Socio-economic Assessment of the Sustainable Development Interventions of the Island of Ikaria, Based on the Utilization of its Cultural and Environmental Reserve (CER), in the Context of the Circular Economy

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Abstract. The purpose of this study is the socio-economic assessment of the Sustainable Development interventions of Ikaria Island, based on the exploitation of its Cultural and Environmental Reserve (CER), focusing on how these interventions affect GDP and employment, both at regional and national level. The interventions studied include projects related to road infrastructure and the CER of the island. An input-output analysis was used to assess the socio-economic impact of the interventions. Based on the results of the input-output analysis, the implementation of the sustainable development proposals on Ikaria Island will result in a change in GDP of €41.15 million at the level of the national economy and €20.57 million at the level of the North Aegean region economy. In terms of employment, the implementation of the sustainable development proposals will result in the creation of 1052 jobs at national level and 594 jobs in the North Aegean region. In conclusion, the sustainable development interventions will have a positive social and economic impact on the island of Ikaria.

Keywords: island development, circular economy, cultural heritage

1 Introduction

Ikaria, an island with a rich cultural and environmental reserve, is an excellent case for the implementation of sustainable development strategies, aiming at the sustainable use of its natural and cultural resources. The socio-economic assessment of sustainable development interventions on the island, focusing on the utilization of the CER, is a crucial step in understanding the contribution of these strategies to the local and national economy. The circular economy, which focuses on reuse, recycling and efficient management of resources, provides an innovative framework for enhancing sustainability and improving the quality of life of residents, while promoting the preservation and enhancement of the island's cultural and environmental assets.

2 Theoretical Framework

2.1 Sustainable Development, Cultural Heritage and Environment

Sustainable Development. In recent years, sustainable development has emerged as a major issue at both theoretical and political levels and has become a concern for both the natural and social sciences. According to the Report of the World Commission on Environment and Development: Our Common Future [1], «sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs» and it contains two key concepts: the concept of 'needs', in particular the essential needs of the world's poor, to which overriding priority should be given; and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.

The three key components of sustainable development are economic growth, social inclusion and environmental protection. These three elements are interconnected and vital for the well-being of individuals and societies. [2]

Economic sustainability means the use of various strategies for employing existing resources optimally so that that a responsible and beneficial balance can be achieved over the longer term. [3] Social sustainability is the ability of society, or any social system, to persistently achieve a good social well-being. [4] Environmental sustainability could be defined as a condition of balance, resilience, and interconnectedness that allows human society to satisfy its needs while neither exceeding the capacity of its supporting ecosystems to continue to regenerate the services necessary to meet those needs nor by our actions diminishing biological diversity. [5]

Cultural Heritage. Although cultural heritage is neither included in the definition of sustainable development nor in its three pillars, it can make a significant contribution to the achievement of social, economic and environmental goals. Both the Budapest Declaration [6] and the Convention on the Protection and Promotion of the Diversity of Cultural Expressions [7] state that cultural heritage and culture in general can create conditions conducive to sustainable development.

Within the framework of the Sustainable Development Goals (SDGs) adopted in September 2015 by the United Nations, the international development agenda refers to culture for the first time. This has been lauded by UNESCO as “an unparalleled recognition”. The safeguarding and promotion of culture is an end in itself, and at the same time it contributes directly to many of the SDGs – safe and sustainable cities, decent work and economic growth, reduced inequalities, the environment, promoting gender equality and peaceful and inclusive societies. The indirect benefits of culture are accrued through the culturally-informed and effective implementations of the development goals. [8] Agenda 2030 explicitly highlights culture and heritage in Target 11.4 of the Sustainable Development Goals, and the European Commission has touted culture as a way to move toward social cohesion. [9]

At the UNESCO World Conference on Cultural Policies and Sustainable Development – MONDIACULT 2022, held in 2022 in Mexico, States affirm for the first time that culture is a “global public good” and call for culture to be included “as a specific objective in its own right” among the next United Nations Sustainable Development

Goals. According to Audrey Azoulay, UNESCO Director-General, "Culture has a fundamental role in our societies. Through culture people can discover their common humanity and become free and enlightened citizens. Yet, despite progress, it still does not have the place it deserves in public policies and international cooperation. MONDIACULT 2022 is a powerful signal to change this. The Declaration adopted today is a commitment to action." According to UNESCO data, the cultural and creative sector is one of the most powerful engines of development worldwide. [10] Based on all the above, we can conclude that there is a strong connection between the cultural heritage of an area and its sustainable development.

Environment. As mentioned above, environmental protection is one of the three pillars of sustainable development. An important connection between sustainable development and the environment was made in 1992 at the United Nations Conference on Environment and Development, which had many great achievements: the Agenda 21, the Rio Declaration and its 27 universal principles, the United Nations Framework Convention on Climate Change (UNFCCC), the Convention on Biological Diversity; and the Declaration on the principles of forest management. [11]

In terms of the 2030 Agenda, environmental sustainability is included in many of the Sustainable Development Goals. It is specifically addressed in goals such as SDG 3 (good health and well-being), SDG 6 (clean water and sanitation), SDG 11 (sustainable cities and communities), SDG 12 (responsible consumption and production), SDG 13 (climate action), SDG 14 (life below water), and SDG 15 (life on land). [12]

2.2 Investment and Sustainable Development

Sustainable investing refers to a range of practices in which investors aim to achieve financial returns while promoting long-term environmental or social value. Combining traditional investment approaches with environmental, social, and corporate governance (ESG) insights has led to investors generating more comprehensive analyses and making better investment decisions. [13]

According to the OECD [14], sustainable investment supports the expansion of an economy's productive capacity while promoting decarbonisation and preserving our planet's natural assets, driving job creation and skills development, and ensuring equal opportunities for all. Investments related to culture and the environment can be considered sustainable investments.

2.3 Circular Economy and Sustainable Development

According to the Ellen MacArthur Foundation [15], circular economy is a system where materials never become waste and nature is regenerated. In a circular economy, products and materials are kept in circulation through processes like maintenance, reuse, refurbishment, remanufacture, recycling, and composting. The circular economy tackles climate change and other global challenges, like biodiversity loss, waste, and pollution, by decoupling economic activity from the consumption of finite resources.

The European Parliament [16] claims that one of the benefits of the circular economy model is the protection of the environment. Reusing and recycling products would slow down the use of natural resources, reduce landscape and habitat disruption and help to

limit biodiversity loss. Switching to circular economy will lead to the reduction of the total annual greenhouse gas emissions. Creating more efficient and sustainable products from the start would help to reduce energy and resource consumption, as it is estimated that more than 80% of a product's environmental impact is determined during the design phase.

Another benefit is the reduction of raw materials dependance. Recycling raw materials mitigates the risks associated with supply, such as price volatility, availability and import dependency. This especially applies to critical raw materials, needed for the production of technologies that are crucial for achieving climate goals, such as batteries and electric engines. In addition to that, moving towards a more circular economy could increase competitiveness, stimulate innovation, boost economic growth and create jobs (700,000 jobs in the EU alone by 2030).

The circular economy relies on resource efficiency and sustainable consumption and production, which are central concepts to achieve sustainable development. Key goals such as SDG 12 on "Ensuring Sustainable Consumption and Production patterns" are particularly relevant to a circular economy, as the targets rely on recirculating what was previously seen as waste back into the economic space, via closed loop processes which reduce negative externalities. A circular economy also relies on achieving goals such as SDG 8, especially target 8.4 which aims to "Improve progressively, through 2030, global resource efficiency in consumption and production and endeavour to decouple economic growth from environmental degradation…". [17]

2.4 Circular economy, Cultural Reserve and Environment

Cultural routes are a well-established development tool to highlight and promote a region's cultural and environmental reserve, as well as having a positive impact on a region's socio-economic development. Underdeveloped or rural areas, which have limited financial and technological resources available, often envision cultural routes as a useful development tool to cater to their needs. However, unless these cultural routes are designed and implemented based on the principles of a circular economy or while respecting the region's cultural identity and heritage, their impact will not be significant.

The success of a region-wide project to connect historic buildings, monuments, and archeological sites, in the context of "cultural routes", can be catalytic in the successful development of Cultural Tourism, proving that funding the preservation of our architectural and cultural heritage is a high-yield investment, able to finance further projects on its own, within a Circular Economy. [18]

As regards infrastructure, the circular economy, and its focus on the cycling and regeneration of resources, necessitates both a reconfiguration of existing infrastructures and the creation of new infrastructures to facilitate these flows. [19] According to Transport Infrastructure Ireland [20], the application of circular economy principles to road projects results in a reduction in carbon emissions and material demand. The value of existing assets, components and materials is maximized and supplemented, which keeps existing materials in circulation and minimizes the embodied carbon that is associated with producing new materials and assets.

The concept of the circular economy can be applied in any industrial activity, including the wastewater treatment sector. Examples of the application of the circular economy model in this sector are the reclamation and reuse of wastewater to increase water resources, by paying particular attention to the risks for human health, the recovery of nutrients, or highly added-value products (e.g., metals and biomolecules among others), the valorisation of sewage sludge, and/or the recovery of energy. [21]

2.5 Classification of Economic Activities (NACE) and Sectors of the Economy

Classification of Economic Activities (NACE). NACE is the "statistical classification of economic activities in the European Community" and is the subject of legislation at the European Union level, which imposes the use of the classification uniformly within all the Member States. [22] NACE is a four-digit classification providing the framework for collecting and presenting statistical data according to economic activity in a wide variety of European statistics in the economic, social, environmental, and agricultural domains. [23]

The NACE Rev. 2, which is the new revised version of the NACE Rev. 1 and of its minor update NACE Rev. 1.1, is the outcome of a major revision work of the international integrated system of economic classifications which took place between 2000 and 2007. NACE Rev. 2 reflects the technological developments and structural changes of the economy, enabling the modernisation of the Community statistics and contributing, through more comparable and relevant data, to better economic governance at both Community and national level. [22]

Sectors of the Economy. Global economic development is structured into three main sectors: primary, secondary, and tertiary. Each plays a fundamental role in the economy, representing different phases of production and services, from the extraction of raw materials to the provision of services to end consumers.

The primary sector focuses on extracting and harvesting natural resources. Activities include agriculture, mining, fishing, and forestry. In the secondary sector, the natural resources extracted are transformed into manufactured products. Activities include construction, goods manufacturing, and industrial production. The tertiary sector, also known as the service sector, includes activities such as education, trade, tourism, transportation, and information technology. [24]

2.6 Macroeconomic Indicators

Gross Domestic Product, abbreviated GDP, is a basic measure of the overall size of a country's economy [25], in particular, the monetary value of all finished goods, materials and services made within a country during a specific period, usually one year. [26] According to Eurostat [25], GDP is equal to the sum of the gross value added of all resident institutional units engaged in production, plus any taxes on products and minus any subsidies on products. GDP is also equal to the sum of the final uses of goods and services (all uses except intermediate consumption) measured in purchasers' prices, minus the value of imports of goods and services; the sum of primary incomes distributed by resident producer units.

The employment level is defined as the number of people engaged in productive activities in an economy. The concept includes both employees and the self-employed. The two main measures used for employment are the number of persons employed or the number of employees. [27]

2.7 Input – Output Analysis (Leontief)

Input–output analysis is the name given to an analytical framework developed by Professor Wassily Leontief in the late 1930s, in recognition of which he received the Nobel Prize in Economic Science in 1973. In its most basic form, an input–output model consists of a system of linear equations, each one of which describes the distribution of an industry's product throughout the economy.

The basic Leontief input–output model is generally constructed from observed economic data for a specific geographic region (nation, state, county, etc.). One is concerned with the activity of a group of industries that both produce goods (outputs) and consume goods from other industries (inputs) in the process of producing each industry's own output.

The fundamental information used in input–output analysis concerns the flows of products from each industrial sector, considered as a producer, to each of the sectors, itself and others, considered as consumers. This basic information from which an input–output model is developed is contained in an interindustry transactions table. The rows of such a table describe the distribution of a producer's output throughout the economy. The columns describe the composition of inputs required by a particular industry to produce its output. [28]

Input-output models estimate three types of impact: direct, indirect, and induced. These terms are another way of referring to initial, secondary, and tertiary impacts that ripple throughout the economy when a change is made to a given input level. By using input-output models, economists can estimate the change in output across industries due to a change in input in one or more specific industries.

The direct impact of an economic shock is an initial change in expenditure. For example, building a bridge would require spending on cement, steel, construction equipment, labor, and other inputs. The indirect, or secondary, impact would be due to the suppliers of the inputs hiring workers to meet demand. The induced, or tertiary, impact would result from the workers of suppliers purchasing more goods and services for personal consumption. This analysis can also be run in reverse, seeing what effects on inputs were likely the cause of observed changes in outputs. [29]

3 Methodology

The methodological approach of the project was based on the standard methodology of the AEI Research Project [30] "Sustainable Development of Less Developed Areas through the Creation of New Tourism Resources and Products via Analysis, Documentation, Modelling, Management and Preservation of Cultural Reserve using ICT Applications", code T2EDK-01278.

The methodological framework for the implementation of the AEI project is developed along four main axes. The first three relate to the project's execution, while the fourth addresses the impact of the new tourism products and services on sustainability, circular economy, and the achievement of social cohesion.

The first axis includes actions for the valorization of the CER and its upgrading through the use of new tourism products and resources, as well as the assessment of its resilience. The analysis, documentation, modeling, and management of the CER will be carried out through user-oriented communication via an interactive dynamic website. This platform allows for the personalized presentation and recommendation of tourism products based on each user's profile and is managed by organized bodies promoting tourism packages and activities that help channel tourist flows from highly developed to less developed areas.

The second axis leverages the results of the analysis, documentation, modeling, and management of the CER through the use of innovative ICT applications. This is achieved via a software platform that enables integrated spatial data analysis and management. The ICT tool is developed using a software platform incorporating artificial intelligence and semantic analysis technologies. Moreover, the tourism products and new tourism resources are spatially adapted and managed accordingly.

The third axis focuses on integrating the implementation planning into local development strategies. It includes the design, planning, programming and execution of infrastructures, projects, and measures necessary for the local application of the AEI initiative.

The fourth axis focuses on investments in tourism and the local economy that are necessary for the creation of new AEI-related resources and products. It highlights the added value these bring to the tourism sector, as well as their multiplier effects on the local economy and social cohesion. Measures and actions aimed at enhancing the resilience of the CER —through the implementation of quality control and management systems—constitute an essential part of the integrated planning approach for the sustainable exploitation and preservation of heritage assets, ensuring environmental and cultural sustainability. [30]

The exact steps that were followed are described below in detail. Initially, the study area, i.e. Ikaria Island, was identified through a literature review. Information on the natural and built environment, history, cultural heritage, demographic and economic data of the area was collected in order to identify both the elements that need to be strengthened and those that can be exploited to improve the socio-economic situation of the area. The sustainable development interventions to be studied were then identified, which include projects relating to the road infrastructure and the area's CER. Essential information for each project was collected, including the budget and the planned activities.

The economic activities according to NACE Rev. 2 that are affected by the abovementioned projects were selected and the budget of each project was allocated to them. The data were entered into the input-output model and the results on how these interventions affected GDP and employment at national and regional level were obtained.

4 Presentation and Discussion of Results

4.1 Study Area Analysis

Ikaria is one of the largest islands of the East Aegean with an area of 255 square kilometers and a coastline of 160 kilometers. [31] It is part of the North Aegean Region and it forms the Regional Unit of Ikaria along with the island of Fournoi. Ikaria forms the unified municipality of Ikaria with the capital and administrative center of Agios Kirykos. [32] The island can be accessed either through the State Airport of Ikaria "Ikaros", which is located to the eastern end of the island near the settlement of Faros, or through the ports of Evdilos and Agios Kirykos, which are located to the homonymous settlements. [33,34]

Ikaria is characterized as a mountainous island with an intense geomorphology and several contrasts between bare steep cliffs and green slopes. The island features gorges, rivers, artificial lakes, broad-leaved and dense pine forests, barren areas and steep slopes of the land, which give the island its intense natural relief. [35] Although it lacks extensive lowlands areas, apart from Kampos and Faros, it has, due to its natural relief, valleys, ravines and small plateaus as well as basins at higher altitudes, many of which are not visible from the sea due to the island's rugged topography. [31]

The flora of Ikaria is noteworthy, comprising 92 plant families, 401 genera, and 829 species. [36] In the northwestern part of the island, the densest vegetation is observed, with forests that are mostly self-sown and consist primarily of pine, as well as chestnut trees at higher altitudes, cypress, holm oak (in the Ranti Forest), and walnut trees. On the eastern side of the island, vegetation is sparser. [35] Regarding its fauna, Ikaria supports a high level of species diversity and population richness, primarily due to the complexity and variability of its geomorphological structure. The island's avifauna is particularly notable, featuring a wide range of species, including several rare and endangered birds. In the surrounding marine environment, a number of threatened species find refuge. [36]

The southwestern part of the island, covering an area of 73.66 square kilometers, has been designated as a Special Protection Area (Bird Directive) and is protected under the Natura 2000 network with the code GR4120005. Additionally, parts of the coastal zones of Ikaria and the Fournoi islands, with a total area of 130.36 square kilometers, have been designated as a Special Area of Conservation (Habitats Directive) under the Natura 2000 network, with the code GR4120004. [37]

Ikaria is rich in historical heritage, as evidenced by its monuments and the various findings from archaeological excavations. The island's present-day name originates from the myth of Icarus. The earliest findings on Ikaria date back to the Neolithic period. The island's first inhabitants were the Pelasgians, who settled there around 7,000 BC. During Roman and Byzantine times, it was repeatedly plundered by pirates. In 1912, the island's inhabitants revolted and declared independence, establishing the "Free Ikaria State" with its capital in Evdilos. This state lasted for four months, after which it was officially incorporated into Greece. The government was formed under the leadership of Dr. I. Malachias, and it had its own constitution, flag, and anthem. Ikaria is known today as the island of exiles or the red island. Due to its geomorphology,

Ikaria received a large number of exiles during World War II and afterwards, many of whom were communists and managed to integrate with the locals. [38]

In Ikaria, there is no evidence of organized urban planning, fortification systems, or a radial model of settlement development. In their efforts to protect themselves from pirate incursions, the inhabitants abandoned coastal settlements and relocated to the mountainous interior of the island. This strategic shift largely accounts for the absence of spatial organization and the lack of centralized settlement patterns. Furthermore, the island's rugged topography, combined with the seasonal utilization of its diverse ecological zones, contributed to the emergence of dispersed settlements lacking a cohesive urban core. A notable characteristic of this pattern is the phenomenon of polycentrism, whereby each household is associated with its own agricultural holding, thus forming an autonomous and self-sufficient unit. Consequently, settlements on the island are sparsely populated, spatially fragmented, densely vegetated, and disproportionately extensive relative to their population size.

Agios Kirykos is the largest settlement and the capital of the island. In Ikaria, there are a total of three designated traditional settlements: Akamatra, Lagkada, and Pezi and three settlements that exhibit notable traditional interest, although they have not been officially designated as traditional: Christos, Arethousa, and Karavostamo. [39]

Ikaria's road network is quite extensive due to the wide dispersion of settlements and the island's rugged terrain. However, it appears to be in poor condition [39] and is considered inadequate for the transportation of both people and goods. [40] The main road axis connecting the settlements at both ends of the island and the ports of Evdilos and Agios Kirykos, is paved and two-way. The primary road arteries are concentrated near the island's ports and airport and lead directly to the coastal and traditional settlements. The secondary road network extends inland toward the foothills of Atheras, as well as westward. It consists of both paved roads and dirt tracks and facilitates the connection between the main road axis and the island's remaining settlements and sites of cultural interest. [39] Finally, it is noteworthy that the southern and southwestern parts of the island lack a developed road network, due to the very limited number of settlements in that area. [39] In particular, the western region of the island shows reduced accessibility, with narrow, unpaved roads and steep gradients. [40]

As previously mentioned, the settlements of Ikaria were built without formal urban planning, are scattered, and disproportionately numerous relative to the island's population. This led to the development of an extensive network of footpaths that historically served to connect the settlements to one another, a significant portion of which has survived to this day. Some of these paths have been adapted to lead to areas of natural beauty or are now used for hiking purposes. Their condition varies, ranging from open and in need of minor maintenance to impassable and overgrown. [39]

Ikaria boasts a rich environmental reserve, with many sites recognized by national legislation and international conventions. These sites are included in the Natura 2000 Network, the list of Areas of Outstanding Natural Beauty, as Important Bird Areas, and as CORINE Biotopes. Some of the key sites of Ikaria's environmental reserve include the Randi Forest (as shown in Figure 1), the Estuary of river Myrsonas, the Estuary of river Halaris, the Estuary of torrent Voutsides, the Estuary of torrent Harakas, the Agios Nikolaos Area, the Fanari Ikaria, the Mount Atheras and the area of Plagia Ikaria, the

Agios Kirykos Reservoir, an Important Bird Area (GR143), the Lake Vathes, the Lake Pezi, Thermal Springs and Caves. [41]

Fig. 1. Randi Forest

Ikaria also boasts a rich cultural heritage with numerous archaeological sites, museums, churches, and monasteries, some of which are shown in Figure 2. These include the Ancient City of Therma, the Archaeological Site of Kampos, the Rock of Icarus, the Castle of Perdiki, the Castle of Koskina, the Kapsalino Castle, Miliopo, Nas, the Cape Drakano, the Ancient Sanctuary, Katafygi, Chryssostomos Cave, Agia Varvara Koukoumas, Agios Charalambos, the Holy Monastery of Evangelistria Mavrianou, the Holy Monastery of Evangelismos Mounte, the Holy Monastery of Agia Theoktisti and Theoskepasti, the Holy Monastery of Agios Onoufrios, the Church of Agios Nikolaos, the Church of Agia Eirini, the Church of Agios Kirykos, the Holy Monastery of Zoodochos Pigi, the Archaeological Museums of Agios Kirykos and Kampos, the Folklore Museums of Agios Kirykos, Agios Polykarpos, Vrakades, and Perdiki, the Mikis Theodorakis Museum and the Local Archival Collection of Ikaria. [42- 45]

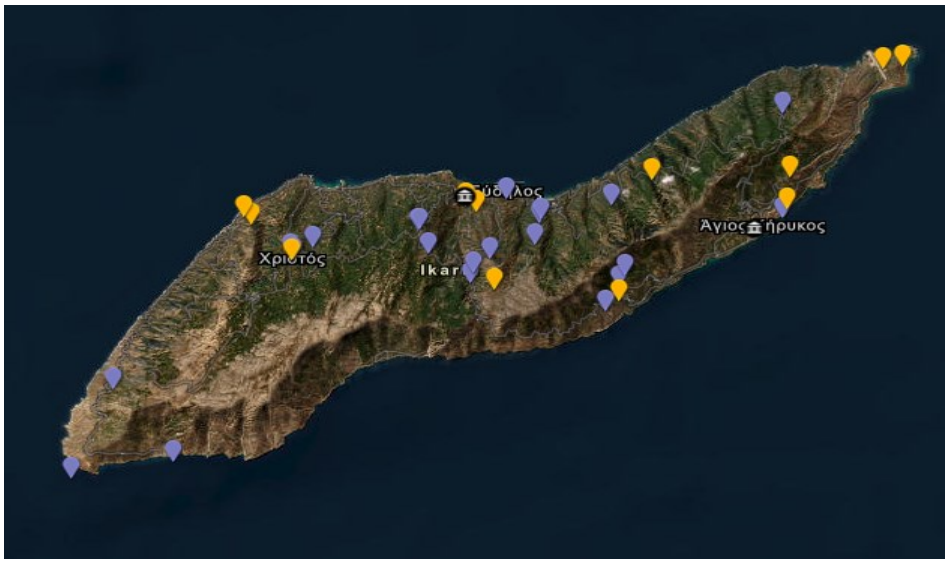

Fig. 2. Map of archaeological sites (in yellow) and monuments (in blue)

According to data from ELSTAT, during the latest census conducted in 2021, the permanent population of the municipality of Ikaria is 8,845 inhabitants, of whom 4,418 are male and 4,430 are female. The economically active population of the island amounts to 3,465, of which 2,770 are employed.[46]

The primary sector of Ikaria is primarily based on livestock farming. Agriculture on the island is gradually declining, mainly due to the fragmentation of land, with cultivation limited mostly to vineyards. Fishing is particularly prevalent; however, it mainly targets the local market rather than exports. The secondary sector of Ikaria primarily involves the processing of locally produced goods, mainly food products, and construction activities, which have flourished in recent years due to the development of tourism. The tertiary sector of employment is the most developed in Ikaria and employs the majority of the workforce. This is primarily due to the increase in tourist activity observed in recent years. [38] The percentage distribution of employees across the three sectors of the economy is as follows: 18% are employed in the primary sector, 12% in the secondary sector, and 70% in the tertiary sector. [47]

4.2 Presentation and economic analysis of sustainable development interventions

The sustainable development interventions for the island of Ikaria concern both its cultural and environmental reserve, as well as its road infrastructure. The aim of these proposals is to highlight and utilize the island's cultural and natural wealth in order to attract tourism and improve the quality of life and economic well-being of its residents, while taking into account the need for environmental protection.

Ikaria's road infrastructure, as previously mentioned, is underdeveloped and in poor condition. The repair, reconstruction, and expansion of the road network will contribute

to economic development, social well-being, and environmental protection, acting as a catalyst for the island's sustainable development. Specifically, it will improve the daily lives and quality of life of residents, attract visitors and investment, and will be designed in a manner that ensures environmental sustainability. Moreover, it will support the successful implementation of the cultural route initiative, as these routes have been planned to utilize both the primary and secondary road networks.

The proposals related to Ikaria's environmental assets include projects for the transportation, treatment, and disposal of wastewater, the replacement of water supply networks, and the monitoring of the island's water balance. These projects contribute to improving the quality of life for residents and ensuring the rational use of natural resources. They help reduce pollution and secure access to clean drinking water, protecting residents from health risks.

By utilizing and promoting Ikaria's cultural heritage, the economic development of the region can be achieved through the attraction of visitors and the development of alternative forms of tourism, while simultaneously strengthening local identity.

All the interventions mentioned below have a fixed budget and are either included in a development program or are in the process of being included, with the exception of the intervention concerning hiking and cultural routes. The selection of the projects and the information related to them were drawn from the Municipality of Ikaria, the North Aegean Region, the Ministry of Culture, and the postgraduate thesis of Ch. Barlas. [39]

The proposal for the hiking and cultural routes includes 10 hiking routes and 6 thematic cultural routes. The hiking routes were selected because they are the most well-known and frequently used in the area. Furthermore, sufficient information was available for these routes, enabling a reliable and thorough analysis. As of the cultural routes, these specific routes were chosen as they were originally developed within the framework of Ch. Barla's project [39], providing a relevant and structured basis for further analysis.

It has been proposed for both types of routes to implement the installation of welcome, directional, and informational signs, to carry out route cleaning, and to place information kiosks. Welcome signs are to be installed at the starting and ending points of each route. Directional signs will be placed every 250 meters and at intersections, while informational signs will be located at the beginning and end of each route as well as at points of interest, that is, the monuments encountered along each route. The proposed information kiosks are planned for installation in the three designated traditional settlements, the three traditionally significant (but not officially designated) settlements, at the ports of Evdilos and Agios Kirykos, and at the airport.

The project also includes wooden posts. Specifically, one wooden post will be installed at the beginning and end of each route, on which the welcome sign and the informational sign will be mounted. Additionally, one wooden post will be used for each informational sign at the points of interest, as well as one wooden post for each directional sign placed at the intersections of the routes. As for route cleaning, it is not included in the cultural routes' proposal, since these routes utilize the existing primary and secondary road network.

The calculations carried out to estimate the project budget are approximate. The prices of the products were determined based on market research.

Figures 3-8 illustrate the maps corresponding to each of the cultural routes included in the study. In red are the points of interest, and in orange, the landmarks where the information kiosks will be placed.

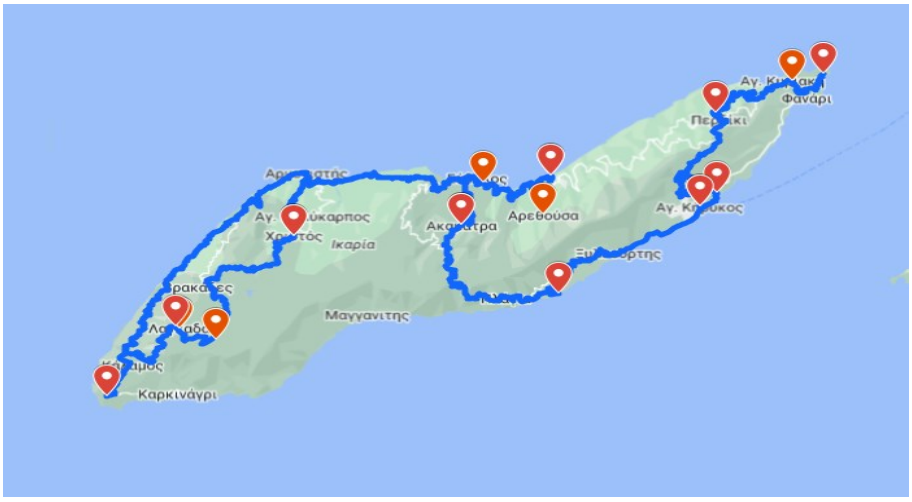

Fig. 3. Map of the archaeological route

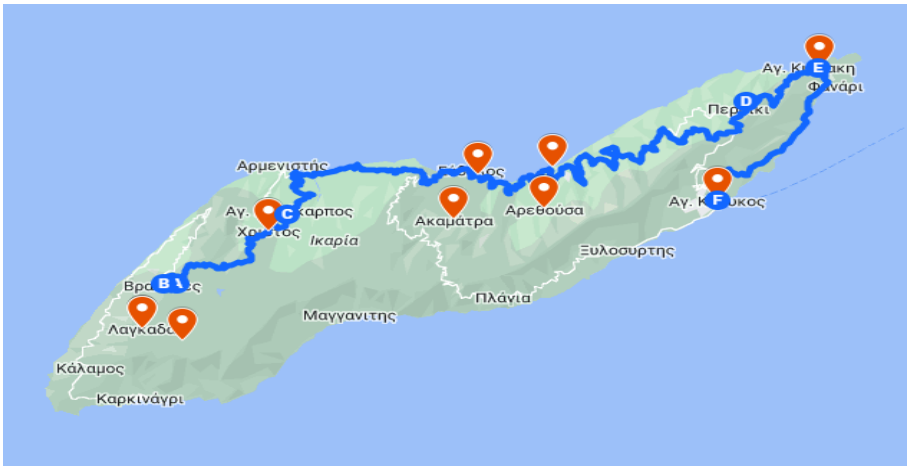

Fig. 4. Map of the modern cultural heritage route

Fig. 5. Map of the religious heritage route

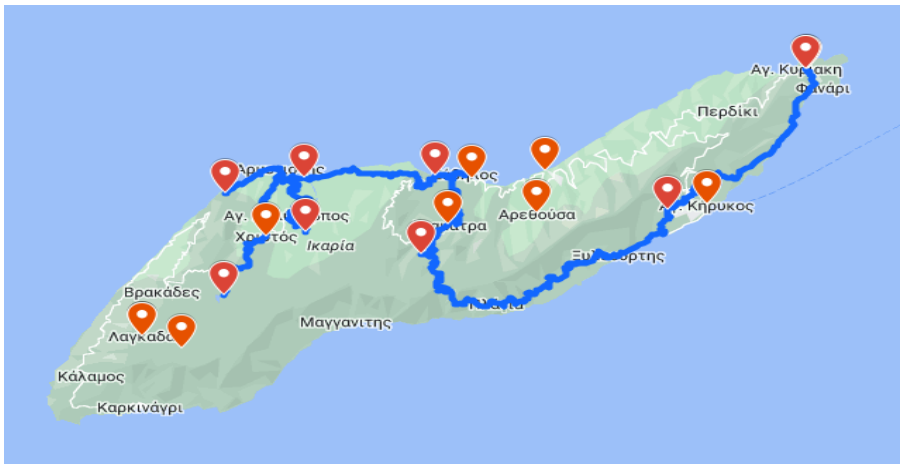

Fig. 6. Map of the exceptional natural beauty route

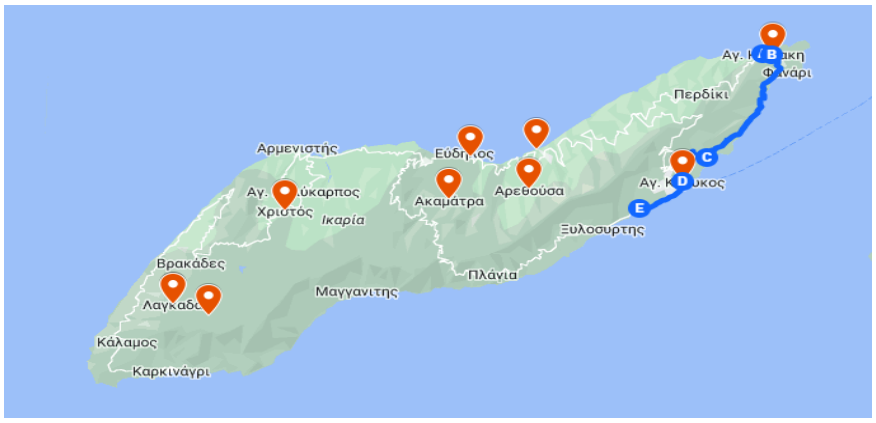

Fig. 7. Map of the thermal springs and baths route

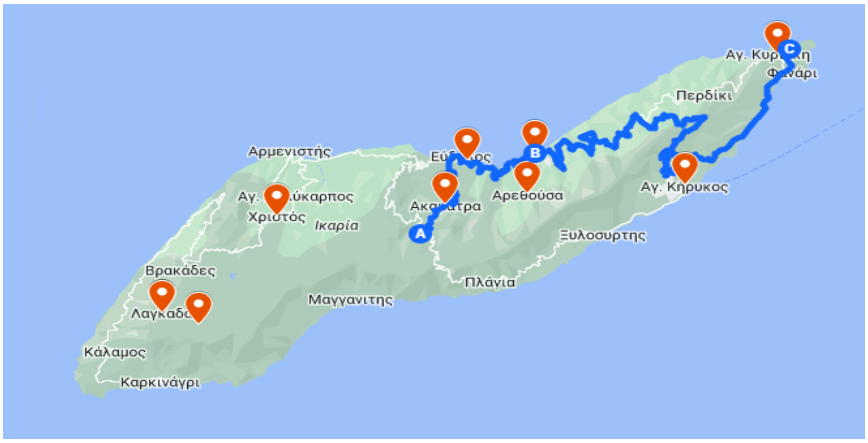

Fig. 8. Map of the speleology route

Tables 1-3 present the projects included in this work and the budget of each project.

Table 1. Road infrastructure interventions

Project	Budget
Improvement of the road network of Ikaria from Pezi to Lagada junction	719.346,46€
Asphalting of rural road Agios Dimitrios – Kato Raches	476.399,08€
Road Kouniadoi-Proespera Ikaria	4.610.000,00€
Improvement of parts of the Agios Kirykos-Evdilos Ikaria provincial road/ Improvement of parts of the Agios Kirykos-Evdilos-Steli-Fradato Ikaria provincial road	1.279.668,98€
Asphalting of Rural Road of Vaoni	246.071,30€
Regional Road of Evdilos Settlement of Ikaria	8.755.000,00€
Total	16.086.485,82€

Table 2. Environmental reserve interventions

Project	Budget
Transport, treatment and disposal of wastewater from the settlement of Karavostamo in Ikaria	1.863.110,84€
Installation of wastewater treatment unit of Faros settlement	486.080,00€
Transport, treatment and disposal of wastewater from the settlement of Agios Kirykos in Ikaria	4.456.943,47€
Replacement of water supply networks of Karavostamo	931.518,01€
Exploitation of the “Tsouredo” hydrogeyser in the area of Agios Kirykos, Municipality of Ikaria and construction of an external aqueduct	324.539,58€
Supply and Installation of stations for the collection and management of consumption and leakage data in the water supply networks of zones ZPY1, ZPY2, ZPY3 of the Municipality of Ikaria	2.995.092,03€
Construction of a Biowaste Treatment Plant (BTP) and a Waste Transfer Station (WTS)	1.300.000,00€
Total	12.357.283.93€

Table 3. Cultural reserve interventions

Project	Budget
Compilation of a structural restoration study for the Church of St. Kirykos in Ikaria	60.000,00€.
Expansion - renovation of the municipal hydrotherapy building "Apollo" in the Municipal community of Therma, Municipality of Ikaria	1.000.000,00€.
Redevelopment of public spaces in the settlement of Therma, Municipality of Ikaria	858.189,98€.
Preparation of an architectural study for the structural reinforcement and restoration of the earthquake-affected Church of St. Irene in Kampos, Ikaria	36.580,00€
Hiking and cultural routes	151.414,00€
Total	2.106.183,98€

4.3 Input-Output Model (Leontief) for the Sustainable Development of Ikaria

Each proposal was entered in monetary terms within the input-output model. To achieve this, the economic activities were identified according to the NACE Rev. 2 classification, into which the budget of each project was allocated. Subsequently, the budget was distributed across the selected activities.

For the purpose of facilitating budget allocation, the following assumptions were made:

1. A smaller percentage of the total budget was allocated to the economic activities of Electricity, gas, steam and air conditioning supply, as well as Water collection, treatment, and supply
2. A reduced percentage of the total budget was allocated to the economic activities related to the transportation of materials (Land transport and transport via pipeline, and Water transport), based on market prices
3. The remaining budget was evenly distributed across the other economic activities

Table 4 presents an example of the selection of economic activities and the allocation of the budget.

Table 4. Example of selection of economic activities and allocation of the budget

	CDA	CD	DSCR	Budget
Improvement of the road network of Ikaria from Pezi to Lagada junction	E	36	Water collection, treatment and supply	1.700,00€
	G	46	Wholesale trade, except of motor vehicles and motorcycles	139.929,26€
	H	49	Land transport and transport via pipelines	9.000,00€
	H	50	Water transport	9.000,00€
	M	71	Architectural and engineering activities; technical testing and analysis	139.929,30€
	N	77	Rental and leasing activities	139.929,30€
	F	42	Civil engineering	139.929,30€
	F	43	Specialised construction activities	139.929,30€
	Total			719.346,46€

4.4 Presentation and Discussion of Results

The results are presented in the form of graphs and include the direct, indirect and induced impacts of the implementation of sustainable development interventions on GDP and employment at local and national level.

Effects on GDP. The direct effect on national GDP amounts to €19.23 million, the indirect effect to €2.20 million and the induced effect to €19.71 million (as shown in Figure 9). The total effect amounts to €41.15 million.

It should be noted that direct effects represent the changes in GDP attributable to the economic activity of sectors that are immediately impacted by the proposed sustainable development interventions—namely, those sectors identified in the preceding subsection. Indirect effects refer to the GDP changes resulting from inter-industry linkages, particularly the supply-chain activities of sectors providing inputs to the directly affected industries. Induced effects correspond to the GDP variation driven by household consumption, stemming from the wages earned by employees in both the directly and indirectly impacted sectors.

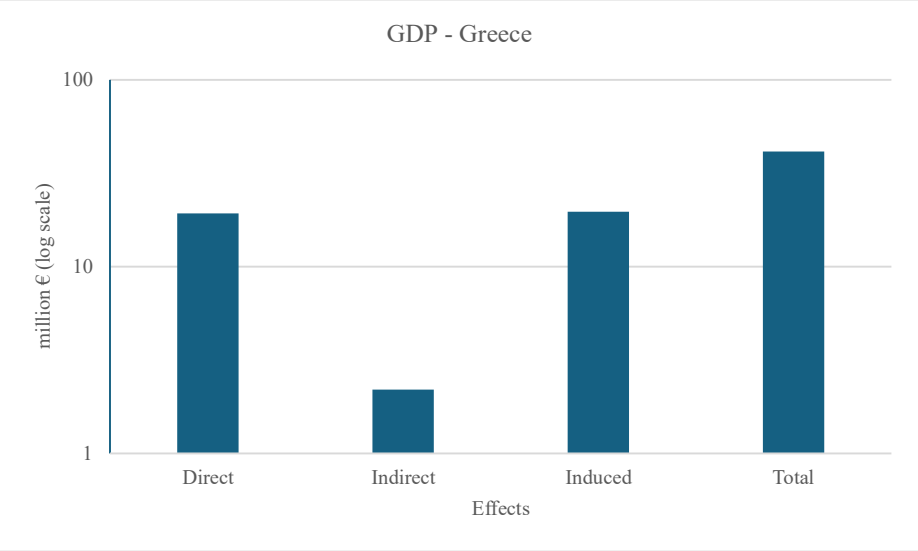

Fig. 9. Graphical representation of the effects of sustainable development proposals on the national economy in terms of GDP (logarithmic scale on Y axis)

The direct effect on the GDP of the North Aegean Region is €19.23 million, the indirect effect to €1.08 million and the induced effect to €0.25 million (as shown in Figure 10). The total effect amounts to €20.57 million.

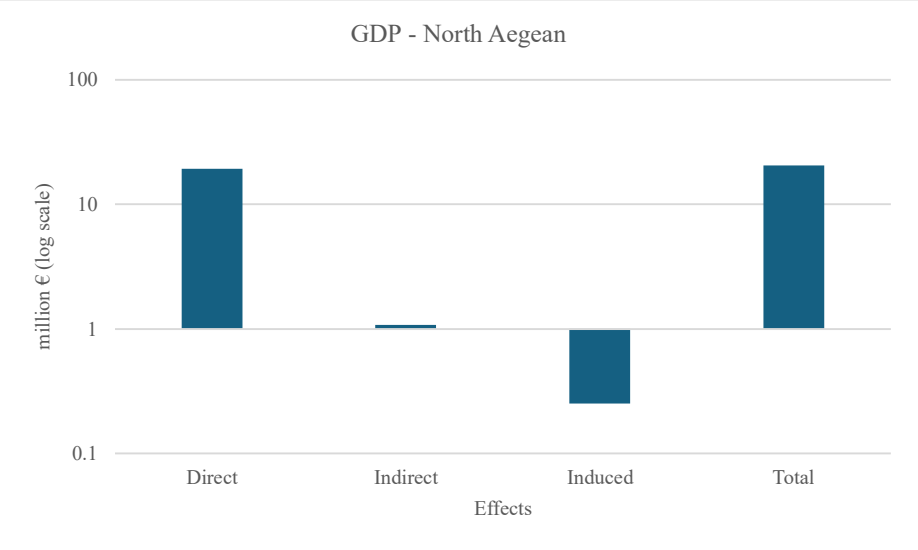

Fig. 10. Graphical representation of the effects of the sustainable development proposals on the North Aegean economy in terms of GDP (logarithmic scale on Y axis)

It is observed that the magnitude of direct effects remains the same at both the national and regional levels, as it corresponds to the same set of regional economic activities through which the sustainable development proposals are implemented.

The analysis suggests that the implementation of the proposed sustainable development interventions contributes to an increase in GDP at both the national and regional levels.

Effects on employment. The direct effect on national employment amounts to 569 employees, the indirect effect to 31 employees and the induced effect to 452 employees (as shown in Figure 11), leading to the creation of 1052 jobs in total.

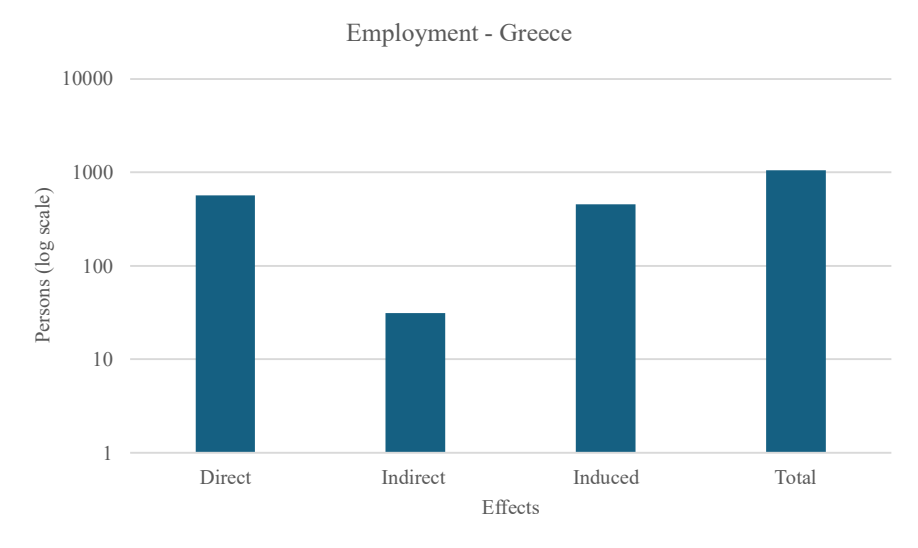

Fig. 11. Graphical representation of the effects of sustainable development proposals on the national economy in terms of employment (logarithmic scale on Y axis)

The direct impact on local employment is 569 employees, the indirect impact is 18 employees and the induced impact is 7 employees (as shown in Figure 12). The total impact amounts to 594 employees.

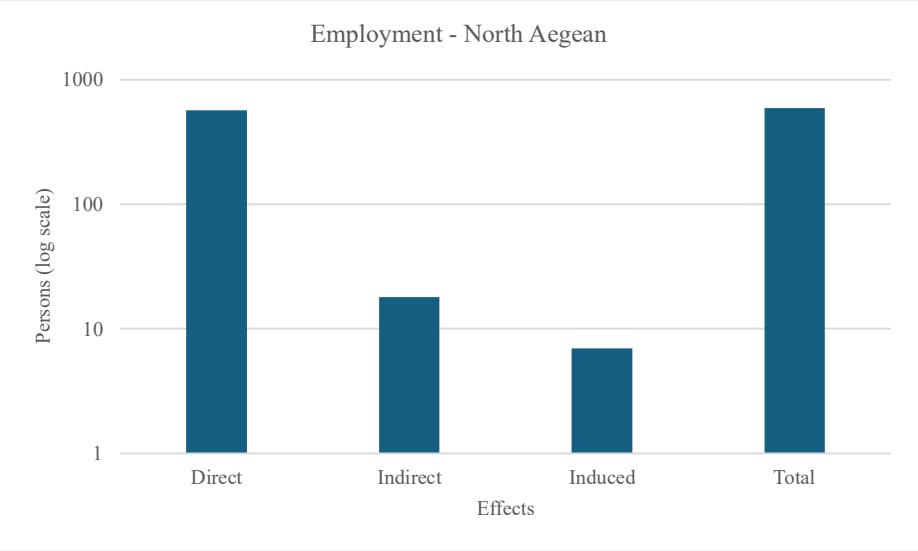

Fig. 12. Graphical representation of the impacts of sustainable development proposals on the North Aegean economy in terms of employment (logarithmic scale on Y axis)

As with GDP, the direct effects concern only the same group of regional economic activities. Therefore, as illustrated in the figures, the corresponding value is identical at both the level of the North Aegean Region and that of the national economy.

Based on the above analysis, it can be concluded that employment increases at both the national and regional levels as a result of the implementation of the proposed sustainable development interventions.

5 Conclusions

The methodological approach adopted in the Ikaria case study exhibits a high degree of transferability and may offer valuable insights for application in comparable contexts and future research endeavors. A concise overview of the methodology used in the Ikaria case study is provided below, highlighting the main research tools and steps followed throughout the study.

The study began with the establishment of a theoretical framework, which included key definitions and a literature review of relevant terms and concepts. Subsequently, the study area was analyzed through an extensive literature review, which focused on information regarding the natural and built environment, history, cultural heritage, as well as demographic and economic data of the region. The sustainable development interventions under investigation were then identified, including projects related to road infrastructure and the area's Cultural and Environmental Reserve (CER). The economic activities affected by these projects were classified according to NACE Rev. 2, and the corresponding project budgets were allocated accordingly. These data were then

integrated into an input-output model, which produced results on the impact of the interventions on GDP and employment at both national and regional levels.

In conclusion, the implementation of sustainable development interventions will have a positive socio-economic impact at national and regional level, increasing both GDP and employment. Based on the multipliers derived from the input-output analysis, for every million invested in the area, €1.35 million is returned to national GDP and €0.67 million to local GDP. Additionally, for every million invested in the area, 34 jobs are returned to national employment and 19 jobs to local employment.

The sustainable development interventions have the potential to stimulate the local economy, establish infrastructure that enhances the quality of life for residents, generate employment opportunities, and attract tourism as well as additional investment. Consequently, they contribute to the island's economic development, promote social well-being, and support the preservation and enhancement of its cultural and environmental assets.

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