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Climate Change Mitigation Performance in the EU Tourism Destination Sector

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Abstract
Climate change mitigation in the tourism sector is expanding research areas due to the importance of this sector and its rapid expansion. Aviation's contribution was found to be the most important source of GHG emissions from tourism. Also, the hospitality sector contributes a lot to GHG emissions in tourism destinations. Hospitality, constituting an essential component of the tourism industry, is a sector that has a high potential to reduce GHG and use of energy and water resources. Therefore, it is important to monitor the climate change mitigation performance of tourism destinations to achieve decarbonization of the tourism sector. The main objectives of this paper are to develop indicators of climate change mitigation performance of tourism destinations based on GHG indicators for the transport and hospitality sectors and apply this framework to assessment and ranking based on climate change mitigation performance of 4 main EU geographical regions as tourism destinations: Central, Northern, Southern, and Western Europe. This paper's main methodological approach is comparing and ranking different geographical regions in the European Union by assessing their climate change mitigation performance as tourist destinations. The study's main results showed that Finland, representing North Europe, is the best-performing country in climate change mitigation in tourism destinations. The second-best-performing geographical region is Western Europe. The worst-performing EU region based on climate change mitigation in tourism destinations was Central Europe. The South Europe region was found to be in a slightly better position than Central Europe but worse in comparison with Western Europe and especially in comparison to Northern Europe. The study's main implications provide policy recommendations for Central Europe as a tourism destination to increase energy and water use efficiency and the carbon footprint of the tourism sector.

Key Words: Tourism, destination, climate change mitigation, indicators, assessment, EU regions

JEL Classification: Z38; Q58.

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1. Introduction

The ongoing expansion of tourism destinations and the concurring severe environmental and climate change impacts are characterizing the rapid expansion of the tourism sector (Yenidogan et al., 2021).

The main contributors to GHG emissions in the tourism industry are transport (Gyamfi et al., 2020), accommodation (Scot et al., 2010; Silva, 2022), as well as food services, including the production and consumption of edible products (Odimegwu & Francis, 2018). Besides, air travel, followed by car trips, is the largest source of carbon emissions (Gössling et al., 2015; Ben Youssef, Zeqiri, 2022). Moreover, climate changes are certainly affected by various activities of tourism, making an imperative need to adapt all tourism destinations to climate change, involving risk minimization or the capitalizing of new opportunities by reducing GHG emissions in transport, hospitality, construction, etc. (Scot et al., 2010).

From a normative and regulatory perspective, the World Travel and Tourism Council (WTTC) and the UNFCCC 2018 agreed to shape a common agenda to tackle climate change through climate actions undertaken by the travel and tourism sectors. In parallel, in 2020, the European Union European Green Deal strategy introduced a new industrial strategy in order to support the tourism development among EU-state members in a sustainable way (European Commission, Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs, 2022).

Several studies analyzed climate change mitigation options in the tourism sector (Gössling et al., 2015; Odimegwu, Francis, 2018; Zeqiri et al., 2020; Adedoyin, Bekun, 2020; Gyamfi et al., 2020; Ben et al., 2022); however, these studies do not include indicators frameworks to measure climate change mitigation performance and potential in tourism destinations.

During the last decade of relevant research, macroprudential measures have been applied in selected countries by testing their efficiency in tourism and reducing the revenue gap in the tourism sector during the pandemic crisis. It was confirmed a positive effect of systemically important institutions buffer (SIB) to reduce the losses in tourism. Besides, impulse response showed the significant impact of SIB on revenue gap (RG) reduction, enabling policymakers to promote appropriate measures for recovery policies and to maintain long-term economic stability. These outcomes are promising to guide the design of exclusive measures that support the tourism recovery and the environmental sustainability of the whole tourism industry (Biškupec et al, 2022).

In a similar study of tourism activities, rural tourism has proven to be a critical determinant in achieving regional and territorial sustainability. Considering the actual sanitary crisis caused by the COVID-19 pandemic and its horizontal impacts, especially impeding the tourism sector (Devkota et al., 2022; Tung & My, 2023), it is important to understand the perceptions of entrepreneurs of establishments related to tourism activities in highly attractive and mostly-visited destinations, as that of the Azores Region (Portugal) highlighting the role of the development of rural tourism and strategies for regional growth of the rural tourism during the pandemic measures. This empirical research was based on a survey of some multiple answer questions in order to disclose perceptions of business managers of the tourist sector regarding regional strategies for the rural tourism practice during and after the actual pandemic crisis (Castanho et al., 2021). Since business managers take an active role in the decision-making process (Ključnikov et al., 2022) and the management of enterprises, their perceptions are very crucial to understand business practices in detail (Civelek et al., 2023).

Based on the aforementioned literature overview, there is a clear gap in assessing the potential effects of the tourism and hospitality sectors on climate change, the contribution of tourism to climate change, and the climate change mitigation performance of tourism destinations.

This paper aims to overcome this gap and propose an indicators framework for analysis of climate change mitigation performance in tourism destination countries. It also conducts a case study on applying a developed framework on climate change mitigation performance of EU regions as tourism destinations.

The paper is structured as follows: in section 2, a literature review is focused on the areas of climate change mitigation in the tourism sector as well as the role of indicators in climate change studies; section 3 represents data and methods of the study; Section 4 provides a case study for a comparative climate change mitigation performance assessment of tourism destinations for EU regions and a discussion on case study results; Section 5 presents a solid and integrated argumentation on the research outcomes; finally, in section 6 the conclusions are presented.

2. Literature review

2.1 Tourism sector and climate change mitigation

The issue of global tourism as a determinant of GHG emissions has attracted scientific interest during the last 3 decades of analysis, mainly focusing on its role in global warming. For this, earlier studies were focused on providing an estimate of emissions from tourism in Northern Europe (such as in Sweden), accounting for 10% of Swedish GHG emissions at an accelerated pace. It was also recommended that governments consider the air travel and aviation industries as among the main contributors to climate policy in the tourism sector (Gössling and Hall, 2008). Indeed, a similar study showed tourist transport and air travel as certain contributors to GHG emissions. In this study, several policies were introduced during the period 2005-2009 towards GHG emissions reduction from domestic and international aviation (Pentelow and Scott, 2010). The authors employed a Jamaica-based case study revealing the role of a variety of marketable segments of tourism interest, such as tourism package vacations, to climate policy as well as oil prices that shape the final air travel costs and, subsequently, determining the economic criteria of tourist arrivals. The management of GHG emissions, especially in air and marine transport, can be directed to the implications for tourist mobility, including tour operator routing and tourism development risks, especially among developing countries with high tourism destination visits (Pentelow and Scott, 2010).

In an attempt to classify industries according to their environmental footprint and idiosyncrasy, Nguyen (2020) demonstrated two basic classifications of them: environmental friendly (F) and sensitive (S) industries. Following this classification, tourism, together with leisure, is characterized as environmental friendly. This author employed the Global Reporting Initiative (GRI) among the standards available, thusm the GRI framework was selected to carry out the research which was based on 97 German large listed firms each year within the research period from 2013 to 2017 with the structure of a 485-observation sample. It was shown that a strong attempt to comply to popular GRI guidelines in reporting sustainability performance does not necessary improve firm value in sensitive environmentally friendly industries (Nguyen, 2020).

In recent research, organizational, environmental, and managerial specifications play a protagonist role in reviewing the tourism sector under climate change mitigation goals (Rahimizhian & Irani, 2021). For this, the currently agreed-upon objective of global warming stability at 1.5°-2.0 °C has to be achieved. In this direction, the tourism sector, jointly with other sectors of national economies, needs to reduce emissions (Gössling et al., 2023). This precondition requires the industrial sector to half emissions by 2030, reaching net zero by mid-century. Therefore, it was shown that a priority focus should be directed on emission inventory comprehensiveness, shared responsibilities for decarbonization, and scheduling significant mitigation strategies. It is also remarkable that without mitigation efforts, tourism will deplete 40% of the remaining global carbon budget to 1.5 °C. However, it cannot be undermined that decarbonization measures have to overcome certain barriers on a political, technical, and corporate basis. Therefore, in the absence of policy efforts at national scales to moderate the sector's emissions, the tourism sector becomes one of the most challenging drivers of climate change (Gössling et al., 2023).

Tackling climate change risks in the tourism sector is determined by various socio-economic conditions, including poverty, poor communication and knowledge, low levels of institutional capacity, and insufficient support from government or tourism authorities. In this case of the tourism business, in a case study of Bali, through interviews, it was indicated the role of CSR in tourism industries can enhance the community's adaptive capacity to climate change; therefore, CSR programs can play a decisive role to address challenges of environmental, economic and social responsibility basis (Rahmawati et al., 2016, Androniceanu & Georgescu, 2023).

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State intervention is crucial in tackling climate change among developed economies. Among similar studies, a study that was focused on the efficacy of mitigation policy in the UK tourism sector disclosed that while policy evaluation is important, efficacy is a more urgent consideration. It is also critical that tourism businesses may be weakly reacting to recently state-issued mitigation policies, implying a less ambitious contribution of state policies and not acknowledging the specifications and the business dynamics in the tourism sector. Therefore, future policies can be directed to issues of practical facilitation, thus making the business case for change clear and transparent (Coles et al., 2013).

In an early last decade study, to understand how the tourism sector understands the decarbonization challenge and the GHG emission reduction settings by the Paris Climate Agreement in specific timeframes, 17 senior tourism leaders were interviewed regarding the role of perspectives, risks, opportunities, and actions associated with climate change (Gössling and Scott, 2018). Respondents' attitudes are that -due to human activities in the tourism sector- the climate is changing. For this, the roles of society and tourism are largely negative and regionally devastating. The Paris Climate Agreement's decarbonization goals should be viewed in alignment with leaders' perspectives in terms of "belief systems" that interpret information in decision-making and forms of angiogenesis (this is defined as the fabrication of uncertainty to justify non-action). Therefore, belief systems and angiogenesis are important barriers to progressing tourism decarbonization and transition to a global low-carbon era (Gössling and Scott, 2018).

At this point, it is important to present an inventory, follow-up, and study for 2005, giving the tourism-related CO_2 emission caused by global tourism, presenting a 30-year projection and 45-year simulation techniques of CO_2 emission reductions of up to 70% by 2050 with respect to 2005. Based on the underlying model and the development of 70 scenarios in a "landscape" graph, the effect of opportunities to reduce GHG emissions was investigated, but such an approach did not conclude that the targeted large GHG emissions decreased. This study prioritized to offer insights into those structural changes required in tourism transport, especially targeting high levels of emission reduction needed. However, the model can be attributed to "complex" behavior (at least at the time of publication, almost 2 decades ago) (Peeters, Dubois, 2010).

2.2 Climate change and environmental-based indicators

Among the most credible and measurable tools for quantifying environmental, including climate change, data from the tourism sector are the sustainability indicators. In the earlier times of developing these types of indicators, there were no distinct optimum sets of sustainable development indicators for tourism sector sustainability monitoring (Manning, 1999). However, currently, a more mature literature production has emerged, revealing key indicator themes in sustainable tourism development topics. Placing this evolution of indicators in chronological order is indicated in the study of Lanquar (2016), who investigated tourism in coastal urbanized areas. This type of tourism is interlinked with various kinds of leisure and cultural undertakings while facing climate change consequences and the concurring effects of unpredictable phenomena like rising sea levels and extreme weather accidents. In this case, the literature identified indicators for sustainability assessment of coastal tourism in urbanized areas linked to environmental, economic, social, and ethical issues. Subsequently, establishing a system of indicators can support local authorities and urban planning institutions in decision-making, also guiding future studies analyzing new smart tourism development concepts and models.

In an attempt at a more systematic investigation of climate change indicators at specific geographical areas where severe climate change mitigation is reported by Nelsen and Lumbsch (2020), who examined indicators for climate change mitigation in Central European countries, following a data-driven approach of lichens evaluation. Indeed, it is well known that lichens can be widely accepted indicators of forest health, and climate change, therefore the lichen species were chosen as climate change indicators in Central Europe. It is noteworthy to stress that today, fewer than half of the indicators available have sufficient data for evaluating climate change indicators (Nelsen and Lumbsch, 2020). Authors (Nelsen and Lumbsch, 2020) illustrated that most lichen climate change indicators can't be strong positive indicators of climate change, and other quantitative-based climate change indicators are necessary to credibly detect and measure the climate change phenomenon.

The multi-parametric nature of tourism sector indicators has been comprehensively disclosed by Agyeiwaah et al. (2017), and Matijová et al., (2023) who highlighted the following dimensions of sustainable tourism: economic, environmental, social, and cultural. The sustainability of tourism industry has been also associated with society and environment by other researchers as well (Vavrova, 2022). These dimensions include more than 40 themes for sustainability assessment of the tourism sector. Nonetheless, these indicators were developed for different countries and by different scholars. Therefore, this system of indicators can be used as a starting point for a sustainable tourism indicators framework in a particular country, as they should be modified to provide a credible assessment of priorities in sustainable tourism development for a particular country. There are several indicators for sustainable tourism monitoring by assessing the current status, goals, and evaluation progress in achieving SDGs (Agyeiwaah et al., 2017; Streimikiene, 2023). Similarly, Rasoolimanesh et al. (2020) evaluated 97 studies in terms of providing credible indicators directed to SDG and found that tourism business viability and new jobs created by tourism are credible economic indicators of quantifying the sustainability of the tourism sector (Butler, 1999; Swarbrooke, 1999).

Other noticeable types of indicators are greenhouse gas (GHG) indicators of theoretical value and practical resolving utility. Among these GHG-based studies are that of Guinée et al. (2009) and Adeyeye et al. (2023). In particular, Guinée et al. (2009) argued that ambitious policy targets have been adopted by industrialized countries while financial measures should be undertaken to encourage bioenergy generation and use. However, the research focus can also be on side effects and associated risks. To reach a knowledgeable policy decision, the Dutch authorities included sustainability criteria in relevant policy instruments. For this, carbon dioxide emissions were included in the geochemical carbon cycle. In solving the multifunctional problem, among other criteria, it was proposed to apply the life-cycle-based GHG emissions of bio-based fuel and fossil-based fuel-based supply chains. Life-cycle-based biofuel studies allow us to evaluate the biogenic carbon balances and treatment and recycling of coproducts (Guinée et al., 2009). An optimum treatment of carbon cycles refers to a genuine cycles overview at the systems level and, then, subtracting the fixation of CO_2 during tree growth from the emitted carbon dioxide in the wood waste recycling step to quantify the emitted methane (Guinée et al., 2009).

On the other hand, the GHG indicator provides room for subsidies to boost bioenergy usage, but no guidelines are drawn on handling biogenic carbon dioxide. Therefore, exploring whether the current GHG indicator can provide robust results to grant such subsidies following guidelines for LCA and GHG assessment of bioenergy systems (Guinée et al., 2009). Therefore, when employing GHG indicators, provisions have to be taken to confirm the robustness and provide a sound basis for granting subsidies (Guinée et al., 2009).

A recent GHG indicator-based study was employed for carbon footprint assessment focused on the GHG emission benchmark model in a Nigerian University (Adeyeye et al., 2023). The problem setting of such a study was the gap in carbon accounting and the lack of activity data for African countries. Studies showed that more efforts to fight global warming could be directed to higher institution activities for reduction emission campaigns and renewable alternative energy shifts (Adeyeye et al., 2023).

Another type of indicator that has been introduced recently is the tool of decarbonization indicators being coupled with relevant decarbonization technologies. In this context, Fikru and Kilinc-Ata (2024) examined the three decarbonization indicators: energy efficiency, the carbon footprint of energy, and renewable generation. The results modeling results for panel data of 33 countries showed that the role of imports is to increase energy efficiency, reduce energy carbon footprint, and foster renewable energy generation. These results also proposed the paramount role of cleaner vehicles: electrification, electricity use, and urbanization, thus indirectly related to climate change mitigation policies. Generalizing these findings, it is noteworthy that these outcomes are useful to the operation of wider manufacturing and industrial sectors, especially in developing strategies to ensure the resilience of the supply chain, especially for minerals necessary for decarbonization technologies (thus affecting the climate change mitigation policies and measures) (Fikru and Kilinc-Ata, 2024).

Closing this literature review of the compilation of indicators for climate change mitigation assessment in tourism, it is necessary to highlight that all types of sustainability and climate change indicators reviewed encounter many problems, especially linked to comparable data availability for countries or regions. In the EU, the European Tourism Indicator System (ETIS) was founded to develop sustainable tourism development indicators due to the lack of national statistics on tourism in EU member states (European Commission, 2013).

3. Methods and data

The main approach followed by this study is to compare and rank different geographical regions in the European Union by assessing their climate change mitigation performance as tourist destinations. The analysis is based on various indicators that measure climate-responsible tourism development. The main indicators used to assess the climate change mitigation performance of tourism destinations were selected from the Cornell Hotel Sustainability Benchmarking Index (CHSB) database (Cornell University, 2022), which includes carbon, energy, and water footprint indicators for hotels and EU Tourism Dashboard (European Commission, 2024).

CHSB is a global data initiative that started in 2013 to enable hotels to assess their carbon footprint and energy and water consumption benchmarks at a low cost. The database has over 25,000 hotels worldwide, includes major hotel brands and operators from 64 countries, and presents data for 2021. The other data important for climate change mitigation in tourism destinations are linked to the transport sector, like air travel carbon intensity, energy, and carbon intensity of tourism per value-added, which were selected from EU Tourism Dashboard indicators of the environmental impact of tourism destinations (European Commission, 2024). The EU Tourism Dashboard was settled with the help of the Joint Research Centre and offered in 2021. It is organized under three policy pillars: "environmental impacts," "digitalization," and 'socio-economic vulnerability" (Androniceanu et al., 2023). The "environmental impacts" indicators cover air travel intensity, tourism GHG intensity, tourism energy intensity, the share of trips by train and excellent bathing water.

The climate change mitigation performance indicators framework of tourism destinations for EU member states is provided in Table 1.

Table 1. **Climate change mitigation performance indicators of tourism destinations for EU regions**

Indicators	Measures	Description	Source
Air travel emission intensity	kg of CO_2/passenger	This calculation involves dividing the total CO_2 emissions produced by all passenger flights in a selected tourism destination country by the number of passengers who travelled within a year. This method takes into account both residents flying to a tourist destination and tourists returning home.	European Commission, 2023

Tourism GHG intensity	kg/million EUR	The calculation involves dividing all greenhouse gas emissions, including CO_2, N_2O, CH_4, HFC, PFC, SF_6, and NF_3, generated by tourism-related activities by the gross value added of the tourism sector in the selected tourism destination country.	European Commission, 2023
Tourism energy intensity	TJ/Million EUR	Indicator was calculated by dividing the energy used in tourism-related economic activities by Gross Value Added of the tourism sector in the selected tourism destination country	European Commission, 2023
Average hotel carbon footprint per occupied room	$kgCO_{2e}$	The carbon footprint of a hotel is calculated by dividing the total carbon footprint for the calendar year by the number of rooms occupied during this period. Then average is calculated for all hotels within the country of tourism destination based on the carbon footprints	Cornell University, 2022
Average hotel energy usage per occupied room	kWh	The energy usage of a hotel for a given year is calculated by dividing the total energy usage by the number of occupied rooms during the same year. Then average is calculated for all hotels in the tourism destination country.	Cornell University, 2022
Average hotel water usage per occupied room	litres	To calculate the water usage per occupied room in a hotel for a specific calendar year, it is necessary to divide the total water usage of the hotel for that year by the number of rooms occupied during the same period. The resulting average is calculated for all hotels in tourism destination country.	Cornell University, 2022
Hotel energy from RES	%	Percentage of total energy used in hotel that is generated from renewable energy sources.	Cornell University, 2022

Source: (European Commission, 2024; Cornell University, 2022)

4. Case study: assessment of climate change mitigation in tourism destinations of EU regions

For a case study on climate change mitigation performance of tourism destinations in main EU geographical regions, the following four regions and countries were selected based on available data in Cornell Hotel Sustainability Benchmarking Index (CHSB) database (Cornell University, 2022):

- Central European region (Poland, Hungary, Czech Republic and Romania);
- Western European region (Netherlands, Austria, Belgium, Germany and France);
- South European Region (Greece, Portugal, Italy, Spain) and
- North European region represented in CHSB) the database just by Finland.

The climate change mitigation performance indicators for tourism destinations for EU regions in 2021 are provided in Tables 2-5. The average for the region is also calculated.

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Table 2. **Climate change mitigation indicators of the tourism destinations of Central European countries in 2021**

Countries	Poland	Hungary	Czech Republic	Romania	Average
Air travel emission intensity, kg of CO_2/passenger	89.5	92.5	98.7	89.5	92.6
Tourism GHG intensity, kg/million EUR	160.0	85.0	51.0	87.0	95.8
Tourism energy intensity, TJ/Million EUR	3.7	4.6	3.7	1.4	3.4
Average hotel carbon footprint per occupied room, $kgCO_{2e}$	35.8	22.0	31.8	25.5	28.8
Average hotel energy usage per occupied room, kWh	73.0	97.0	89.6	96.0	88.9
Average hotel water usage per occupied room, litters	343.5	559.1	420.1	496.4	454.8
Hotel energy from RES, %	0	0	0	0	0

Source: (European Commission, 2024; Cornell University, 2022)

As shown in Table 2, hotels in Central European countries do not use renewable energy sources and use extensively energy and water resources, but air travel GHG emissions are not significant. The highest tourism GHG intensity per GDP is in Poland, as the country distinguishes itself with a high carbon intensity of energy due to the high share of local fossil fuels, i.e., coal, in the energy mix. However, Poland has the lowest average energy and water consumption per occupied hotel room. Nevertheless, Polish hotels have the highest carbon footprint per occupied room among other Central European countries because of the high share of carbon-intensive fuel in the energy mix. At the same time, due to the high share of renewables in the energy mix, the Czech Republic has the lowest tourism GHG intensity.

Table 3. **Climate change mitigation indicator of tourism destinations of Western European countries in 2021**

Indicators	Netherlands	Austria	Belgium	Germany	France	Average
Air travel emission intensity, kg of CO2/passenger	239.7	110.8	227.3	172.8	191.8	188.5
Tourism GHG intensity, kg/million EUR	119.0	47.0	156.0	62.0	77.0	92.2
Tourism energy intensity, TJ/Million EUR	3.2	1.6	4.0	2.1	2.8	2.7
Average hotel carbon footprint per occupied room, kgCO2e	21.2	11.9	11.6	18.2	7.5	14.1
Average hotel energy usage per occupied room, kWh	70.5	68.2	62.7	64.0	70.9	67.3
Average hotel water usage per occupied room, litters	337.6	475.3	306.5	324.1	389.8	366.7
Hotel energy from RES, %	1.5	0	0.8	1.9	0.1	0.86

Source: (European Commission, 2024; Cornell University, 2022)

Information presented in Table 3 shows that Western European countries have the highest air travel GHG emission intensity (almost twice higher as Central European countries) and lower average hotel carbon footprint as well the lower energy and water consumption per occupied room in hotels showing more energy and water saving practices implemented in hotels of these countries. In this region, due to a better economic situation, new technologies like renewable energy microgeneration are implemented on a larger scale compared to other European regions. Austria showed the lowest carbon intensity of tourism due to the lowest energy intensity of tourism compared to other countries in Western Europe. The average energy use per occupied room was the lowest in Germany and highest in France, and the lowest water consumption per occupied room in a hotel was in Belgium and highest in Austria.

Table 4. **Climate change mitigation indicator of tourism destinations of Southern European countries in 2021**

Indicators	Greece	Portugal	Italy	Spain	Average
Air travel emission intensity, kg of CO2/passenger	84.5	129.7	112.6	129.7	114.1
Tourism GHG intensity, kg/million EUR	12.0	44.0	70.0	53.0	44.8
Tourism energy intensity, TJ/Million EUR	0.8	7.6	2.8	1.6	3.2
Average hotel carbon footprint per occupied room, kgCO2e	42.8	27.2	23.9	16.3	27.6
Average hotel energy usage per occupied room, kWh	110.1	92.1	92.0	64.5	89.7
Average hotel water usage per occupied room, litters	584.3	756.8	685.9	472.2	624.8
Hotel energy from RES, %	0	0	1.2	1.0	0.6

Source: (European Commission, 2024; Cornell University, 2022)

Data for Southern Europe provided in the table above shows that South European countries have a high average carbon footprint, energy, and water consumption per occupied hotel room compared especially to Western countries, showing that resource savings are a lower priority for hotels in Southern Europe. Renewable energy usage in hotels is also very limited compared to Western Europe, and this is mainly due to the worse economic situation of South European countries not allowing for fast penetration of new energy-saving and clean technologies. Greece has the lowest GHG intensity of tourism due to the very low energy intensity of tourism compared to other countries in the region. However, Greece has the highest average hotel carbon footprint and energy consumption per occupied room. Spain has the lowest average hotel carbon footprint and energy and water consumption per occupied room. In addition, the share of renewable energy consumption is the highest in Spanish hotels, showing advanced resource-saving practices followed by Spanish hotels in contrast to Portugal and Italy.

Table 5. **Climate change mitigation indicator of tourism destinations of Northern European countries in 2021**

Indicators	Finland	Average
Air travel emission intensity, kg of CO2/passenger	124.4	124.4
Tourism GHG intensity, kg/million EUR	59.0	59.0
Tourism energy intensity, TJ/Million EUR	2.0	2.0
Average hotel carbon footprint per occupied room, kgCO2e	11.1	11.1
Average hotel energy usage per occupied room, kWh	76.3	76.3

Average hotel water usage per occupied room, litters	323.6	323.6
Hotel energy from RES, %	3.1	3.1

Source: (European Commission, 2024; Cornell University, 2022)

The data for climate change mitigation performance in Finland, the only representative country, shows the high share of renewable energy technologies used in hotels in comparison with other regions which have better geographical locations to use renewables such as solar power plants. The low carbon footprint, energy, and water consumption per occupied room in Finland shows that hotels are keen to save resources and implement relevant technologies and resource-saving measures in their properties.

Table 6 summarizes the results of the rankings of European Union regions based on climate change mitigation indicators of tourism destinations.

Table 6. **Summarized ranking results of EU regions' tourist destinations in 2021**

Indicators	Northern Europe		Central Europe		Western Europe		Southern Europe	
	Average Values	Ranking	Average Values	Ranking	Average Values	Ranking	Average Values	Ranking
Average hotel carbon footprint per occupied room, kgCO2e	11.1	1	28.8	4	14.1	2	27.6	3
Average hotel water usage per occupied room, litters	323.6	1	454.8	3	366.7	2	624.8	4
Hotel energy from RES, %	3.1	1	0	4	0.86	2	0.6	3
Tourism energy intensity, GJ/Million EUR	2.0	1	3.4	4	2.7	2	3.2	3
Average hotel energy usage per occupied room, kWh	76.3	2	88.9	3	67.3	1	89.7	4
Tourism GHG intensity, kg/million EUR	59.0	2	95.8	4	92.2	3	44.8	1
Air travel emission intensity, kg of CO2/passenger	124.4	3	92.6	1	188.5	4	114.1	2
Total sum/ final ranking	11/1		23/4		16/2		20/3	

Source: own results

Results presented in Table 6 are ordered on the ranking 1 up to 3 of the 1st region: Northern Europe and, then, following the alphabetical name of the Indicators A-Z. Results presented in Table 6 show that the best-performing country in terms of climate change mitigation in tourism destinations is

Finland, representing North Europe following the Western Europe region consisting of five states (Netherlands, Austria, Belgium, Germany, and France) in the current study. The worst-performing EU region based on climate change mitigation in tourism destinations was Central. European. In this study, Central Europe was addressed by four states (Poland, Hungary, Czech Republic, and Romania). The South Europe region, represented by four countries (Greece, Portugal, Italy, and Spain), was found to be in a slightly better position than Central Europe but worse in comparison with Western Europe and especially in comparison to Northern Europe.

5. Discussion

Tackling climate change and ensuring Paris agreements to be met make countries to look for alternative ways of production, consumption, disposal of wastes, promisingly adopting the circular economy principles. In this context renewable energy, as a part of the circular economy, can further contribute to climate change mitigation and to sustainable development. Among other tools and policies the efficient implementation of circular economy and the adoption of renewable energy practices can ensure that sustainable development goals are realistic and implementable. Subsequently, EU programs and renewable energy strategies can support countries to move towards clean energy and to ensure efficient implementation of SDGs (Jakubelskas and Skvarciany, 2023).

Within the last decade of research production there is a blossom of studies related to climate change affiliation with tourism industry (Hadi et al., 2023, AL-Jawahry et al., 2022, Gusakov et al., 2020, Dumitru et al., 2016). From an international perspective it is noteworthy that as an outcome of a global consensus on combating climate change, two financial-based tools have been, almost simultaneously, literature-reported: green finance (Zheng et al., 2023) and climate finance (Lyeonov et al., 2023). Green finance is anticipated to play a protagonistic role in promoting green growth and innovation progress. Such green growth strategies have also stimulated sustainability of tourism industry (Chang et al., 2022). Sparse studies denote that green credit policy yields a negative influence on green innovation, while how green finance affects renewable energy innovation has received scant academic/research attention (Zheng et al., 2023). This study focuses on the impact of green finance on renewable energy innovation, considering that green finance varies for different kinds of energy types and economic development levels. Given that policies are key to renewable energy technology development, researches have to be prioritized in checking whether government stability changes the relationship companion between green finance and renewable energy innovation (Zheng et al., 2023).

Similarly, climate finance is originated from the fact that the largest recipients of international climate assistance are countries with significant corruption in the public sector made necessary the probabilistic assessment of corruption consequences in climate finance on achieving zero emissions (Lyeonov et al., 2023). This study adopted the methods of survival analysis, such as the Kaplan-Meier approach and the Cox proportional hazards regression model, through investigating 114 countries that received international climate assistance during 2005-2021. The empirical analysis demonstrated that the most probable time frame for achieving 5% reduction in GHGs is five years. Moreover, the response of climate finance to reducing GHGs is faster in countries with medium levels of corruption than in countries with high and very high levels of corruption (Lyeonov et al., 2023).

Based on the research outcomes, the following remarks and conclusions have been derived.

Western European countries have the highest air travel GHG emission intensity (almost twice as high as Central European countries) and lower average hotel carbon footprint as well as lower energy and water consumption per occupied room in hotels, showing more energy and water saving practices implemented in hotels of these countries. In this region, due to a better economic situation, new technologies like renewable energy microgeneration are implemented on a larger scale compared to other European regions where renewable energy is not used in hotels.

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South European countries have a high average carbon footprint, energy, and water consumption per occupied hotel room compared to Western countries, showing that resource savings are a lower priority for hotels in Southern Europe. Renewable energy usage in hotels is also very limited compared to Western Europe, and this is mainly due to the worse economic situation of South European countries not allowing for fast penetration of new energy-saving and clean technologies like in Western or Northern European countries.

Finland, representing North Europe, shows a high share of renewable energy technologies used in hotels in comparison with other regions that have better geographical locations to use renewables like PV panels. The low hotel carbon footprint, energy, and water consumption per occupied room in Finland show that hotels in Northern Europe are keen to save resources and implement advanced clean technologies and resource-saving measures in their properties.

The research outcomes of our study are consistent with similar studies that signified the long-term attractiveness of the recreational and tourist contexts and its investment level in the market of recreation, entertainment, and sports (Pacana et al., 2023, Shpak et al., 2022). In this context the impact of the investment component on the development of the Recreational and Tourist Industry (RTI), and to perform a comprehensive analysis in order to elaborate a strategic development plan for the tourism sector support authorities of different levels to formulate a rational policy for the development of the tourism industry (Shpak et al., 2022).

Such conscious policies of tourism industry development have to consider that the turbulent environment and the following climate change are intensifying qualitative-environmental actions, which can be perceived differently by enterprises and customers. Therefore, research and policies are targeted to approach qualitative-environmental aspects of product improvement among SMEs and customers from the V4 countries. Such trends and relationships enable the formulation of quality and environmental rules for these enterprises. Indeed, SMEs in the V4 countries can establish new activities that will allow product quality management consistently with current customer expectations, being also environmentally friendly. Furthermore, other types of companies can follow such managerial tools in order to continuously improve the quality of products according to the principles of sustainable development (Pacana et al., 2023).

6. Conclusion

Tourism has a significant effect on climate change due to the transport and hospitality sectors. There are no widely accepted indicator frameworks to measure the climate change mitigation performance of tourism destinations and compare countries or regions based on climate change mitigation performance in the tourism sector, mainly due to the lack of comparable data.

The conducted pilot study on climate change mitigation performance in tourism destinations of EU geographical regions used indicators framework from different databases to measure carbon and energy intensities of transport, hospitality, and other sectors of tourism destinations.

The case study on climate change mitigation performance of tourism destinations includes the following EU geographical regions: Central European region (Poland, Hungary, Czech Republic, and Romania); Western European region (Netherlands, Austria, Belgium, Germany, and France); South European Region (Greece, Portugal, Italy, Spain) and North European region represented in CHSB) the database just by Finland.

The results showed that the best-performing country in terms of climate change mitigation in tourism destinations is Finland, representing North Europe. The second-best-performing geographical region is Western Europe. The worst-performing EU region based on climate change mitigation in tourism destinations was Central Europe. The South Europe region was found to be in a slightly better position than Central Europe but worse in comparison with Western Europe and especially in comparison to Northern Europe.

Hotels in Central Europe are distinguished in the extensive use of energy and water resources and high carbon footprint per occupied room. Also, Central European countries have a high energy intensity and GHG intensity per GDP in the tourism sector.

The conducted research has several limitations. A deeper analysis of the climate change mitigation policies in the transport and hospitality sectors of tourism destinations in EU regions is necessary to define the reasons for such differences in climate change mitigation performance of tourism destinations of EU regions.

The audience interested in this research is academia and policymakers working in the field of tourism and scholars researching climate change mitigation performance indicators and their applications in various sectors, including tourism.

Therefore, future research for assessing the climate change mitigation performance of tourism destinations in EU regions will include the missing information on climate change mitigation policies and policy analysis, which are necessary for a better interpretation of the research results and findings of this study on climate change mitigation performance in tourism destinations of European geographical regions.

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