Article

Assessment of Carbon-Related Scenarios for Tourism Development in the Island of Lefkada in Greece

Niovi Soldatou, Pinelopi Chatzianastasiadou and Dimitra G. Vagiona *

Department of Spatial Planning and Development, Aristotle University of Thessaloniki, 54124 Thessaloniki, Greece; niosoldatou@hotmail.com (N.S.); chatzianastasiadou.96@gmail.com (P.C.)

* Correspondence: dimvag@plandevel.auth.gr; Tel.: +30-2310-995954

Abstract: To address the adverse impact of climate change, the concept of low-carbon tourism has recently been developed, which promotes a new way of travelling to obtain higher value and travel experience for tourists as well as more social, economic, and environmental benefits for society by reducing carbon emissions caused by tourists' activities. The present study proposes and applies a methodological approach to assess various carbon-related scenarios for tourism development on the island of Lefkada, Greece. The methodology includes two phases: the diagnosis and the assessment phase. The diagnosis phase includes four distinct steps: (i) SWOT analysis, (ii) STEEP analysis, (iii) identification of driving forces (DF) and (iv) formulation of four tourism development scenarios based on two axes of uncertainty. The assessment phase includes: (i) a pairwise comparison of DF and (ii) selection of the preferred tourism development scenario. A combination of two multicriteria analyses, namely the Analytical Hierarchy Process (AHP) and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), is implemented to rank the four tourism development scenarios. The two most essential driving forces for defining the priority order of the tourism development scenario are National Policies—Green Development and Local Community Awareness. The scenario that promotes low-carbon tourism is the preferred scenario for the study area. The presented research results could provide a reference for relevant tourism development in the study area and the proposed methodology can be applied in all tourism destinations.

1. Introduction

Nowadays, mankind faces a huge environmental crisis. Climate change, in conjunction with the problems it brings to the planet, is the one of the utmost priorities of world politics. The ever-increasing concentrations of greenhouse gases, mainly due to anthropogenic activities, cause adverse implications both for the environment and people. Future forecasts are becoming even more disappointing. Therefore, addressing the negative impacts of climate change as well as the mitigation of greenhouse gas emissions and adaptation of production sectors to climate change should be an immediate priority.

According to the World Tourism Organization, tourism has experienced continued growth and diversification to become one of the fastest-growing sectors of the world economy over the last six decades [1]. However, tourism is considered, and provably so, to be an activity that is closely related to both the environment and climate, and so it is characterised as a climate-sensitive economy sector [2]. The exponential growth of tourism, in addition to growing tourist demand, is responsible for problems such as increasing carbon emissions, depletion of natural resources and the continuous decay of the environment [3].

The World Tourism Organization (2019) reported that, in 2005, the tourism sector contributed 5% to global CO_2 emissions. These emissions derive mainly from the transportation sector, which produced 75% of all tourism industry emissions [4]. According to

estimates, the further development of this sector could lead to an increase in CO_2 emissions by 152% in 2035. More precisely, it has been estimated that, by 2035, the tourism industry's emissions are expected to double compared to 2005, with the tourism sector being the 5th most important cause of pollution worldwide [3].

In response, the development of low-carbon emissions has been adopted, which has as a priority the promotion of carbon removal from the tourism industry as well as continuous and sustainable tourism development. In this context, the theory of low-carbon tourism (LCT) was formulated. Low-carbon tourism has lately become popular as an alternative tourism model for travellers who want to help mitigate climate change by providing a high-quality travel experience while also contributing to a low-carbon economy [5].

The official proposal for the implementation of the concept of low-carbon tourism was articulated in May 2009 at the World Economic Forum, entitled 'Go to Low-Carbon Travel and Tourism Industry'. The concept was the first concrete step by the tourism industry towards sustainable development [6].

Low-carbon tourism is an emerging issue and is associated with the term 'low carbon' [7]. This type of tourism is based on the economy of low-carbon emissions [8] and is often referred to as a measure of carbon mitigation in the tourism sector [9]. It concerns a new way of calculating sustainable development, with socio-economic and environmental benefits. What is also important is the concept's promotion of lower carbon emissions to the tourist public. It is a modern tourist trend, which contributes not only to a change in lifestyle but also to a change in the behaviour of people (both tourists and the local/tourist community. Taking into consideration that LCT is a new concept, a standard definition has not yet been given [9].

Even though there is no unique definition of LCT, the basic idea is that energy consumption and CO_2 emissions from tourism activities, products and services are minimised. Tourism carbon emissions can be separated into two categories: direct and indirect. Direct emissions include transportation, accommodation, restaurants and other tourist activities. On the other hand, indirect emissions include the construction of infrastructure related to the tourism sector as well as the production and transfer of energy. Although indirect emissions play an important role in the tourism sector, they are negligible in calculating the carbon footprint of tourism [5].

The purpose of the present study is the creation of different scenarios concerning tourism development based on carbon emissions and the selection of the optimal scenario based on specific driving forces. More specifically, a methodological approach is developed and applied to assess different scenarios related to the carbon emissions intensity of tourism development in Lefkada. The methodology is divided into two phases. The diagnosis phase includes the following four steps: (i) SWOT analysis, (ii) STEEP analysis, (iii) identification of driving forces and (iv) formulation of four tourism development scenarios based on two axes of uncertainty. The assessment phase includes: (i) pairwise comparisons of driving forces and (ii) selection of the preferred tourism development scenario. SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis is used for the diagnosis of the study area, and STEEP (Sociological, Technological, Economic, Environmental, and Political) analysis is performed to identify the appropriate driving forces from which to assess the proposed tourism development scenarios. Two multicriteria analyses methods, the Analytical Hierarchy Process (AHP) and the Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), are performed to define the most preferred tourism development scenario.

The rest of the paper is structured as follows: Section 2 examines the relevant literature of low-carbon tourism, Section 3 presents the proposed methodological approach as well as the relevant tools and techniques applied, and Section 4 presents the results. Section 5 concludes with useful remarks and suggestions for future research.

2. Low-Carbon Tourism in Destinations: A Rigorous Literature Review

The concept of low-carbon tourism has been growing in recent years in various regions around the world. A typical example is Copenhagen, where significant steps have been

taken in order to deploy, until 2025, a low-carbon city utilising abundant wind energy. According to [10], Copenhagen has a strong overall implementation track record, both in terms of energy supply adjustments and emission reductions, as Copenhagen exceeded its 2015 objective and is on track to meet its 2025 carbon neutrality goal. Similar shorter-range actions have been undertaken in Thailand and Indonesia, where low-carbon hotels have been built. Nitisoravut et al. [11] developed guidelines for low-carbon hotels in Koh Chang and its neighbouring islands (Thailand) based on those key elements, as well as excellent practices that indicate low carbon emissions within hotel operations and management, such as corporate commitment to sustainability, energy management, water and waste management, and CO_2 emissions to the environment in the tourism industry. Mbulu and Gunadi [12] revealed in their study that Aston Hotel & Resort Bogor in Indonesia, have implemented the Ministry of Tourism of the Republic of Indonesia's Green Hotel policy. Apart from the low-carbon hotels, there are several scientific museums that promote lower carbon emissions. One typical example is the Science Museum in California, whose roof is covered with domestic ecological plants, making it 70% more environmentally friendly than average [8]. The roof does not have an exclusively decorative role but greatly reduces the energy consumption of air conditioning. In China, this new ecological shift in the tourism sector is at the centre of interest, as evidenced by the organisation of the World Expo which took place in Shanghai in 2010. For many industries in China, including tourism, tackling climate and environmental change by promoting energy conservation and emission reduction has always been a mid- and long-term challenge [13,14]. In this context, a series of initiatives were formulated that would provide solutions to the issue of reducing carbon emissions and in which measures for carbon offset were planned. Finally, a chain of hotels in the Hangzhou area began the implementation of a new, innovative project called 'Low-Carbon Rewards Program' [8].

However, the studies that have investigated low-carbon tourism are only a handful. Peeters and Dubois [14] found that tourists are the main component of global carbon emissions (4.4%), while the main sector of these emissions production is transportation (72%). They report that climate change is expected to increase by more than 3% per year according to the current tourism development. Consequently, they promoted sustainable low-carbon tourism by reducing the carbon footprint of transportation. Can and Hongbing's study [8] established the development of the low-carbon tourism model, based on the low-carbon economy. The research focused on the development of this kind of tourism for China, as it is a country where low-carbon tourism shows small growing signs. The research results indicated that the most important issue for the development of low-carbon tourism is to make it clear to tourists that this type of tourism is a positive and, at the same time, responsible way to travel [8]. According to Changbo and Jingjing [15], low-carbon tourism development is a complex process, which demands the contribution of tourism operators, travel agents and tourists. Thus, they attempt to depict the current state of China's tourist attractions, with the creation of low-carbon standard attractions as the main purpose. More specifically, it is proposed that they strengthen the rational management of tourist attractions, green tourists' education and awareness and effective green technology [15]. Alam and Nageh [16] investigated the possibility of applying low-carbon tourism in the Egyptian coastal areas, through which the main target specifies the tourists' profile. The study results revealed high levels of awareness among tourists of low-carbon tourism. Nevertheless, the development of environmentally friendly policies, such as alternative methods of transportation and the promotion of low-carbon practices, etc. constitutes the main proposal for achieving the sustainable development of Egyptian coastal areas with low carbon emissions. Pongthanaisawan et al. [17], focused their study on the design of scenarios that are related to the implementation of low-carbon tourism for the case of Nan province. The research concluded that mass tourism development is the main cause of the production of atmospheric carbon emissions. At the same time, it is pointed out that the new generation's participation is a main component in the implementation of

low-carbon tourism for this specific region. However, a set of indicators is proposed in order to continuously monitor and evaluate the implementation of low-carbon tourism.

Zhang and Zhang [18] attempted to implement a model for the evaluation of urban tourist areas (Tourism-Based Urban Destinations, TBUDs). The study focuses exclusively on urban tourism and emphasises the importance of carbon emissions from the hospitality industry. Also, it proposes dissemination of the low-carbon tourism idea to the tourist actors and relevant training to contribute to the establishment of this specific tourism model, which focuses on the implementation of new political legislation that will reflect and promote its development [18].

3. Materials and Methods

3.1. Study Area

The present paper considers Lefkada, a part of the Heptanese cluster of Ionian Islands, as a case study. It forms a complex of islands together with Kastos and Kalamos constituting the municipality of Lefkada (Figure 1).
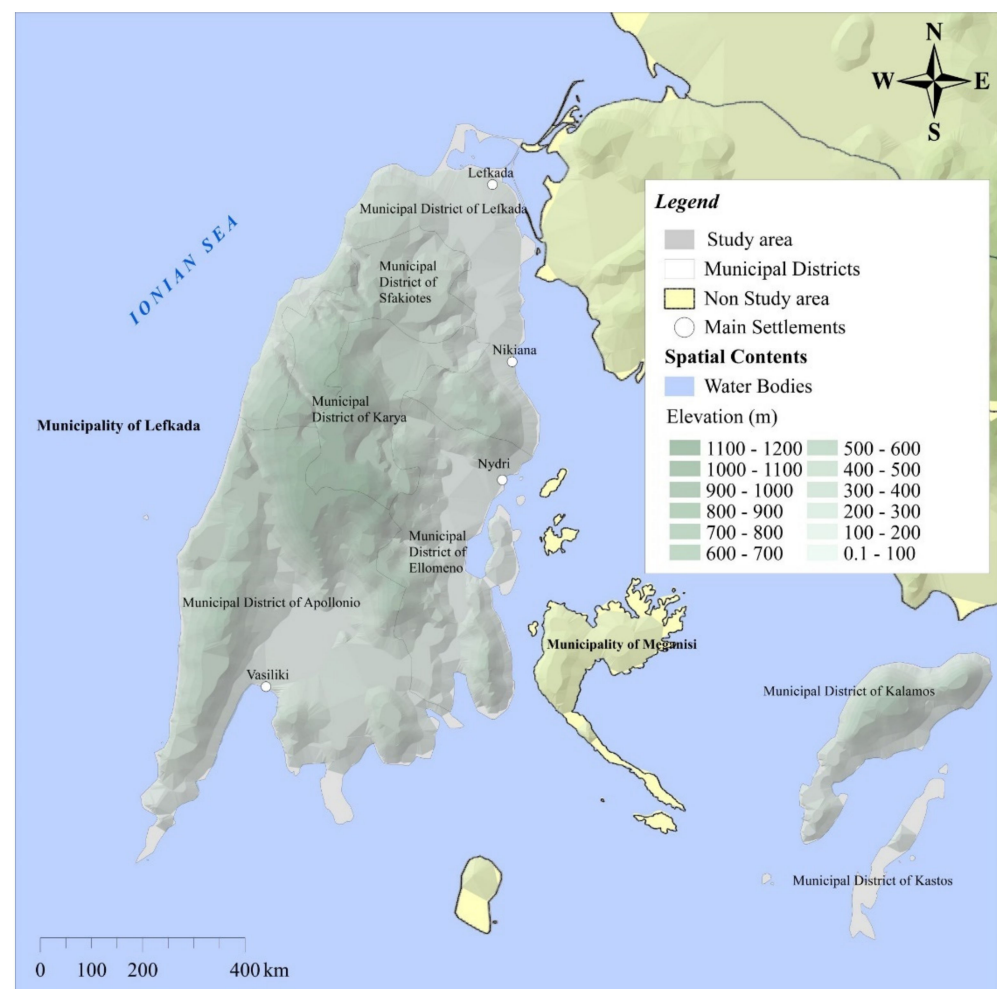
Figure 1. Study area of the present study.

Lefkada island is famous for its complex geographical relief. Its landscape diversity and easy accessibility contribute to the increasing development of tourism there. The island is endowed with valuable natural resources (biodiversity, mountainous parts, brilliant landscapes, caves, etc.). Certain parts of the island (both land and sea areas) are protected under Natura 2000. Additionally, many cultural resources such as archaeological and historical places, local traditions, architecture, and traditional settlements exist on the island (Figure 2).

(**a**) (**b**)

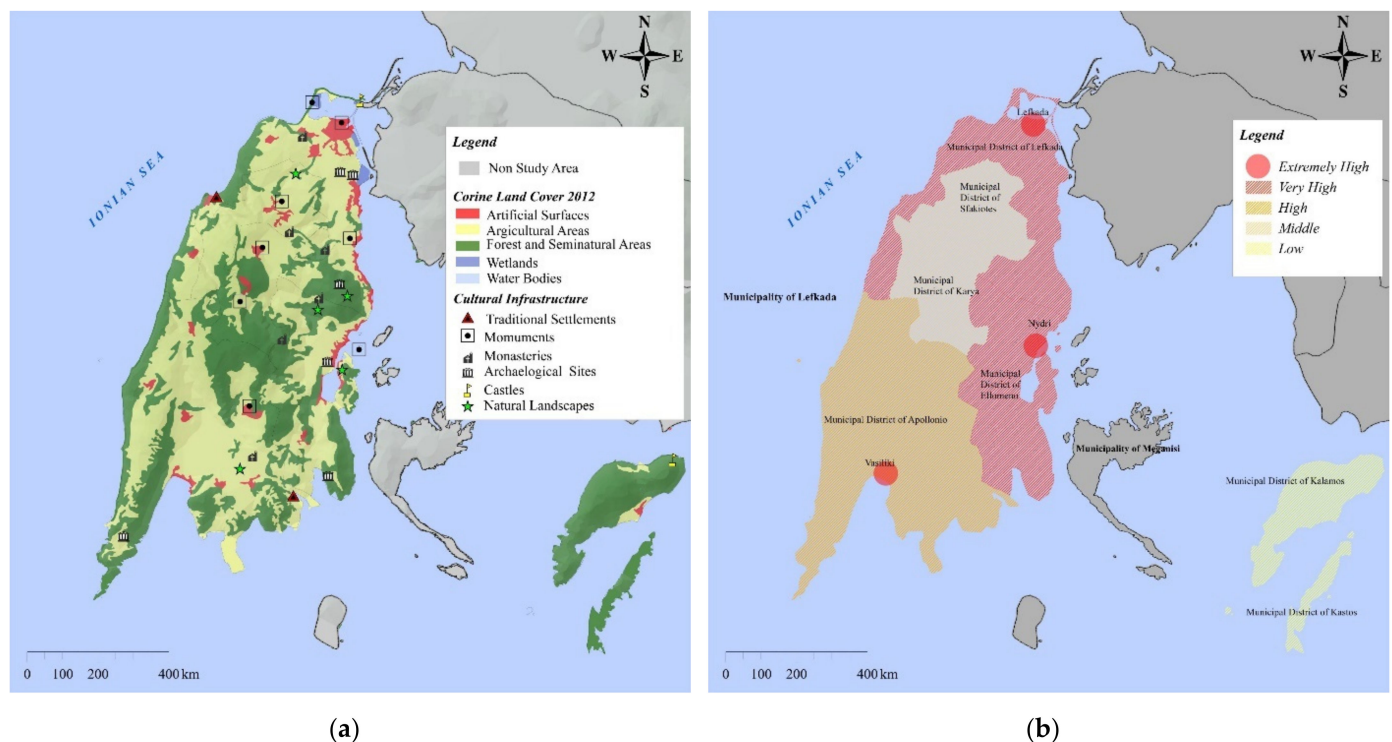**Figure 2.** Maps depicting: (**a**) land uses and cultural infrastructure in the study area and (**b**) levels of tourism concentration based on hotel accommodation and tourist attractions.

The tourism sector is mainly characterised by a model of mass tourism that is based on the rapid and unplanned tourism development of the past decades. Katsoni and Stratigea [19] noted that there has been a steady increase in the number of visitor flows during the last years. The unplanned development of tourism has led to a variety of negative consequences, such as the corruption of both natural and man-made environments, the exploitation of natural resources and conflicts in land use. The steady increase in tourism development has resulted in the continuous reconstruction of visitor facilities and services in order to ameliorate tourist/visitor services. The tourist supply of the island is mainly concentrated on the eastern part of the island where the largest percentage of hosting infrastructure (hotels and family rooms for rent) is located.

Tourists mainly gather on the east coast of the island, due to its special geomorphology with many small beaches and bays. On the south part of the island the most important tourist attraction is Vasiliki. Every year many surfers visit Vasiliki's beach, which is considered one of the 10 best beaches in the world for surfing. Finally, on the western part of the island, the mountains form steep cliffs where long, white sandy beaches exist.

Regarding hotel accommodation, many hotels are small, family-owned operations. In recent years, there has been an increase in larger hotel units, but compared to the rest of the islands of the country and considering the increase in the number of tourists, they are still few. According to [20], there are 102 hotels and most of them belong to the second class. Apartments and rooms to let serve significantly as tourist accommodation. Several rented rooms (1171) have been built during the last twenty years in the island [21] and many hotels and rooms to let can be found in Nydri and Nikiana.

The most important advantages of Lefkada, which make it competitive with the rest of the island areas, are easy access, the excellent beaches and the unchanged natural landscape. The forms of tourism that have been developed in the study area are the so-called "Sun and Sea" package, cultural and religious tourism, and marine tourism. The "Sun and Sea" package is the top choice of tourists and visitors, while in recent years, maritime tourism has also been flourishing.

Regarding the tourist demand of the island, Lefkada shows a steady increase in its arrivals, but it is characterized by seasonality, as 84% of its arrivals occur during the period May–September [21].

3.2. Methodological Framework

Figure 3 presents the methodological framework developed and implemented in this paper. It consists of the following two phases: the diagnosis phase (1st Phase) and the assessment phase (2nd Phase).
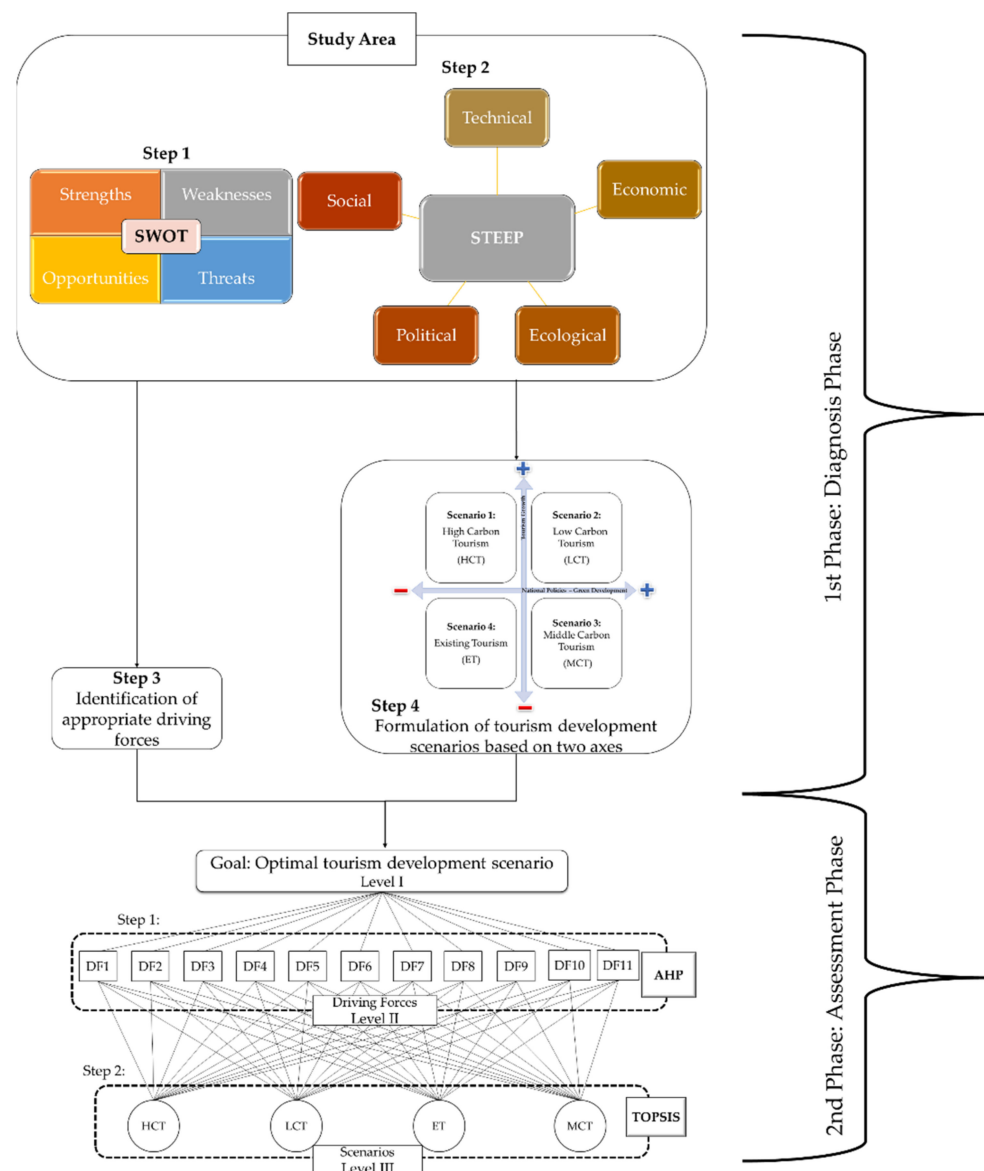
Figure 3. Methodological framework.

3.2.1. Diagnosis Phase

The diagnosis phase consists of the following four steps:

Step 1: SWOT analysis

SWOT stands for Strengths, Weaknesses, Opportunities, and Threats, and is a technique that was created for business and marketing analysis, but, since then, it has been widely applied in various research domains. In the tourism planning field, SWOT has been used in identifying issues that influence the tourism industry's development in specific areas, such as the Boujagh National Park in Iran [22], as well as in the assessment

of sustainable tourism in general [23]. Internal and external assessments make up the SWOT framework. The internal evaluation is carried out in order to show the strengths and weaknesses of an organisation or a strategic plan, while the external evaluation is used to uncover opportunities and dangers. Any accessible resources that can be utilised to improve performance are referred to as strengths. Weaknesses are defects in a product or service that can reduce competitive advantages, efficiency, or financial resources. Threats are external variables that may cause issues, whereas opportunities are external changes that may contribute to additional development [24]. In the present study, internal and external environmental research aim at determining the general characteristics of the study area (environmental, economic, cultural, transport and infrastructure) as well as the existing situation of the tourist industry.

Step 2: STEEP analysis

STEEP is an acronym for Social, Technological, Economic, Ecological and Political. The Chartered Institute of Personnel and Development defines STEEP analysis as the 'audit of an organisation's environmental influences with the purpose of using this information to guide strategic decision making'. It is a powerful and widely used strategic tool that helps in obtaining a comprehensive view of an organisation's current environment and future threats. The fundamental principle of the tool is that the only factors that are included are the ones directly related to the impact of the industry or that are likely to change in the near future [25]. STEEP analysis can be used not only for the development of organisations or companies, but also for the development of sectors such as tourism. In this study, STEEP analysis focuses on determining the appropriate driving forces that will influence the deployment of tourism development scenarios.

Step 3: Identification of driving forces

Scenarios offer a possible development of future situations, which are based on various combinations of facts and trends. In order to create a scenario, the influencing factors should be defined and the uncertainty and complexity of a situation should be considered [17]. In this study, the selection of appropriate driving forces for tourism scenario planning is performed through the analysis of the study area, as well as through STEEP analysis. Appropriate driving forces are adopted for each parameter of STEEP analysis: the Social, Technological, Economic, Ecological and Political parameters.

Step 4: Formulation of tourism development scenarios

The structure of four tourism development scenarios on two axes of uncertainty is based on scenario planning. Herman Kahn, who is considered one of the founders of scenario planning, defines it as 'a hypothetical sequence of events leading to a possible future' [26]. Thus, scenarios are not necessarily considered a forecast of future situations, but describe a possibility of the future with regard to a specific situation. This tool has become valuable for strategic purposes that have helped international organisations and businesses to prepare for potential challenges. Scenarios are a strategy that describes potential aspects of a possible future. Scenario planning has been widely used as a strategic tool not only for the development of international organisations or companies, but also in other sectors, such as tourism. A typical example of this methodology is described in Scotland's tourism plan for 2025 [27]. In the proposed scenarios, emphasis is placed on the spatial pattern of tourism development, trying to compromise between the development of the tourist sector and the promotion of National Policies and Green Development.

3.2.2. Assessment Phase

Starting with the overall goal of the analysis, which is to identify the most preferable tourism development scenario with the use of the SWOT and STEEP analyses, the authors identified a comprehensive set of driving forces that reflect all the concerns relevant to the decision. The first step of the assessment phase includes pairwise comparisons of the driving forces, while the second is the prioritisation of the proposed scenarios.

Step 1: Driving Forces Assessment

The driving forces assessment is performed through the Analytic Hierarchy Process (AHP) method. AHP was introduced by Saaty [28,29]. AHP breaks down the decision problem into a hierarchical top-down process. In our case, we use the AHP method to determine the importance weights to be assigned to the DF in defining the overall goal. Pairwise comparisons are performed to compare the relative preference of each pair of DF (e.g., DFi over DFj) with respect to the goal, based on a nine-point binary comparison scale (1 = equal, to 9 = very strong preference), known as Saaty's fundamental scale. A comparison matrix A is formed, where aij is the relative importance of DFi over DFj and the relative importance of DFj over DFi is defined as its reciprocal, i.e., aji = 1/aij and aii is equal to 1. The weights of the DF are estimated by calculating the principal eigenvector w of the matrix A. The consistency of comparisons is assessed through the consistency index (CI) and the consistency ratio (CR).

The consistency index (CI) is determined by Equation (1):

$$CI = \frac{\lambda_{max} - n}{n - 1} \tag{1}$$

where n is the number of the DF in the assessment matrix, and the value λmax corresponds to the maximum eigenvalue of the comparison matrix A. The consistency ratio (CR) is calculated as the ratio of the consistency index (CI) to the random consistency index (RI), as shown in Equation (2):

$$CR = \frac{CI}{RI} \tag{2}$$

where RI is a random consistency that depends on the size of the comparison matrix (n × n) [30]. A consistency ratio lower than 0.10 ($CR \leq 0.1$) verifies that the results of the comparison are acceptable.

Step 2: Selection of the optimal tourism development scenario

Hwang Ching-Lai and Yoon invented the TOPSIS method (Technique for Order Preference by Similarity to Ideal Solution) in 1981 [31]. The TOPSIS method is based on the idea that, in a multicriteria analysis problem, the preferable alternative (scenario) should be as close as possible to the ideally optimal solution, and as far away as possible from the ideally non-optimal solution. Therefore, the method considers the distances from the optimal ideal and non-optimal ideal solutions at the same time, computing the relative distance between them.

An initial assessment matrix is created, which includes the numerical values of i alternatives (scenarios) in relation to j driving forces. A normalised decision matrix is then calculated, using Equation (3):

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \tag{3}$$

where xij is the value of the ith alternative (scenario) to the jth DF.

The normalised decision matrix is multiplied by the weights of the corresponding DF calculated by the AHP method in the previous step. From the weighted normalised decision matrix, the ideal optimal value V_j^+ and the ideal non-optimal value V_j^- of each DF are defined. The Euclidean distance of each alternative (scenario) from the ideal optimal value $\left(S_i^+\right)$ and the ideal non-optimal value $\left(S_i^-\right)$ are calculated using Equations (4) and (5):

$$S_i^+ = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - V_j^+\right)^2} \tag{4}$$

$$S_i^- = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - V_j^-\right)^2} \tag{5}$$

The variable v_{ij} represents the value of the ith alternative (scenario) corresponding to the jth DF in the weighted normalised decision matrix. The closeness coefficient of each alternative (scenario) to the optimal ideal and the non-optimal ideal solution is calculated as follows in Equation (6):

$$C_i = \frac{S_i^-}{S_i^+ + S_i^-} \tag{6}$$

The most preferable alternative (scenario) receives the highest value of the relative proximity measure and is ranked in the first place.

4. Results

4.1. Selection of Appropriate Driving Forces for Tourism Scenario Planning

Analysing the existing state of the study area is a vital step in planning its future development. Table A1 presents the internal and external environment obtained by SWOT analysis, while Table 1 highlights several driving forces identified by analysing the existing situation in the study area, combined with the STEEP strategic tool analysis, as well as the selected main driving forces that were finally selected for tourism development planning.

Table 1. Driving forces obtained by STEEP analysis and selected driving forces for tourism development scenario in Lefkada island, Greece.

STEEP	Main Driving Forces	Selected Driving Forces
Sociological Parameter	Population retention in isolated settlements Level of youth activity Level of cultural heritage preservation Level of awareness of the local community	DF1 DF2 DF3
Technological Parameter	Level of application of green technology Level of social media networking use	DF4
Economic Parameter	Seasonality of tourism Level of tourism development Level of local products promotion Expected level of new job opportunities	DF5 DF6
Environmental Parameter	Level of sustainable natural resource exploitation Transportation system Air pollution Environmental culture—ecological footprint of enterprises related to tourism Level of renewable energy sources exploitation	DF7 DF8 DF9 DF10
Political Parameter	National policies—green development Level of participation of local communities in policy making	DF11

4.2. Selection of Uncertainties

In this paper, the scenario technique was applied, which is based on 'two axes of uncertainty'. Specifically, the axes refer to possible future developments in the tourism sector, which are used as a basis for the integrated development of the island of Lefkada. These axes include the following.

- A horizontal axis of uncertainty, which refers to National Policies and Green Development: The horizontal axis of uncertainty includes national policy decisions and policy measures in conjunction with the adoption and implementation of green development.
- A vertical axis of uncertainty, which is related to the degree of tourism development. The intensity and the form of the tourism as well as the development of tourist activities are crucial for the future development of alternative scenarios.

The above axes are crucial for handling the challenges that the external environment may present. At the same time, they are considered capable of creating a suitable internal

environment in which to achieve sustainable tourism development. Through the above axes, four qualitative and contradictory alternative future scenarios are proposed.

4.3. Scenario Analysis

In this section, the four proposed scenario are described and spatially depicted in Figure 4a–d.
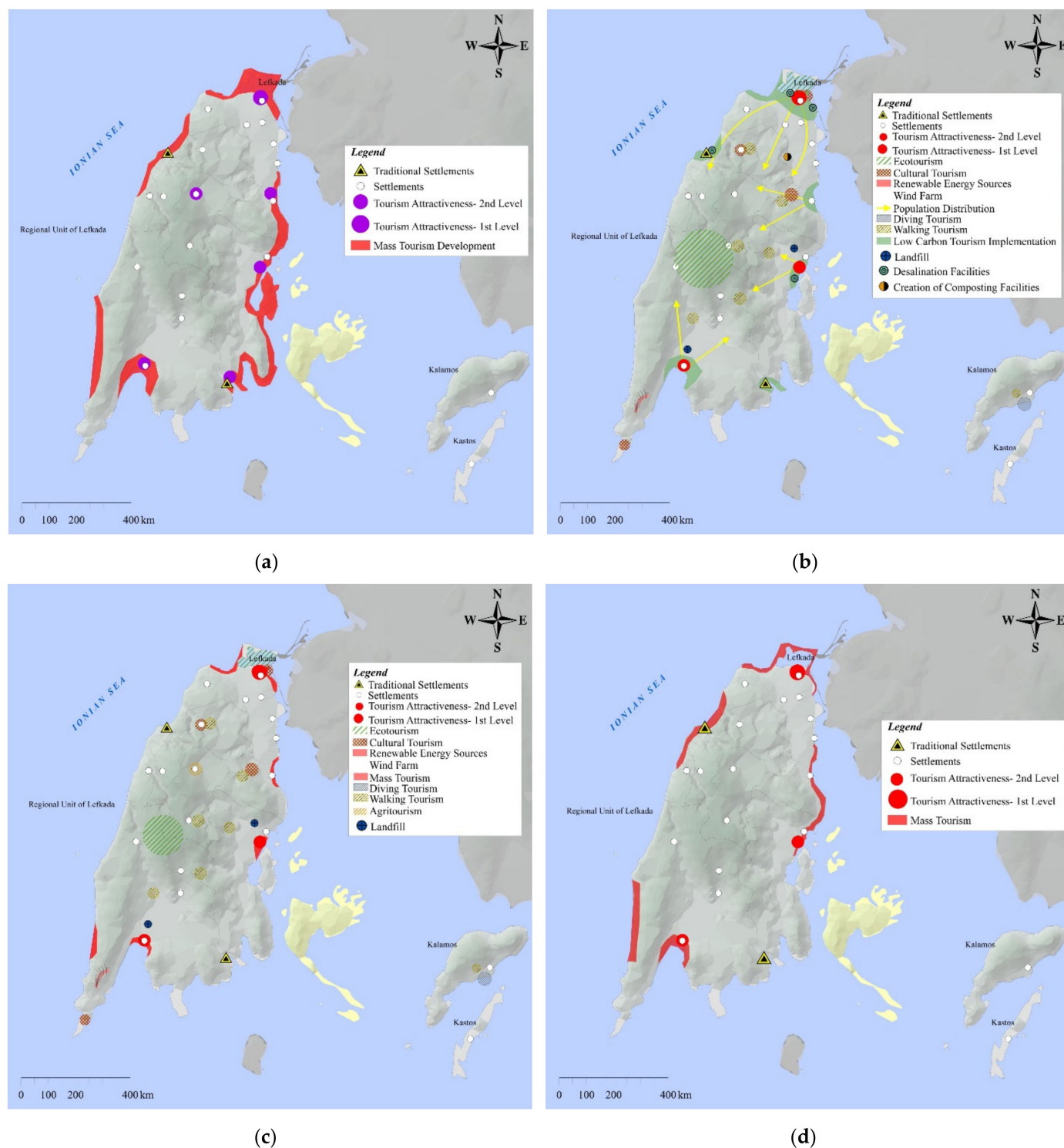

Figure 4. Maps depicting the four different tourism planning scenarios: (**a**) High-Carbon Tourism (HCT), (**b**) Low-Carbon Tourism (LCT), (**c**) Existing Tourism (ET), and (**d**) Middle-Carbon Tourism (MCT).

4.3.1. High-Carbon Tourism (HCT)

This scenario represents the excessive demand of tourism as well as the further development of the mass tourism model (Figure 4a). It follows past and present trends without considering the development prospects of low-carbon tourism or alternative forms of tourism. The development of tourism becomes more intense on the east side of the island, mostly in the coastal settlements, while the hinterland is completely abandoned. The shares of primary and secondary sectors in the local economic structure are progressively declining, threatening the stability and competitiveness of the local economy, while, the tourism sector is based exclusively on the model of mass tourism.

This model has brought some economic benefits to the local community; however, it creates intense problems, as the environmental and cultural resources are gradually degraded, leading to a risk of a decline in the competitive advantage on which the tourism product is based. The high dependence of the island on this form of tourism increases the vulnerability of the local economy to external threats (e.g., climate change) while weakening the potential for new market opportunities (e.g., eco-tourism).

4.3.2. Low-Carbon Tourism (LCT)

This scenario aims to create low-carbon tourism, which is characterised as particularly attractive in the tourism market. The second scenario (Figure 4b) promotes activities based on low carbon emissions, a low carbon footprint and the exploitation of renewable energy sources. This type of tourism can upgrade the study area and turn it into an exemplary tourist destination, where it will have the preservation of the natural environment and reducing of the carbon footprint as priorities. In this scenario, a highly environmentally friendly culture prevails, which permeates all sectors of the local economy, including the tourism sector. Particular emphasis is given to upgrade the tourism potential based on the conditions of this model. The development of low-carbon tourism creates exemplary tourist accommodations that are fully harmonised with the environment but also are following the standards of environmental sustainability. Existing and new hotel businesses rely on enhancing the green behaviour of tourists, the adoption of green products and services as well as energy savings. Finally, the implementation of a legislative framework that promotes and ensures the development of this model is proposed.

4.3.3. Existing Tourism (ET)

This scenario represents the current state of tourism in the study area. It focuses on the maintenance of the model of mass tourism development, and it is based on the existing dynamics (trends) of the tourism sector (Figure 4c). The tourist destinations of the island follow a specific route, which has been economically successful so far. The development of tourism demonstrates a specific spatial structure that can be found in the eastern part of the study area, along the coastal settlements. The model of mass tourism development, combined with the high concentration of visitors in the city of Lefkada or other tourist attractions, leads to the gradual degradation of the study area. Finally, the current model of tourism development on the island has already shown some negative impact, as emphasis is placed on the emergence of the place as a tourist destination, mainly mass tourism, and on the promotion of the reckless use of local resources, high seasonality of the tourist product and attracting low-impact tourist flows.

4.3.4. Middle-Carbon Tourism (MCT)

The proposed scenario aims to attract quality tourism that will result from the enhancement of the quality of the offered services and the enlargement of the tourism product. This scenario aims to utilise the natural and cultural resources that are found in abundance on the island in a sustainable manner (Figure 4d). According to this scenario, eco-friendly tourist activities are a high priority. Alternative forms of tourism aim at both the waterfront region of the study area and the development of the hinterland, succeeding in balancing tourism development. The identity of the island is mainly based on the development of

alternative forms of tourism. The environmental culture that prevails leads to the development of a series of environmentally friendly tourism activities. This way, a network of settlements can be created inland, based on the settlement of Karya, which is considered the main centre of alternative tourism development.

4.4. Weighting of Driving Forces

After defining the driving forces, the AHP implementation requires a pairwise comparison matrix of these driving forces to quantify their relative weights in relation to the overall goal (the optimal tourism development scenario). The priority vector is formed by these weights, which indicate the importance and influence of each driving force on the overall goal. Table 2 shows the 11 × 11 pairwise comparison matrix of the eleven driving forces, and the relevant weights of the driving forces are presented in Figure 5. The pairwise comparison judgements are performed based on the authors' expertise and experience [32–34]. It should be noted that the consistency of the 11 × 11 pairwise comparison matrix has been confirmed by calculating *CR* (Equation (2)), which is equal to 8%, which is less than the threshold of 10%.

Table 2. Pairwise comparison matrix of driving forces DF1–DF11 with respect to the goal.

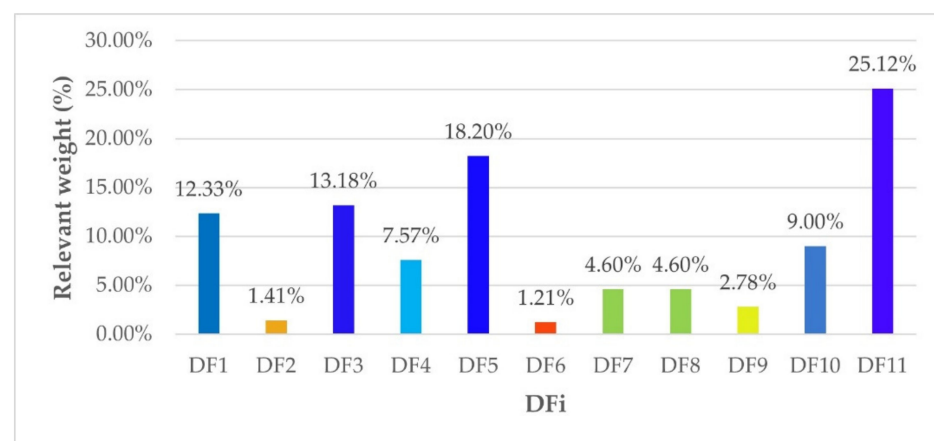| Driving Forces (DF)	DF1	DF2	DF3	DF4	DF5	DF6	DF7	DF8	DF9	DF10	DF11
DF1	1	7	1	4	1/2	8	4	4	5	2	1/3
DF2	1/7	1	1/7	1/7	1/8	3	1/5	1/5	1/3	1/7	1/8
DF3	1	7	1	3	1/2	8	5	5	6	2	1/3
DF4	1/3	7	1/3	1	1/4	8	3	3	5	1/2	1/5
DF5	2	8	2	4	1	9	5	5	7	3	1/2
DF6	1/8	1/3	1/8	1/8	1/9	1	1/7	1/7	1/5	1/8	1/9
DF7	1/4	5	1/5	1/3	1/5	7	1	1	3	1/3	1/6
DF8	1/4	5	1/5	1/3	1/5	7	1	1	3	1/3	1/6
DF9	1/5	3	1/6	1/5	1/7	5	1/3	1/3	1	1/5	1/7
DF10	1/2	7	1/2	2	1/3	8	3	3	5	1	1/4
DF11	3	8	3	5	2	9	6	6	7	4	1

Figure 5. Relevant weights of Driving Forces DF1–DF11 with respect to the goal.

From Figure 5, it can be seen that the relative weights of DF11 and DF5 have the highest values (equal to 25.12% and 18.20%, respectively), indicating that the National Policies—Green Development and the Degree of Awareness of the Local Community present the two most important driving forces for determining the preference order of the tourism development scenario on Lefkada island. Driving forces DF3 and DF1 follow with a relative weight equal to 13.18% and 12.33%, respectively, while the rest of the driving forces, in decreasing order of priority, are ranked as follows: DF10, DF4, DF7, DF8, DF9, DF2, DF6.

4.5. Assessment of Tourism Development Scenarios Using TOPSIS

Table 3 presents the performance of each tourism development scenario in relation to each driving force (DF1–DF11). It should be noted that a ten-point Likert scale (1 = extremely low, to 10 = extremely high) was used based on the significance/contribution of each driving force to each tourism development scenario.

Table 3. Assessment matrix of tourism development scenarios.

Scenario	DF1	DF2	DF3	DF4	DF5	DF6	DF7	DF8	DF9	DF10	DF11
HCT	2	3	2	3	1	4	2	3	1	1	1
LCT	8	5	9	8	9	7	7	7	8	8	10
ET	7	8	9	5	6	6	6	6	7	6	7
MCT	5	4	4	2	4	5	3	3	3	1	4

Table 4 displays the distance values to the optimal ideal and the negative ideal solutions (S_i^+ and S_i^-) as well as to the Ci values that exhibit the closeness coefficient of each scenario to the optimal ideal and the negative ideal solutions for tourism development scenarios using Formulae (4)–(6).

Table 4. S_i^+, S_i^-, and C_i values.

Scenario	S_i^+	S_i^-	C_i
HCT	0.032	0.000	0.000
LCT	0.002	0.031	0.933
ET	0.009	0.023	0.708
MCT	0.027	0.008	0.228

The preferred scenario must have the closest value to 1; therefore, in this case, it corresponds to the alternative scenario of LCT. The descending ranking of the rest of the scenarios is as follows: ET, MCT, HCT.

The proposed LCT scenario promotes the tourism sector as an activity with the least possible environmental impact for the sustainable development of the tourist destination. Based on this, some of the most important development strategies that need to be undertaken to promote and enhance this tourism model are considered.

According to estimates of the present study, transportation occupies the largest percentage of carbon dioxide production in the tourism sector. Thus, the reduction of means of transportation for tourism and the use of alternatives can significantly contribute to the mitigation of carbon emissions, such as public transport, electric and hybrid vehicles, but also bicycles, while the use of alternative fuels (biofuels) is proposed. Tourist infrastructure and services, such as travel agencies, hotels and leisure facilities, as well as tourist attractions such as tourist resorts, cultural sites, monuments and museums, dominate the tourism sector. This is the reason that the development of green products and services, proper management for energy savings through the reuse of materials or the use of environmentally friendly products and services as well as the effort for green certification, which mainly concerns the hotels that are certified with the eco-label, are a set of measures and innovative techniques that enhance the holistic design of low-carbon tourism infrastructures and services. Furthermore, an important prerequisite of the proposed tourism model development is the design of low-carbon tourist attractions. Finally, tourists are the key feature of a trip. Therefore, we consider it necessary to promote low-carbon tourism to the tourism public, to enhance the environmental awareness of both visitors and the local population through information and education programs and campaigns as well as actions with a carbon-neutral footprint. Low-carbon tourism should be considered as an innovative, positive and responsible way of travelling.

5. Conclusions

The current study presents and uses a methodological approach to evaluate alternative carbon-related tourism development scenarios on the Greek island of Lefkada.

Four discrete future development scenarios of the tourism sector in the study area are presented, which, apart from the existing tourism scenario, are built upon the amount of carbon emissions produced by the tourism sector. The preferred scenario is the one that promotes low-carbon tourism. This scenario reflects the need to implement a type of tourism based on the reduction of carbon dioxide, the protection of the environment, the promotion of the local identity of the study area, the mitigation of the phenomenon of climate change and the raising of awareness of the need for a comprehensive and long-term perspective for sustainable tourism development. However, low-carbon tourism is described as an emerging tourism model that aims to make the development of tourist destinations sustainable. Several studies have shown that the adoption of this model is important for the tourist industry to achieve sustainability. The main goal of this type of tourism is to minimise both energy consumption and CO_2 emissions caused mainly by tourist accommodations and transportation.

The main contribution of the current study is that, for the first time, a methodological framework has been implemented that assesses tourism development based on carbon-related scenarios using a combination of strategic management tools (SWOT and STEEP analyses) and multicriteria analysis methods (AHP and TOPSIS). Although SWOT analysis has been widely used in spatial planning, this is the first time that STEEP analysis contributes to spatial planning issues. Considering the multicriteria analysis methods, Zhang and Zhang [18] highlights that the most widely used methods for assessing low-carbon development and sustainability are AHP [35,36] and the entropy weight method [37–39]. However, the present study considers the TOPSIS method for assessing the proposed carbon-related scenarios. The most important advantage of the TOPSIS method is that the best alternative is not only closer to the ideal solution but is also more distant from the ideal negative solution.

The subjectivity of judgements both in pairwise comparisons of driving forces and in the performance evaluation of each tourism development scenario in relation to each driving force is one weakness of this study, which could lead to misleading results. Changing numbers in pairwise comparisons may change the relative weights of driving forces, and different performance assessments may change the results. A participatory contribution from local stakeholders is proposed as a potential solution to the above limitations and as future work.

The application of the proposed methodology can lead to improvement of the tourism sector in the study area through adoption of this specific model of tourism development. The proposed methodological approach can provide an example for the application of low-carbon tourism both on islands as well as in larger tourism destinations, contributing to both the sustainability and the competitiveness of the destinations.

Author Contributions: Conceptualization, N.S., P.C., and D.G.V.; methodology, N.S., P.C., and D.G.V.; software, N.S., P.C. and D.G.V.; formal analysis, N.S. and P.C.; investigation, N.S. and P.C.; data curation, N.S., P.C. and D.G.V.; writing—original draft preparation, N.S., P.C. and D.G.V.; writing—review and editing, D.G.V.; visualization, N.S., P.C. and D.G.V. supervision, D.G.V. All authors have read and agreed to the published version of the manuscript.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. SWOT analysis.

Sector	Internal Environment		External Environment	
	Strengths (S)	**Weaknesses (W)**	**Opportunities (O)**	**Threats (T)**
Structure of Economic Activity	Continuous development of the tertiary economy sector, as a result of the development of the tourism industry	Low participation of the primary and secondary sectors in employment	Upgrade of the primary sector	Unilateral deployment of the tertiary sector, due to global tourism development
	Development of the secondary sector, related to construction deployment	Inability to keep the economically active population in mountainous areas	Creation of new jobs in the tourism sector	
			High activity of the younger generation	
			Connection of productive sectors with each other and promotion of local products	
Transportation and Technical Infrastructure Network	Easy and economical accessibility of the island	Limited utilisation of international and national connections (airports, ports)	Use of alternative means of transportation	Deficiencies in environmental infrastructure (landfills, composting facilities, desalination facilities, water and wastewater networks)
	Existence of Lefkada's marina, which contributes to the island's development	Low use of alternative means of transportation	Improving accessibility to the study area with the implementation of the submarine highway connection	
	Existence of a waterway	Deficiencies in the local road network	Improvement of the road network, which will contribute to the development of heartland	
		Non-exploitation and absence of renewable energy sources	Exploitation of renewable energy sources	
		Significant waste management problems		
Cultural Environment	Existence of remarkable cultural resources, archaeological sites and monuments, numerous churches and monasteries	Inadequate exploitation and protection of cultural resources	Promotion of the cultural identity of the study area and protection and restoration of archaeological sites and monuments	Degradation of cultural resources due to tourism development
			Cultural and religious tourism development	Commercialisation of cultural heritage, traditions and customs

Table A1. *Cont.*

Sector	Internal Environment		External Environment	
	Strengths (S)	**Weaknesses (W)**	**Opportunities (O)**	**Threats (T)**
Natural Environment and Protected Zones	Existence of ecosystems and numerous protected areas	Degradation of the natural environment and protected areas due to tourism and other anthropogenic activities	Rational management of protected areas and natural resources and promotion of the protected areas	Air and water pollution due to tourism development and other anthropogenic activities
	Famous beaches with excellent bathing water quality	Lack of a protected areas management body		
	Landscape diversity (mountainous, coastal)	Lack of an environmental culture in society		
Tourism	The study area is an attractive tourist destination	Mass tourism	Development of alternative forms of tourism	Dominance of mass tourism model
	High tourism development	Seasonal tourism—shrinkage of tourist period	Extension of tourist period	
	Development of maritime tourism	Spatial concentration of tourism activity in coastal settlements	Balanced development of the tourism sector in all areas of the study area	
	High numbers of arrivals and overnight stays during the summer months	Limited interconnection of the tourism sector with other productive sectors	Attracting new types of tourists	
			Creation of new accommodation facilities with green certification and an ecological footprint	

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