34583*** |
| Air Transportation | -6.37207*** | -4.21032*** | -10.1913*** | -9.02394*** |
| Economic Growth | -2.96457*** | -3.49606*** | -9.97393*** | -7.52413*** |
| Tourism | -2.00394** | 4.90632 | -3.82728*** | -4.13445*** |

*** and **: Statistically significant at 1% and 5% respectively.

Before utilizing the ARDL method, we carried out the Pedroni cointegration test to determine whether the variables are cointegrated, which would indicate a link that has existed for a considerable amount of time. At the 1% significance level, four out of seven dependent variables (shown in Table 3) reject the null hypothesis of non-cointegration. In contrast, there are no notable outcomes for Panel-v, Panel-rho, and

Group-rho. Panel cointegration tests show that the constant-level independent variable in the model exhibits long-run cross-national cointegration.

**Table 3. Pedroni Cointegration Results**

| Dependent Variable | CO2 | |
|---|---|---|
| **Statistics** | **Stats.** | **p-value** |
| Panel v-Stat. | 0.701788 | 0.2414 |
| Panel rho-Stat. | 1.279714 | 0.8997 |
| Panel PP-Stat. | -1.910400** | 0.0280 |
| Panel ADF-Stat. | -4.911798*** | 0.0000 |
| Group rho-Stat. | 2.247438 | 0.9877 |
| Group PP-Stat. | -5.236000*** | 0.0000 |
| Group ADF-Stat. | -6.947634*** | 0.0000 |

*** and ** indicate significance at the 1% and 5% levels respectively.

Following cointegration analysis, the cointegrating independent variables for the data are estimated utilizing ARDL, FMOLS, and DOLS methodologies. Table 4 presents the results of the ARDL, FMOLS, and DOLS methodologies. A rejection of the non-cointegration null hypothesis follows from the ARDL results, which show that all variables are statistically significant at the 1% level. This data demonstrates that, on a global scale, every independent variable substantially impacts the dependent variable. On the other hand, DOLS shows that both the AIR and TOUR variables are statistically significant at the 1% level, but FMOLS only shows that GDP is statistically significant. In agreement with the ARDL results, the FMOLS and DOLS procedures validate the analysis. In the long run, CO2 emissions rise 0.22 percent for every 1 percent increase in air travelers, according to the ARDL findings. Similarly, the DOLS method finds that for every 1% rise in air transportation, $CO_2$ emissions rise by 0.15 percent. There is a negative relationship between economic growth and CO2 emissions, just as in the case of air transportation. As expected, the results show that CO2 emissions increase by 0.32% for every 1% increase in economic development. According to the FMOLS study, if GDP were to rise by one percent, emissions would rise by half a percentage point over time. Tourism harms $CO_2$ emissions, which contradicts air transportation and GDP growth results. According to ARDL and DOLS, a decrease in CO2 emissions of 0.34 percent and 0.15 percent is associated with increased tourism receipts. At the $CO_2$ emissions nexus, this finding agrees with Ayvaz (2025) and Dursun (2022). Upon analyzing the correlation between GDP growth and $CO_2$ emissions, our findings align with those of Bakhsh et al. (2017), Habib et al. (2022), Işık et al. (2024), Namahoro et al. (2021), and Prakash (2025), however, they contradict Huang & Ren (2024). The positive association between air transportation and $CO_2$ emissions observed in the ARDL and DOLS models aligns closely with previous research. Our finding that a 1% increase in air transportation results in a 0.22% (ARDL) to 0.15% (DOLS) increase in $CO_2$ emissions is consistent with the works of Lo et al. (2020) and Habib et al. (2022), who identified aviation as a significant contributor to atmospheric pollution. These studies underscore how air

transportation's reliance on fossil fuels and high-altitude emissions leads to disproportionate environmental consequences. The role of exhaust gases and airport-related emissions, as discussed by Masiol & Harrison (2014) and Ovdiienko et al. (2021), further supports the causality established in our results. Likewise, our finding that economic growth exacerbates $CO_2$ emissions (0.32% increase in emissions per 1% GDP growth; 0.50% in FMOLS) is broadly in line with the existing literature. Studies such as Islam et al. (2021) and Saleem et al. (2023) highlight that GDP growth often correlates with increased energy consumption and urbanization, intensifying environmental degradation. Moreover, this finding lends support to the first half of the Environmental Kuznets Curve (EKC) hypothesis, as posited by Cole (2000) and Ekins (1997), which suggests that environmental quality initially deteriorates with economic expansion. However, our study does not confirm the turning point posited by EKC theory, thereby aligning with critical perspectives from Farhani & Rejeb (2012) and Özokcu & Özdemir (2017), which challenge the universality of the EKC, especially in developing economies. A significant point of divergence, however, lies in our finding that tourism has a negative impact on $CO_2$ emissions. Both ARDL and DOLS estimations indicate that a rise in tourism receipts leads to a decline in emissions (–0.34% and –0.15%, respectively), suggesting that tourism might contribute to environmental improvement. This result contradicts several studies in the literature. For example, Raihan (2024) and Amin et al. (2024) observed that increased tourism contributes to higher emissions due to increased transport and energy use. Similarly, Musah et al. (2025) found that tourism in China resulted in a short-term increase in GHG emissions.

Nevertheless, our finding resonates with a growing body of literature that presents tourism as a potential tool for sustainability when managed strategically. For instance, Ahmad and Ma (2022) and Gao and Zhang (2021) found that when integrated with cleaner energy and regulated infrastructure, tourism can reduce emissions. It is plausible that the tourism sector in our study area may benefit from cleaner energy policies, better regulation, or a higher proportion of low-emission activities, which could explain this inverse relationship.

**Table 4. Long-term Estimation Results**

| Dependent Variable (CO2) | | ARDL | | | FMOLS | | | DOLS | |
|---|---|---|---|---|---|---|---|---|---|
| Variables | Coefficients | Std. Error | t-statistics | Coefficients | Std. Error | t-statistics | Coefficients | Std. Error | t-statistics |
| AIR | 0.223663*** | 0.041532 | 5.385369 | -0.020914 | 0.038965 | -0.536734 | 0.159215*** | 0.030409 | 5.235760 |
| GDP | 0.320810*** | 0.122228 | 2.624681 | 0.515858*** | 0.182868 | 2.820929 | -0.071429 | 0.175903 | -0.406068 |
| TOUR | -0.343379*** | 0.046544 | -7.377557 | -0.058897 | 0.050369 | -1.169300 | -0.152347*** | 0.039939 | -3.814453 |

The symbol *** denotes 1% level of significance.

Finally, we check for a causal relationship between the variables by doing a Granger causality analysis. Table 5 displays the results of the Granger causality investigation. We can infer that there are unidirectional causal links based on the results: emissions

to air transportation, economic growth to CO2 emissions, tourism to CO2 emissions, economic growth to air transportation, tourism to economic growth, and so on.

**Table 5. Granger Causality Results**

| | F - Statistics | P- value | Causality |
|---|---|---|---|
| AIR ≠> CO2 | 1.26080 | 0.2894 | Uni-directional |
| CO2≠>AIR | 2.45147* | 0.0650 | |
| GDP≠>CO2 | 4.24760*** | 0.0061 | Uni-directional |
| CO2≠>GDP | 0.21671 | 0.8847 | |
| TOUR≠>CO2 | 2.26804* | 0.0821 | Uni-directional |
| CO2≠>TOUR | 1.87357 | 0.1356 | |
| GDP≠>AIR | 2.51442* | 0.0598 | Uni-directional |
| AIR≠>GDP | 0.58493 | 0.6256 | |
| TOUR≠>AIR | 5.12328*** | 0.0020 | Uni-directional |
| AIR≠>TOUR | 0.79956 | 0.4957 | |
| TOUR≠>GDP | 3.91184*** | 0.0096 | Uni-directional |
| GDP≠>TOUR | 0.62050 | 0.6025 | |

The symbols *** and * denote 1% and 10% level of significance, respectively.

## 4. Conclusion

The impact of tourism, air transportation, and economic growth on carbon dioxide emissions in Balkan nations was examined in this research. From 1995 to 2020, the ARDL, FMOLS, and DOLS techniques were used for this objective. This study's long-run coefficient estimation results shed light on the interplay of air transportation, GDP development, and air pollution in Balkan nations. According to the results, carbon emissions are being impacted more and more by air transportation and economic expansion. Specifically, more economic activity and the growth of air transportation lead to higher consumption of fossil fuels and, by extension, higher carbon dioxide emissions. However, it turns out that tourist spending has a varied influence on carbon dioxide emissions. According to the results, decreasing carbon emissions is one benefit of increasing tourist spending. This result can be caused by eco-friendly regulations, renewable energy, and sustainable practices, which all contribute to a more tourist-friendly environment.

Additionally, the causal linkages between variables are determined by applying Granger causality analysis. When looking at time series, one way to determine if two variables are causally related is to perform the Granger causality test. This is accomplished by checking for a statistically significant relationship between the two variables. The results of the study's analysis show that some pairs of variables have unidirectional causal links. The results show a direct relationship between emissions and air transportation. According to this discovery, it is possible that changes in pollution levels could impact air transportation. From GDP growth to $CO_2$ emissions, a similar unidirectional causal relationship was found. This discovery suggests that as economic growth is enhanced, $CO_2$ emissions also increase. A noteworthy discovery highlights the environmental consequences of tourism activities: a unidirectional causal relationship between tourism and $CO_2$ emissions. There are also one-way causal links between economic growth and air transportation, tourism and air transportation, and economic growth and tourism. These findings collectively indicate

that the tourism sector substantially influences economic growth and air transportation. Considering these findings, it is imperative that policymakers carefully analyze the relationships between the variables and evaluate these results.

Despite the valuable insights provided by this study, several limitations should be acknowledged. First, the analysis is confined to a specific regional context, such as Balkan nations, which may limit the generalizability of the findings to other regions with different economic, environmental, or tourism dynamics. Second, while the study employs robust econometric techniques such as ARDL, FMOLS, DOLS, and Granger causality tests, these methods primarily capture linear relationships and may not fully account for potential nonlinearities, threshold effects, or structural breaks beyond those already considered. Third, data availability constrained the analysis to the 1995–2020 period; more recent developments, especially post-pandemic shifts in tourism and air transportation patterns, are not captured. Additionally, aggregate national-level data may obscure important sub-national or sector-specific variations in emissions behavior. The study also does not directly incorporate qualitative factors such as policy interventions, technological innovation, or behavioral shifts, which could influence the relationships among the variables. While numerous factors can influence carbon dioxide ($CO_2$) emissions, this study deliberately focuses on three core independent variables: tourism expenditure, air transportation, and economic growth, for theoretical and practical reasons. (1) These variables represent key components of the Balkan region's modern service-based and mobility-driven economies, where tourism and aviation are rapidly expanding industries with significant environmental implications. (2) Existing literature consistently identifies these variables as major contributors to ecological degradation in emerging and transition economies, justifying their inclusion in a focused econometric framework. For example, economic growth is widely regarded as a primary driver of energy consumption and emissions, while tourism and air transportation are directly linked to transport-related fossil fuel usage. (3) A parsimonious model is preferred in this context to reduce multicollinearity risks, enhance interpretability, and ensure robustness in long-run estimations, especially given data limitations over the 1995–2020 period. Therefore, while acknowledging that other factors, such as energy prices, urbanization, industrial structure, or environmental regulation, may also play a role, this study prioritizes these three variables due to their central relevance, empirical tractability, and policy significance within the regional and temporal scope of the analysis. Future research could address these limitations by employing more advanced or complementary methodological approaches such as Nonlinear ARDL (NARDL) to account for asymmetric effects, panel quantile regressions to capture heterogeneity, panel vector error correction models (VECM) to distinguish short- and long-run dynamics, or structural equation modeling (SEM) to assess indirect causal pathways. Moreover, wavelet coherence analysis could be used to explore time–frequency dependencies, while machine learning algorithms such as random forests or neural networks may uncover complex nonlinear patterns. Incorporating such tools would provide a more nuanced understanding of the evolving interplay between tourism, air transportation, economic growth, and environmental sustainability.

The findings suggest that while air transportation and economic growth significantly increase $CO_2$ emissions, tourism may contribute to environmental improvement under certain conditions. Therefore, policymakers should implement targeted strategies to mitigate aviation-related emissions, such as investing in sustainable aviation fuels (SAF), promoting electric ground support equipment at airports, and enhancing air

traffic management systems like Europe's SESAR project. Given tourism's potential to reduce emissions, governments should support ecotourism and encourage sustainable transport options within tourist regions where ecotourism and renewable energy integration have coexisted successfully. Furthermore, green taxation on air transportation and incentives for low-emission tourism operators could balance economic benefits with environmental sustainability. Future studies could expand the scope of the analysis to distinguish between different types of emissions such as $NO_x$ PM2.5, use panel data sets to conduct country comparisons, or examine the environmental impacts of tourism's subcomponents like ecotourism mass tourism in detail to offer different perspectives.

## References

Adebanjo, S. A., & Shakiru, T. H. (2022). Dynamic relationship between air pollution and economic growth in Jordan: An empirical analysis. *Journal of Environmental Science and Economics*, *1*(2), 30-43.

Ahmad, N., & Ma, X. (2022). How does tourism development affect environmental pollution?. Tourism Economics, *28*(6), 1453-1479.

Aksoy, H., Domene, M. G., Loganathan, P., Blakey, S., Zea, E., Vinuesa, R., & Otero, E. (2025). Case study on SAF emissions from air travel considering emissions modeling impact. *Transportation Research Interdisciplinary Perspectives, 29*, 101341.

Alonso, G., Benito, A., Lonza, L., & Kousoulidou, M. (2014). Investigations on the distribution of air transport traffic and CO2 emissions within the European Union. *Journal of Air Transport Management, 36*, 85-93.

Amin, N., Rahman, S. U., Khalid, S., & Idress, S. (2024). How Does Tourism, Trade Openness and Green Energy Influence CO2 emissions? Evidence from ASEAN Countries. *Bulletin of Business and Economics (BBE), 13*(2), 71-79.

Anser, M. K., Khan, M. A., Khan, M. A., Huizhen, W., & Haider, A. (2024). The effectiveness of emerging markets' legal structure in explaining financial development. *Plos One*. https://doi.org/10.1371/journal.pone.0299831

Arifin, M. Z., Putra, S. P., & Sari, M. (2024). The future of ground handling in the form of electric ground support equipment. *Advances in Transportation and Logistics Research*, 7, 72-83.

Ayvaz, E. E. (2025). Çevre vergileri, hava taşımacılığı ve co2 emisyonları ilişkisi: Avrupa ülkeleri üzerine bir çalışma. *Erzurum Teknik Üniversitesi Sosyal Bilimler Enstitüsü Dergisi*, *21*, Article 21. https://doi.org/10.29157/etusbed.1436615

Bahizi, M., Safari, K., Butare, G. W., Rutikanga, C., & Bikorimana, G. (2021). Empirical analysis of foreign direct ınvestment on economic growth: evidence from the east african community. *International Review of Economics and Management*. https://doi.org/10.18825/iremjournal.977022

Bakhsh, K., Rose, S., Ali, M. F., Ahmad, N., & Shahbaz, M. (2017). Economic growth, CO2 emissions, renewable waste and FDI relation in Pakistan: New evidences from 3SLS. *Journal of Environmental Management*, *196*, 627–632. https://doi.org/10.1016/j.jenvman.2017.03.029

Balcı İzgi, B. (2020). ARDL Yaklaşımıyla Türkiye'de Çevre Kirliliği ve Geleneksel Kuznets Eğrisi (EKC) Literatürüne Bir Bakış. *Çukurova Üniversitesi İktisadi Ve İdari Bilimler Fakültesi Dergisi, 24*(1), 111-125.

Barak, D., Kocoglu, M., Jahanger, A., & Tan, M. (2024). Testing the EKC hypothesis for ecological and carbon intensity of well-being: The role of forest extent. *Science of the Total Environment, 945*, 173794.

Belis, C. A., Matkovic, V., Ballocci, M., Jevtic, M., Millo, G., Mata, E., & Van Dingenen, R. (2023). Assessment of health impacts and costs attributable to air pollution in urban areas using two different approaches. A case study in the Western Balkans. *Environment International*, *182*, 108347.

Bieber, F., & Tzifakis, N. (2019). The Western Balkans in the world: Linkages and relations with non-Western countries. *Routledge*.

Boubel, R. W., Vallero, D., Fox, D. L., Turner, B., & Stern, A. C. (2013). *Fundamentals Of Air Pollution*. Elsevier.

Boussiga, N., & Ghdamsi, M. (2016). The corruption-terrorism nexus: a panel data approach. *International Journal of Economics and Finance*. https://doi.org/10.5539/ijef.v8n11p111

Brooker, P. (2006). Civil-aircraft design priorities: air quality? climate change? noise? *The Aeronautical Journal, 110*(1110), 517-532.

Brunekreef, B., & Holgate, S. T. (2002). Air pollution and health. *The Lancet*, *360*(9341), 1233-1242.

Bruvoll, A., & Medin, H. (2003). Factors behind the environmental kuznets curve. a decomposition of the changes in air pollution. *Environmental and Resource Economics*, *24*, 27-48.

Burger, P., & Rensburg, L. J. V. (2008). Metropolitan house prices in South Africa: do they converge? *South African Journal of Economics*, *76*(2), 291–297. https://doi.org/10.1111/j.1813-6982.2008.00190.x

Canpolat Gökçe, E., & Kızılkaya, F. (2022). Türkiye için Turizm Kaynaklı EKC Hipotezinin Test Edilmesi. *Kahramanmaraş Sütçü İmam Üniversitesi Sosyal Bilimler Dergisi, 19*(1), 352-362. https://doi.org/10.33437/ksusbd.875357

Carvalho, J., Sachsida, A., Loureiro, P. R. A., & Moreira, T. B. S. (2004). Uncovered interest parity in Argentina, Brazil, Chile, and Mexico: a unit root test application with panel data. *Review of Urban and Regional Development Studies*, *16*(3), 263–269. https://doi.org/10.1111/j.1467-940x.2005.00091.x

Castell, M. von. (2014). *Analysis of the influence of the Air Traffic Management initiatives SESAR and NextGen on Airline Operations Control Centers' workflows.*

Chen, F., & Chen, Z. (2021). Cost of economic growth: air pollution and health expenditure. *Science of the Total Environment*, *755*, 142543.

Çiçek, I. (2024). The sustainability evaluation for ground-handling companies. *Necmettin Erbakan Üniversitesi Siyasal Bilgiler Fakültesi Dergisi*, *6*(2), 482-507.

Cole, M. A. (2000). Air pollution and 'dirty'industries: How and why does the composition of manufacturing output change with economic development? *Environmental and Resource Economics*, *17*, 109-123.

Conesa, J. A., & Mortes, J. (2025). The contribution of commercial flights to the global emissions of inorganic and organic pollutants. *Processes, 13*(4), 995.

Curley, S. (2023). *Negotiating Space, Place, and Destination: Tourism in the Balkans as a Worlding Practice.*

Denby, B. R., Klimont, Z., Nyiri, A., Kiesewetter, G., Heyes, C., & Fagerli, H. (2024). Future scenarios for air quality in Europe, the Western Balkans and EECCA countries: An assessment for the Gothenburg protocol review. *Atmospheric Environment*, *333*, 120602.

Dhara, A., Kaur, G., Kishan, P. M., Majumder, A., & Yadav, R. (2021). An efficient decision support system for selecting very light business jet using CRITIC-TOPSIS method. *Aircraft Engineering and Aerospace Technology*, *94*(3), 458-472. https://doi.org/10.1108/AEAT-04-2021-0135

Dinda, S., Coondoo, D., & Pal, M. (2000). Air quality and economic growth: An empirical study. *Ecological Economics*, *34*(3), 409-423.

Dogan, E., & Aslan, A. (2017). Exploring the relationship among CO2 emissions, real GDP, energy consumption and tourism in the EU and candidate countries: Evidence from panel models robust to heterogeneity and cross-sectional dependence. *Renewable and Sustainable Energy Reviews*, *77*, 239–245. https://doi.org/10.1016/j.rser.2017.03.111

Dumrul, Y., & Kılıçarslan, Z. (2018). The Effect of Research and Development (R D) Expenditures on Export: Evidence From a Panel of Selected OECD Countries. *Pressacademia*, *5*(3), 234–241. https://doi.org/10.17261/pressacademia.2018.932

Dursun, E. (2022). Investigating the Air Transport-Induced EKC Hypothesis: Evidence from NAFTA Countries. *International Journal of Energy Economics and Policy*, *12*(4), 494–500. https://doi.org/10.32479/ijeep.13347

Ekesiobi, C., Emmanuel, P. M., Mgbemena, Emilia. M., Ibekilo, B., Chukwuemeka, D., & Madueme, I. S. (2022). *Modelling International Trade, Foreign Direct Investment, and Carbon Emission Nexus in Nigeria: A Reconsideration of the Pollution Haven Hypothesis*. https://doi.org/10.21203/rs.3.rs-2140267/v1

Ekins, P. (1997). The Kuznets curve for the environment and economic growth: Examining the evidence. *Environment and Planning A*, *29*(5), 805-830.

El Asri, H., & Tsiakalos, S. (2024*). Digital Solutions for Enhanced Operational Efficiency: NextGen Air Traffic Management Systems*. 212-221.

Ergen, H., Aslan, A., & Ayvaz, E. E., (2024). Can Air Transportation Reach to Zero Carbon Emissions: Comparative Econometric Analysis Between Transportation Modes in US. *International Journal of Shipping and Transport Logistics, 1(*1), 1-29.

Faiz, A., Weaver, C. S., & Walsh, M. P. (1996). *Air pollution from motor vehicles: Standards and technologies for controlling emissions*. World Bank Publications.

Farhani, S., & Balsalobre-Lorente, D. (2020). Comparing the role of coal to other energy resources in the environmental Kuznets curve of three large economies. *The Chinese Economy*, *53*(1), 82-120.

Farhani, S., & Rejeb, J. B. (2012). Energy consumption, economic growth and CO2 emissions: Evidence from panel data for MENA region. *International Journal of Energy Economics and Policy*, *2*(2), 71-81.

Folinsbee, L. J. (1993). Human health effects of air pollution. *Environmental Health Perspectives*, 100, 45-56.

Fregnani, J. T., & Mattos, B. S. (2016). *Aviation and electrical road vehicles*. 3754.

Fujii, H., & Managi, S. (2016). Economic development and multiple air pollutant emissions from the industrial sector. *Environmental Science and Pollution Research*, *23*, 2802-2812.

Gao, J., & Zhang, L. (2021). Exploring the dynamic linkages between tourism growth and environmental pollution: new evidence from the Mediterranean countries. *Current Issues in Tourism, 24*(1), 49-65.

Gao, J., Wu, D., Xiao, Q., Randhawa, A., Liu, Q., & Zhang, T. (2023). Green finance, environmental pollution and high-quality economic development—a study based on China's provincial panel data. *Environmental Science and Pollution Research, 30*(11), 31954-31976.

Graf, R. (2018). Analysis of granger causality between daily and monthly temperatures of water and air, as illustrated with the example of noteć river. *Acta Scientiarum Polonorum Formatio Circumiectus*. https://doi.org/10.15576/asp.fc/2018.17.3.101

Granger, C. W. J. (1969). Investigating causal relations by econometric models and cross-spectral methods. *Econometrica*, *37*(3), 424. https://doi.org/10.2307/1912791

Grossman, G. M., & Krueger, A. B. (1995). Economic growth and the environment. *The Quarterly Journal of Economics, 110*(2), 353-377.

Gürçam, S., Konuralp, E., & Ekici, S. (2021). Determining the effect of air transportation on air pollution in the most polluted city in Turkey. *Aircraft Engineering and Aerospace Technology, 93*(2), 354-362.

Habib, Y., Xia, E., Hashmi, S. H., & Yousaf, A. U. (2022). Testing the heterogeneous effect of air transport intensity on CO2 emissions in G20 countries: An advanced empirical analysis. *Environmental Science and Pollution Research*, *29*(29), 44020–44041. https://doi.org/10.1007/s11356-022-18904-w

Habib, Y., Xia, E., Hashmi, S. H., & Yousaf, A. U. (2022). Testing the heterogeneous effect of air transport intensity on CO2 emissions in G20 countries: An advanced empirical analysis. *Environmental Science and Pollution Research, 29*(29), 44020-44041.

Hadri, K. (2000). Testing for stationarity in heterogeneous panel data. *Econometrics Journal*, *3*(2), 148–161. https://doi.org/10.1111/1368-423x.00043

Han, C., Hua, D., & Li, J. (2023). A View of Industrial Agglomeration, Air Pollution and Economic Sustainability from Spatial Econometric Analysis of 273 Cities in China. *Sustainability, 15*(9), 7091.

Hari, T. K., Yaakob, Z., & Binitha, N. N. (2015). Aviation biofuel from renewable resources: Routes, opportunities and challenges. *Renewable and Sustainable Energy Reviews*, *42*, 1234-1244.

Harrison, R. M., Masiol, M., & Vardoulakis, S. (2015). Civil aviation, air pollution and human health. *Environmental Research Letters, 10*(4), 041001.

Hechmy, B. (2019). Can conventional energy be replaced by renewable energy without harming economic growth in non-oil-MENA? evidence from granger causality in VECM. *World Journal of Entrepreneurship Management and Sustainable Development*. https://doi.org/10.1108/wjemsd-11-2018-0098

Holman, C. (1999). Sources of air pollution. İçinde *Air Pollution and Health* (ss. 115-148). Elsevier.

Huang, Z., & Ren, X. (2024). Impact of natural resources, resilient economic growth, and energy consumption on CO2 emissions. *Resources Policy*, *90*, 104714. https://doi.org/10.1016/j.resourpol.2024.104714

Huskić, A. (2023). A Comparative *Overview of the External Actors' Influence in the Western Balkans and Croatia. Western Balkans at the Crossroads: Democratic Backsliding and External Actors' Influence Final Report*, 100.

Hussain, B., Naqvi, S. A. A., Anwar, S., & Usman, M. (2023). Effect of wind and solar energy production, and economic development on the environmental

quality: Is this the solution to climate change? *Gondwana Research, [Online first]. 11*. https://doi.org/10.1016/j.gr.2023.01.012

Hussain, M. N., Li, Z., Sattar, A., & Ilyas, M. (2025). Dynamic linkage between tourism, corruption and CO2 emission on economic growth in BRI countries. *Leisure Sciences, 47*(4), 673-691.

Idroes, G. M., Rahman, H., Uddin, I., Hardi, I., & Falcone, P. M. (2024). Towards sustainable environment in North African countries: The role of military expenditure, renewable energy, tourism, manufacture, and globalization on environmental degradation. *Journal of Environmental Management, 368*, 122077.

Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics*, *115*(1), 53–74. https://doi.org/10.1016/S0304-4076(03)00092-7

Işık, C., Bulut, U., Ongan, S., Islam, H., & Irfan, M. (2024). Exploring how economic growth, renewable energy, internet usage, and mineral rents influence CO2 emissions: A panel quantile regression analysis for 27 OECD countries. *Resources Policy*, *92*, 105025. https://doi.org/10.1016/j.resourpol.2024.105025

Islam, M., Alam, M., Ahmed, F., & Al-Amin, A. Q. (2023). Economic growth and environmental pollution nexus in Bangladesh: revisiting the environmental Kuznets curve hypothesis. *International Journal of Environmental Studies, 80*(1), 68-92.

James, D., Omodero, C. O., Nwobodo, H., Odhigu, F. O., & Adeyemo, K. A. (2024). Taxation and consumers' spending patterns in Nigeria: an autoregressive distributed lag and error correction model approach. *International Journal of Economics and Financial Issues*. https://doi.org/10.32479/ijefi.16129

Jiang, M., Kim, E., & Woo, Y. (2020). The relationship between economic growth and air pollution—A regional comparison between China and South Korea. *International Journal of Environmental Research and Public Health*, *17*(8), 2761.

Kale, U., Jankovics, I., Nagy, A., & Rohács, D. (2021). Towards sustainability in air traffic management. Sustainability, *13*(10), 5451.

Kampa, M., & Castanas, E. (2008). Human health effects of air pollution. *Environmental Pollution*, *151*(2), 362-367.

Kırıkkaleli, D., & Sofuoğlu, E. (2023). Does financial stability matter for environmental degradation? *Geological Journal*. https://doi.org/10.1002/gj.4707

Kousoulidou, M., & Lonza, L. (2016). Biofuels in aviation: Fuel demand and CO2 emissions evolution in Europe toward 2030. *Transportation Research Part D: Transport and Environment*, *46*, 166-181.

Kueh, J., & Wei, Y. S. (2018). FDI-led-growth in Malaysia: autoregressive distributed lag (ardl) bounds testing approach. *International Business Research*. https://doi.org/10.5539/ibr.v11n11p46

Kukla-Gryz, A. (2009). Economic growth, international trade and air pollution: A decomposition analysis. *Ecological Economics*, *68*(5), 1329-1339.

Kumari, V., & Singh, S. (2022). Effect of financial development and foreign direct investments on economic growth in Saarc countries: a panel ardl approach. *Asian Journal of Management Studies*. https://doi.org/10.4038/ajms.v2i1.44

Lau, L. S., Yii, K. J., Ng, C. F., Tan, Y. L., & Yiew, T. H. (2025). Environmental Kuznets curve (EKC) hypothesis: A bibliometric review of the last three decades. *Energy & Environment*, *36*(1), 93-131.

Levin, A., Lin, C.-F., & James Chu, C.-S. (2002). Unit root tests in panel data: Asymptotic and finite-sample properties. *Journal of Econometrics*, *108*(1), 1–24. https://doi.org/10.1016/S0304-4076(01)00098-7

Li, J., Hou, L., Wang, L., & Tang, L. (2021). Decoupling analysis between economic growth and air pollution in key regions of air pollution control in China. *Sustainability*, *13*(12), 6600.

Liang, Z. (2017). *A Unified Approach on the Local Power of Panel Unit Root Tests*. https://doi.org/10.48550/arxiv.1710.02944

Lo, P. L., Martini, G., Porta, F., & Scotti, D. (2020). The determinants of CO2 emissions of air transport passenger traffic: An analysis of Lombardy (Italy). *Transport Policy, 91*, 108-119.

Magazzino, C., Porrini, D., Fusco, G., & Schneider, N. (2021). Investigating the link among ICT, electricity consumption, air pollution, and economic growth in EU countries. *Energy Sources, Part B: Economics, Planning, and Policy*, *16*(11-12), 976-998.

Maisonnave, M., Delbianco, F., Tohmé, F., Maguitman, A. G., & Milios, E. (2020). *Assessing Causality Structures Learned From Digital Text Media*. https://doi.org/10.1145/3395027.3419594

Mannucci, P. M., & Franchini, M. (2017). Health effects of ambient air pollution in developing countries. *International Journal of Environmental Research And Public Health*, *14*(9), 1048.

Masiol, M., & Harrison, R. M. (2014). Aircraft engine exhaust emissions and other airport-related contributions to ambient air pollution: A review. *Atmospheric Environment*, *95*, 409-455.

Mehrara, M., Ebrahimian, A., & Falahati, Z. (2014). The relationship among information and communication technologies and gdp in middle east countries: panel cointegration approach. *International Letters of Social and Humanistic Sciences*. https://doi.org/10.18052/www.scipress.com/ilshs.44.13

Mentel, G., Tarczyński, W., Azadi, H., Abdurakmanov, K., Zakirova, E., & Salahodjaev, R. (2022). R&D human capital, renewable energy and co2 emissions: evidence from 26 countries. *Energies*. https://doi.org/10.3390/en15239205

Milne, S., & Ateljevic, I. (2001). Tourism, economic development and the global-local nexus: Theory embracing complexity. *Tourism Geographies*, *3*(4), 369-393.

Mirović, V., Kalaš, B., & Pavlović, N. (2020). An empirical analysis of relationship between tourism and economic growth: Panel evidence from Western Balkan countries. *5th International Thematic Monograph: Modern Management Tools and Economy of Tourism Sector in Present Era, Belgrade*, 39–52.

Musah, M., Mensah, I. A., Onifade, S. T., Ankrah, I., & Gyamfi, B. A. (2025). On China's Sustainable Future: How do Eco-Technological Innovations and Financial Development Moderate the Tourism-Environmental Pollution Nexus?. *Journal of Cleaner Production*, 144987.

Muthalib, A. A. (2024). The impact of cross-border travel restrictions on financial performance: a capital market perspective from ASEAN countries. *SUKUK:*

*International Journal of Banking, Finance, Management and Business*, *3*(I), 29-41.

Namahoro, J. P., Wu, Q., Zhou, N., & Xue, S. (2021). Impact of energy intensity, renewable energy, and economic growth on CO2 emissions: Evidence from Africa across regions and income levels. *Renewable and Sustainable Energy Reviews*, *147*, 111233. https://doi.org/10.1016/j.rser.2021.111233

Nunes, L. J. (2023). The rising threat of atmospheric CO2: a review on the causes, impacts, and mitigation strategies. *Environments*, *10*(4), 66.

Ouyang, X., Shao, Q., Zhu, X., He, Q., Xiang, C., & Wei, G. (2019). Environmental regulation, economic growth and air pollution: Panel threshold analysis for OECD countries. *Science of the Total Environment*, *657*, 234-241.

Ovdiienko, O., Hryhorak, M., Marchuk, V., & Bugayko, D. (2021). An assessment of the aviation industry's impact on air pollution from its emissions: Worldwide and the Ukraine. *Environmental & Socio-economic Studies*, *9*(2), 1-10.

Özokcu, S., & Özdemir, Ö. (2017). Economic growth, energy, and environmental kuznets curve. *Renewable and Sustainable Energy Reviews*, *72*, 639-647.

Pedroni, P. (1999). Critical values for cointegration tests in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and Statistics*, *61*(S1), 653–670. https://doi.org/10.1111/1468-0084.0610s1653

Peeters, J. (1998). Aviation and air pollution. At *Studies in Environmental Science* (C. 72, ss. 601-613). Elsevier.

Petrova, Y. (2019). On cointegration between the insurance market and economic activity. *Empirical Economics*. https://doi.org/10.1007/s00181-019-01669-6

Płanda, B., & Skorupski, J. (2017). Methods of air traffic management in the airport area including the environmental factor. *International Journal of Sustainable Transportation*, 11(4), 295-307.

Popescu, F., & Ionel, I. (2010). Anthropogenic air pollution sources. *Air Quality*, 1-22.

Porfido, E. (2020). Tourism development in the Western Balkans: Towards a common policy. *Annual Review of Territorial Governance in the Western Balkans*, *2*, 24-45.

Pourzanjani, A. A., Herzog, E. D., & Petzold, L. (2015). On the inference of functional circadian networks using granger causality. *Plos One*. https://doi.org/10.1371/journal.pone.0137540

Prakash, N. (2025). Income disparities and environmental dynamics: Exploring varied impacts of renewable energy, innovations, and economic growth on CO2 emissions. *Renewable Energy*, *243*, 122596. https://doi.org/10.1016/j.renene.2025.122596

Quadrelli, R., & Peterson, S. (2007). The energy–climate challenge: Recent trends in CO2 emissions from fuel combustion. *Energy Policy*, *35*(11), 5938-5952.

Raihan, A. (2024). The influence of tourism on the road to achieving carbon neutrality and environmental sustainability in Malaysia: the role of renewable energy. *Sustainability Analytics and Modeling, 4*, 100028.

Ringquist, E. J. (1993). Does regulation matter?: Evaluating the effects of state air pollution control programs. *The Journal of Politics, 55*(4), 1022-1045.

Roca, J., Padilla, E., Farré, M., & Galletto, V. (2001). Economic growth and atmospheric pollution in Spain: Discussing the environmental Kuznets curve hypothesis. *Ecological Economics*, *39*(1), 85-99.

Romano, A. A., & Scandurra, G. (2011). Dynamics of economic growth and electricity consumption at regional level: the Italian case. *Energy Systems*. https://doi.org/10.1007/s12667-011-0028-7

Sadullayeva, G. (2025). The Impact of Air Pollution on Tourism Demand in Uzbekistan: A Fixed Effects Analysis. *Frontiers of Global Science, 3*(1), 34-37.

Sahoo, M., Saini, S., & Villanthenkodath, M. A. (2021). *Determinants of Material Footprint in BRICS Countries: An Empirical Analysis*. https://doi.org/10.21203/rs.3.rs-225820/v1

Saleem, F., & Ahmed, T. (2023). *Role of ICTs in Environmental Degradation: A Cross-Country Analysis*. https://doi.org/10.21203/rs.3.rs-2298281/v1

Saleem, H., Khan, M.B. & Mahdavian, S.M. The role of economic growth, information technologies, and globalization in achieving environmental quality: a novel framework for selected Asian countries. *Environ Sci Pollut Res 30*, 39907–39931 (2023). https://doi.org/10.1007/s11356-022-24700-3

Saria, M., & Wan Mohamed, W. M. (2022). The optimization using electric ground support equipment in aviation industry. *International Journal of Energy Economics and Policy*, *12*(1), 401-406.

Sarkodie, S. A. (2020). Dynamic linkage between renewable and conventional energy use, environmental quality and economic growth: Evidence from Emerging Market and Developing Economies. *Energy Reports*, *6*, 965-973.

Schmidt, C. Q., Pester, B., Schmid-Hertel, N., Witte, H., Wismüller, A., & Leistritz, L. (2016). A multivariate granger causality concept towards full brain functional connectivity. *Plos One*. https://doi.org/10.1371/journal.pone.0153105

Selimi, N., Sadiku, L., & Sadiku, M. (2017). The impact of tourism on economic growth in the Western Balkan countries: An empirical analysis. *International Journal of Business and Economic Sciences Applied Research (IJBESAR)*, *10*(2), 19–25.

Seth, A. K., Barrett, A. B., & Barnett, L. (2015). Granger causality analysis in neuroscience and neuroimaging. *Journal of Neuroscience*. https://doi.org/10.1523/jneurosci.4399-14.2015

Sinclair, M. T. (1998). Tourism and economic development: A survey. *The Journal of Development Studies*, *34*(5), 1-51.

Stanojević, G., Malinović-Milićević, S., Brđanin, E., Milanović, M., Radovanović, M. M., & Popović, T. (2024). Impact of Domestic Heating on Air Pollution—Extreme Pollution Events in Serbia. *Sustainability*, *16*(18), 7920.

Stern, A. C. (1977). *Air Pollution: The effects of air pollution* (C. 2). Elsevier.

Sumarni, L. (2019). Financial development and economic growth in Indonesia: an ardl-bounds testing approach. *Economic Journal of Emerging Markets*. https://doi.org/10.20885/ejem.vol11.iss1.art9

Thonemann, N., Pierrat, E., Dudka, K. M., Saavedra-Rubio, K., Dragsdahl, A. L. S. T., & Laurent, A. (2024). Towards sustainable regional aviation: Environmental potential of hybrid-electric aircraft and alternative fuels. *Sustainable Production and Consumption*, *45*, 371-385.

Urhie, E., Odebiyi, J., & Popoola, R. (2017). Economic growth, air pollution standards enforcement and employment generation nexus in the Nigerian context. *International Journal of Innovative Research and Development, 6*(5), 10-24.

Vedantham, A., & Oppenheimer, M. (1998). Long-term scenarios for aviation: demand and emissions of CO2 and NOx. *Energy Policy*, *26*(8), 625-641.

Vladi, B. (2014*). Innovation in Tourism: "Attractor" Model as a Good Opportunity to Increase Economic Cooperation in the Balkans*.

Wadden, R. A., & Scheff, P. A. (1983). *Indoor air pollution*.

Wahid, A. N., Salahuddin, M., & Noman, A. M. (2010). Savings and investment in South Asia. *Journal of Economic Studies*, *37*(6), 658–666. https://doi.org/10.1108/01443581011086684

Walters, R. (2010). Toxic atmospheres air pollution, trade and the politics of regulation. *Critical Criminology*, *18,* 307-323.

WDI. (2023). *World Development Indicators | DataBank*. https://databank.worldbank.org/source/world-development-indicators

Xu, S.-C., Miao, Y.-M., Gao, C., Long, R.-Y., Chen, H., Zhao, B., & Wang, S.-X. (2019). Regional differences in impacts of economic growth and urbanization on air pollutants in China based on provincial panel estimation. *Journal of Cleaner Production*, *208*, 340-352.

Yarde, K., & Zhang, C. (2024). Socio-economic Impact of Air Connectivity. İçinde *Strategies for Sustainable Air Services Development* (ss. 23-44). Routledge.

Zhang, L., & Gao, J. (2016). Exploring the effects of international tourism on China's economic growth, energy consumption and environmental pollution: Evidence from a regional panel analysis. *Renewable and Sustainable Energy Reviews, 53*, 225-234.

Zhang, P., Ding, R., Wang, Y., Zhang, Q., & Zhao, L. (2023). Emission reduction with hybrid mechanisms in civil aviation: An evolutionary game approach. *Frontiers in Environmental Science*, *11*, 1138931.

Zhong, C., Hao, Y., Wang, C., & Wang, L. (2025). Analysis of regional differences and spatial and temporal evolution of tourism carbon emissions in China: Considering carbon sink effect. *Current Issues in Tourism, 28*(8), 1282-1305.

Zhong, X., Chen, P., Kang, S., Zheng, H., Guo, J., Hu, Z., ... & Li, C. (2025). Tourism activities significantly contributed to atmospheric pollutants in a remote town of Tianshan revealed by the continuous observation of two years. *Atmospheric Pollution Research, 16*(1), 102356.