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Land Use Changes, Environmental Impact and Socio-Economic Effects of Road Infrastructure Mega Projects: The Combined Case of the Rio–Antirio Bridge and the Ionian Road in Greece

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Abstract: The research aims at studying land use changes, the environmental impact and socio-economic effects from the construction of major road transport infrastructure projects. The methodology adopted herein includes a review of the relevant literature to examine the relationship between infrastructure provision and associated positive or negative impacts on land, environment, society and economy. Statistical data mainly from the Hellenic Statistical Authority and useful informational data from relevant research and recent studies were collected and processed in order to evaluate the overall effect of the two major road projects Gefyra "Charilaos Trikoupis" (Rio–Antirio Bridge) and Ionia Odos (Ionian Road) in the Regions of Dytiki Ellada (Western Greece), Ipeiros (Epirus) and Ionioi Nisoi (Ionian Islands). The descriptive statistical analysis indicates that positive impacts include the following: transport time savings and road safety improvement; increased commercial imports/exports activity; increased private building activity and tourist traffic/employment; and intensified truck traffic at the port of Igoumenitsa. Conversely, negative impacts involve: less arable agricultural land; increased whilst tolerable environmental pollution; and a general reduction in all types of traffic activity at the port of Patras. From the quantitative analysis using the analytic hierarchy process (AHP), it emerged that the most overall benefitted region is the Ionian Islands, followed by Epirus and Western Greece. The general conclusion from the research seems to support the theoretical approaches and related studies: transport infrastructure is an important condition but not a guarantee of regional development.

Keywords: infrastructure; land use; environment; socio-economic effects; AHP; Greece

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1. Introduction

Infrastructure is defined in the Merriam-Webster dictionary [1] as the basic physical systems of a business, region or nation and often involves the production of public goods or production processes. According to the World Bank, infrastructure is the basic framework for delivering energy; transport; water and sanitation; and information and communication technology (ICT) services to people, directly or indirectly affecting their lives [2]. The European Union (EU) Regulation no. 1303/2013 defines a "major project" as an investment operation comprising a series of works, activities or services intended to accomplish an indivisible task of a precise economic and technical nature, which has clearly identified goals and for which the total eligible cost exceeds EUR 50 million [3]. Major, or *mega*, infrastructure projects require complex decision making processes and a long period of design and construction [4]. The land footprint of large projects extends beyond their physically occupied space to a much greater extent than a typical construction project which has always a spatial effect. In this sense, such projects may be regarded as a factor of change that is not only spatial but social [5]. Among the different types of infrastructure, transport infrastructure is considered to be one of the most important by policy makers, since transport cost is very crucial in deciding the choice of location for firms and therefore economic regional development [6]. Mega transport projects express national aspirations for economic and social development as a means of achieving territorial cohesion, reducing economic disparities and fostering economic growth [7]. Transport infrastructure is the cornerstone of EU regional development policy. Between 1995 and 2013, over 60% of transport infrastructure investment in the EU was devoted to roads. In terms of financial resources, the investment in road infrastructure over this period amounted to EUR 66 billion. Out of this, 76% was spent on the Trans-European Networks (TEN-Ts) that cover motorways and express roads [8]. Thus, public investments in road transport projects are a key component of the Greek economy, corresponding approximately to 85% of the total public budget for infrastructure [9]. Examples of major transport investments in Greece are as follows: the Attico Metro, the Egnatia Odos, the Gefyra "Charilaos Trikoupis" (Rio–Antirio Bridge) and the Ionia Odos (Ionian Road). The combined effects of the last two mega projects are examined in detail in subsequent sections.

The magnitude and number of changes caused by transport infrastructure directly or indirectly, in the areas they affect, have raised key and reasonable questions, which should be considered by project planning bodies in general and decision makers involved. The first and foremost issue is whether the operation of the project will achieve the initial expectations and predictions of increased traffic and resulting user benefits. The second issue relates to the land use changes and environmental impacts, which may be caused by the construction and operation of a large transport project. The third question is whether the economic and developmental benefits of transport infrastructure are greater than the benefits of other public material or intangible investments (education, health, social welfare, etc.). The fourth issue concerns the real contribution of interregional road infrastructure to the strengthening of less developed regions [10].

This research at first introduces a methodological framework for the exploration of a number of positive and negative regional effects from transport infrastructure major projects which is founded on the following five pillars: (i) road network and transport; (ii) land use; (iii) natural environment; (iv) economy; and (v) society. Based on recent relevant statistical data that was collected and analyzed, the above framework is then applied to the combined case study of the Rio–Antirio Bridge and the Ionian Road in order to assess the magnitude of changes caused by the construction and operation of these two major transport projects to the core Regions of Dytiki Ellada (Western Greece) and Ipeiros (Epirus) as well as to the adjacent Region of Ionioi Nisoi (Ionian Islands). Using the widespread multicriteria decision making technique of the analytic hierarchy process (AHP), a quantitative pairwise comparative analysis is conducted to assess the overall impact on the above three regions under study.

The remainder of the paper is organized as follows. Section 2 shortly reviews prior literature regarding several impacts of transport infrastructure mega investments on regional economic development. Section 3 provides the research methodological framework based on the different types of these effects. Section 4 presents the results from the combined case study of the Rio–Antirio Bridge and the Ionian Road in Greece with emphasis on the AHP application. Finally, concluding remarks are offered in Section 5.

2. Literature Review

The term impactor effect is a general term which covers all economic and physical effects (positive or negative) of an investment on the environment. The positive effects (+) constitute what are called benefits, while the negative effects (−) constitute what are called costs. The most important impacts are those that are purely economic in nature, but there are always social ones as well, which are usually a consequence of economics.

The direct effects of road infrastructure production, such as the reduction of transport costs, combined with migration changes of households and business locations, lead to increased regional productivity. Within households, a decrease in travel times leads to the achievement of the same level of productivity but also consumption in a shorter time. It also stimulates elasticity relating to the migration process. Within the business sector, transport improvements lead to the effectiveness of production and positive impact on the "just in time" principle. In the labor market, commuting time is significantly reduced [11].

The effect of road infrastructure on traffic accidents was studied in [12], and the results showed a reduction in the rate of road accidents up to 20–25%.

In [13], it was stated that, due to the lack of roads, or the poor condition of the existing roads, and due to the low level of road safety, at some tourist destinations, there may be a decrease in traffic for tourist needs. This means that developed tourism must be preceded by a developed road infrastructure. The study in [14] concludes that a good transportation network is imperative for promoting tourism development and ultimately tourism sustainability in Nigeria.

According to [15], public investments in road transport infrastructure have positively affected regional productivity performance in Spain. The authors in [16] analyzed data from China and found that higher economic growth levels come, to a great extent, from better transport infrastructure and that public investment in road construction in poor areas is crucial to growth and poverty alleviation.

New road infrastructure in Greece is a cost-saving input in most manufacturing industries, as it enhances their productivity growth [17].

Indirect impacts of transport infrastructure construction can be analyzed through changes of attractiveness of the monitored region, size of movement of goods and services and changes in the size of transport costs, i.e., changes in relative competitiveness of the regions. In addition to these changes, indirect effects also refer to changes in the environment, i.e., noise, vibrations, air and water pollution, conservation of nature, landscape changes, land development, etc. [18]

Transport accessibility facilitates the functioning of local enterprises, facilitating transport related to the acquisition of materials needed to produce goods or the provision of service sand ordinary residents who can move quickly and meet their daily needs [19].

Transport improvements decrease transportation costs and improve access to markets and labor, which may foster economic integration, stimulate competition and generate agglomeration economies and other "wider" economic benefits. A key finding is that road improvements increase ward-level employment and the number of establishments. A 1% increase in accessibility leads to a 0.3–0.5% increase in establishments and employment. However, no employment effects at establishment level are seen, implying that local employment changes come about through establishment of entries and exits. Conversely, positive impacts on labor productivity (specifically on gross output and average wages) were found [20].

The transport sector is the largest contributor to anthropogenic pollutant emissions in urban environments worldwide. The importance of vehicle emissions in total urban pollution and the associated serious consequences naturally lead to concerns by policy makers, the media and the general public about traffic emissions. By definition, total traffic emissions are a product of vehicle volume and unitary emission. Thus, one way to contain urban pollutions is to reduce the number of vehicles on the road. However, in growing and urbanizing economies such as China, this appears to be impossible [21].

The main conclusion of an econometric analysis [22] is that the geographic landscape of the production per worker in the manufacturing sector in Mexico depends significantly on road infrastructure endowment. Road infrastructure in general has a positive and significant impact on regional variations in output per worker. Access to international and regional markets has large and significant spillovers on output per worker, while a poor quality of regional roads may be associated with losses in output per worker.

The literature discussion with respect to the importance of infrastructure development over general well-being has been the subject of constant debate. Although the idea of a positive relationship between both variables is accepted, it is of the utmost importance to keep in mind that both concepts must be properly delimited to verify a significant and positive relationship. The lower the level of development, the greater the impact through from the density of roads than on paved roads [23].

Roads generate an array of ecological effects that disrupt ecosystem processes and wildlife movement. Road placement within the surrounding landscape is possibly the most important factor determining the severity of road impacts on wildlife because it influences roadkill locations and rates and the observed presence or absence of species. Herpetofauna throughout the world have the potential to be negatively influenced by roads as a consequence of urbanization, either directly from on-road mortality or indirectly as a result of a variety of ecological impacts, particularly increased human access to the landscape [24].

Polluting substances are spread as a consequence of the construction and use of roads. The combustion processes of vehicles, the wearing of vehicles, road surface degradation, the wearing of signposts and crash barriers and the application of road maintenance chemicals disseminate pollutants into the environment; some are spread diffusely while others are deposited in the immediate vicinity of the road [25].

The vast road network spread over the landscape contributes directly to the mortality of other species and to the attrition, shrinkage and fragmentation of their habitat. Similarly, traffic noise on busy highways causes inconvenience to people and wildlife alike. Furthermore, because of their negative effect on the structure and function of ecosystems, the flow and quality of water and the earth's climate, roads and the resulting traffic can be seen as a threat to the long-term survival of species [26].

3. Methodological Framework

Following the relevant literature, the impacts of major road infrastructure projects usually concern the following: road network and transport; land use; natural environment; the economy (both regional and national); and society. Accordingly, the proposed framework for examining positive and negative effects of road transport projects is summarized in Table 1.

Table 1. Proposed framework for the effects of road transport infrastructure mega projects.

1. Road Network and Transport	1.1 Reduction in transport costs: (+) and (−) The most essential direct effect of the improvement of transport infrastructure is the reduction in transport costs within the region and among regions. Transport costs can be financial (e.g., time cost, vehicle operating costs, etc.) or non-financial (e.g., traffic accidents).
	1.2 Development of side and neighboring road networks: (+) and (−) On the occasion of the construction of a mega road project, the local authority may construct or apply for funding for side and neighboring road projects.
	1.3 Reduction of urban traffic load: (+) and (−) The construction of city center bypass roads, which usually accompany motorways connecting major urban centers, results in the decongestion of urban road networks. A possible negative effect may be the increase in urban traffic load on roads near highway entry/exit junctions.

Table 1. *Cont.*

2. Land Use Changes	2.1 Reduction in arable agricultural land: (−) This problem arises mainly due to expropriations for the construction of the highway, uneven junctions, toll stations, service stations, etc.
	2.2 Replacement of agricultural land by industry/handicrafts: (−) and (+) This phenomenon is particularly observed near nodes due to accessibility. The current legislative framework on land uses, building conditions, etc., has a decisive role in the way land use is changed. This phenomenon is not necessarily negative, since it can have significant developmental and social benefits, such as the creation of new jobs at new businesses.
3. Natural Environment	3.1 Noise from construction and operation: (−) Usually, the environmental conditions of the studies of modern highways do not permit their construction near residential areas. Even if noise from the highway is noticed or reported, there are ways to deal with it, such as the construction of sound barriers.
	3.2 Air pollution: (−) As in the case of noise, the distances of modern highways from residential areas are sufficient to avoid the adverse effects of pollution on residents. However, the same is not the case for workers in areas near highways, and this is an issue to be investigated. In general, it could be argued that vehicles traveling at constant speeds on highways cause less air pollution than vehicles traveling at varying speeds.
	3.3 Local flora, fauna and water pollution: (−) Modern specifications of environmental studies of road projects take seriously the protection of wetlands that may be located near the project. In some cases, such as the construction of bridges that cross rivers, the local flora and fauna may be affected.
	3.4 Flood phenomena: (−) The temporary interruption of the natural flow of water during the construction of bridges that cross rivers can cause flooding. Also, during maintenance (either by the district or by the concessionaire), regular maintenance of wells, drainage works, etc. must be carried out.
4. Economy	4.1 Increase in production activity: (+) This is perhaps the most significant economic impact of a major road project. For example, when a product's lead time is shorter, then its production is more attractive. The increase in accessibility due to faster and safer access results in both the easier transportation of raw materials and the possibility of making the produced products available in more markets.
	4.2 Attracting investments/innovation: (+) Examples are new logistics businesses in areas close to main roads and increases in private building activity.
	4.3 Increase in tourism: (+) This is a particularly critical effect, since it is known that tourism constitutes the "heavy industry" of Greece. A new fast and safe highway can significantly increase the traffic of resorts, tourist attractions, museums and even cities, especially on weekends and holidays. The improvement of the road network can also lead to the development of other types of tourism, such as agritourism and conference and cultural tourism.
5. Society	5.1 Population changes: (+) or (−) Economic development that could be brought about by a large infrastructure project could also have an effect on population change in areas affected by the project. As a negative consequence of the phenomenon, overpopulation of urban centers, regional inequalities and the isolation of remote areas could be mentioned.
	5.2 Improving health quality: (+) According to the World Health Organization, quality of life involves a person's perception of their life situation in relation to their culture, value system, goals, aspirations and concerns. A basic condition, perhaps the most important for the quality of life, is health. The reduction in travel time brings the major hospitals of the urban centers closer to the most remote areas. Quick access and a sense of proximity to large health units can contribute to the safety and tranquility of the population, especially in the elderly and vulnerable groups.
	5.3 Improving quality of education: (+) Another factor that seems to be positively affected by the construction of major road projects is that of education, due to faster and safer access to major educational institutions.
	5.4 Increase in employment/decrease in unemployment: (+) or (−) The employment sector is also expected to benefit from the construction of major road projects. In the short term, the construction of large infrastructure projects requires a significant number of workers, resulting in the creation of new jobs and new employment opportunities for local residents. In the long term, the creation of new jobs will depend on the economic effects of the project but also on the general course of the economy at national and international level. A reduction in unemployment has a positive impact on the economy and well-being but also on the psychology of citizens.
	5.5 Individual and social well-being: (+) Prosperity indicators such as income and purchasing power can be positively affected by the financial success of a major infrastructure project. Safe and fast access to ports, airports and large cities are elements of citizens' daily lives that contribute to their well-being. It would be remiss not to mention the impact on social well-being, which is linked to personal relationships, such as friendship, family and community. A major road project can bring residents of areas it connects closer together and develop relationships between them.

Based on the above table, these effects will be examined in the study of the combined case of the Rio–Antirio Bridge and the Ionian Road.

4. Combined Case of the Rio–Antirio Bridge and the Ionian Road

Figure 1 shows the location and relative size of the two Greek regions where the two mega projects, the Rio–Antirio Bridge and Ionian Road, operate, i.e., the Region of Dytiki Ellada (RDE) and the Region of Ipeiros (RIP). The total study area is 20,553 sq.km, i.e., 15.5% of the total area of Greece. The DMS (degrees, minutes, seconds) latitude/longitude span of the study area is from 39°39′54.1008″ N/20°51′13.4856″ E (Ioannina) to 38°14′47.9004″ N/21°44′4.4628″ E (Patras).

Figure 1. Location and size of the Regions of Dytiki Ellada and Ipeiros [own elaboration [27]].

For the assessment of the effects of both the Rio–Antirio Bridge and the Ionian Road, the categorization of Table 1 is followed. Data from several sources are used: the Hellenic Statistical Authority (ELSTAT); the Port Organizations of Patras and Igoumenitsa; studies by the Road Axis Observatory of Dytiki Ellada and Peloponnisos (POADEP); the official websites of the projects under study; and relevant satellite photos and maps. Indicators per region are examined, focusing on the directly affected the RDE and the RIP and the neighboring Region of Ionioi Nisoi (RIN). For comparison purposes, data concerning the Regions of Attiki, Peloponnisos and the entire country are also shown. This section is divided into subsections, depending on the type of impact as described in Section 3.

4.1. Road Network and Transport

4.1.1. Reduction of Transport Costs

a. Travel time savings

Before the construction of the Ionian Road, the average vehicle speed did not exceed 70 km/h. Due to the quality of the new road surface and the existence of uneven junctions, cars can today move comfortably at an average speed of 110 km/h. Based on these speed figures, prior to the operation of the Ionian Road, the trip from Antirio to Ioannina lasted approximately 3 h, while with the Ionian Road, it takes 1 h and 40 min, i.e., 44% less travel time. To cross the Rio–Antirio Sea by ferry usually takes 45 min, while using the bridge requires only 3 min of driving, i.e., a time saving of 93%. Combined with the construction of these infrastructure projects, the travel time between the two major urban centers of Patras and Ioannina was reduced from 4 h to 2 h, i.e., by 50%.

b. Vehicle crossings/traffic load of the Rio–Antirio Bridge

Since the opening of the bridge in 2004, the total traffic of vehicles or otherwise the total number of crossings (bridge and ferry) increased steeply, with an average annual growth rate of 13% [28]. According to a qualitative study carried out by the Observatory of Road Axes of Dytiki Ellada and Peloponnisos [29], among the main advantages of the operation of the bridge are the following: proper travel planning and timely arrival at various destinations; not being blocked by weather conditions; the avoidance of discomfort, irritation and minor accidents on the ferries from the waiting lines before boarding, from the procedures during boarding, from overcrowding and frequent violations of priority during disembarkation and from any damage to the boats; strikes, etc. Disadvantages were also expressed in the aforementioned social acceptance survey: the cost of transit and the non-possibility of rail transit through the bridge, which would significantly increase the benefits of the bridge both at local and national levels [29].

c. Road traffic accidents

According to the Road Safety Committee of the Hellenic Parliament [30], Greece has one of the highest numbers of deaths per million inhabitants in traffic accidents compared to the EU average (149/109 in 2002; 91/54 in 2012; and 61/46 in 2022). One of the main benefits from the improvement of road axes is the reduction in traffic accidents. As can be seen in Figure 2, there has been a steady decrease in the number of road traffic accident fatalities per 1,000,000 inhabitants in Greece generally (from 79.9 in 2013 to 62.5 in 2022, i.e., a reduction of 21.78%) and in the RDE specifically (from 133.3 in 2013 to 92.8 in 2022, i.e., a decrease by 30.38%), the RIP (from 116.6 in 2013 to 59.5 in 2022, i.e., a reduction of 48.97%) and the RIN (from 144.1 in 2013 to 127.3 in 2022, i.e., a decrease by 11.66%).

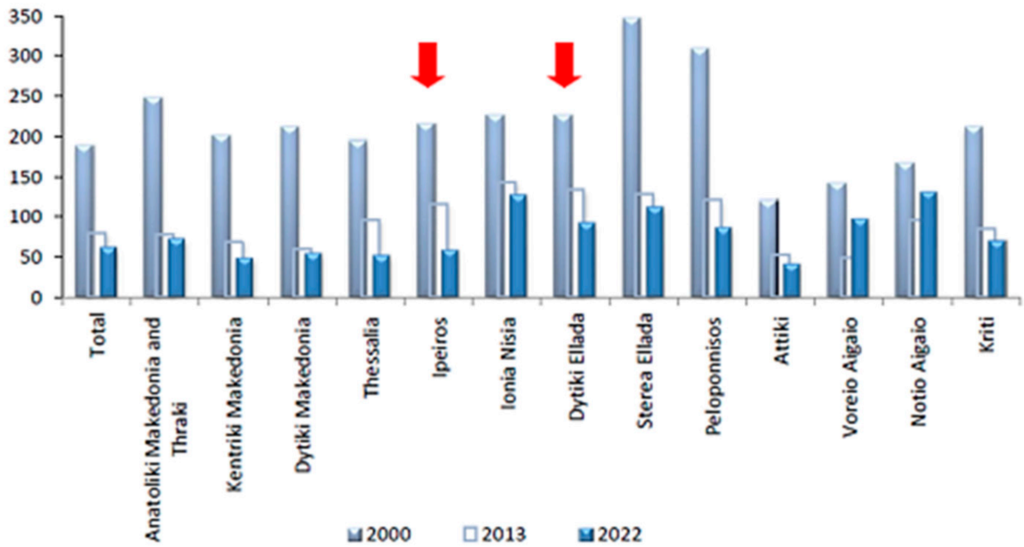

Figure 2. No. of road traffic accident fatalities per 1,000,000 inhabitants; NUTS 2, 2000–2022 [31].

In 2022, the RIP succeeded in having fewer fatalities than the country's average (Figure 3). This fact can be attributed to the operation of the Ionian Road, which crosses the region.

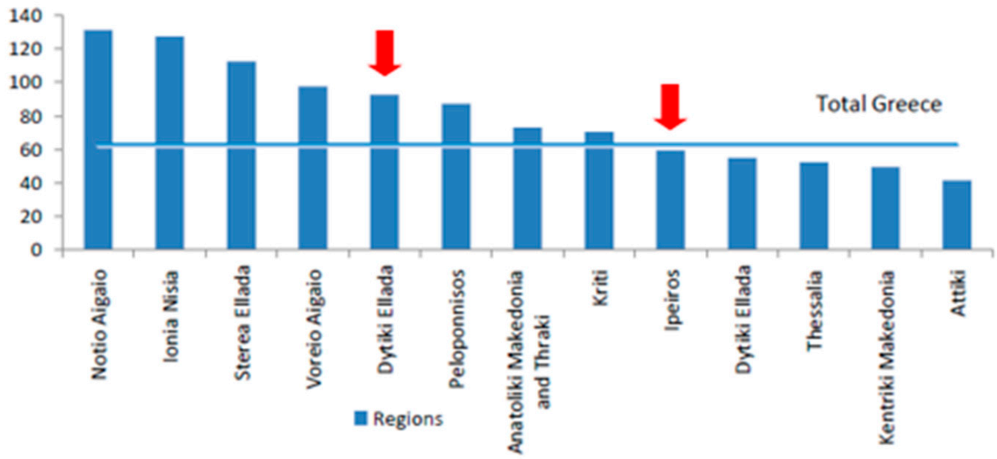

Figure 3. No. of road traffic accident fatalities per 1,000,000 inhabitants; NUTS 2, 2022 [31].

4.1.2. Development of Side and Neighboring Road Network

The construction and operation of a major road axis can be an additional tool in the effort of regions to finance, build or accelerate studies and projects of side or neighboring road networks. Within the framework of the objectives of the regional operational programs (ROP) of the two regions [32,33], a total budget of approximately 72 million euros was approved for road development projects of the side and neighboring road network of the Ionian Road.

4.1.3. Reduction of Urban Traffic Load

The Perimetric Road of Patras is an expressway that crosses the perimeter of Patras and connects the New National Highway of Patras–Athens (Olympia Odos) with the National Highway of Patras–Pyrgos (Figure 4). The benefits of the operation of this perimetric road for the quality of life of the residents of Patras are reduced traffic, noise and pollutants because cars from the Corinthos–Patras National Highway in the direction of Pyrgos are no longer passing through the central streets of the city.

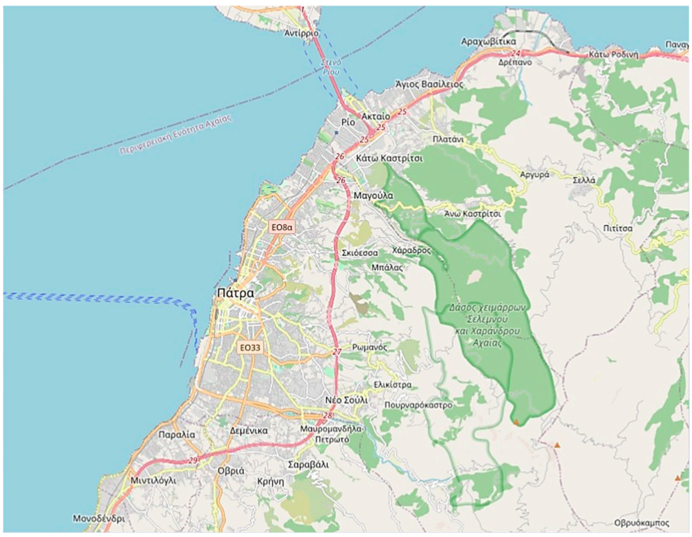

Figure 4. Perimetric Road of Patras [34].

In addition, the quality of life of Arta's residents has also been improved by the road project for the bypass of Arta and Philippiada (Figure 5).

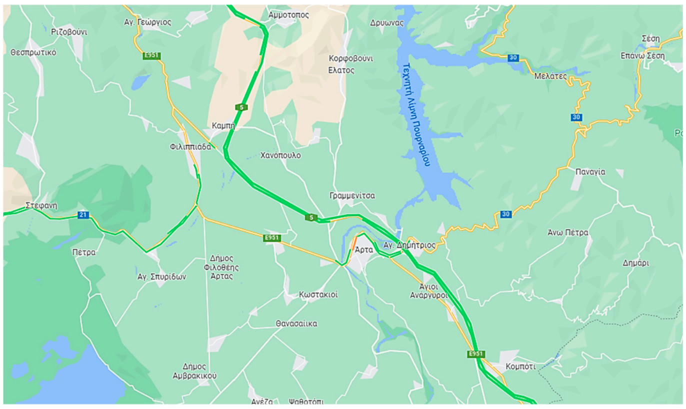

Figure 5. Ionia Odos, Arta and Philippiada bypass [34].

4.2. Land Use Changes

4.2.1. Reduction in Arable Agricultural Land

Table 2 shows a general reduction in arable agricultural land from 2015 to 2022. The RIP's rate shows no change in essence (−0.70%), but the RDE has a significant decline of 16%. This decline is much less than that of Peloponnisos and Ionioi Nisoi but higher than nationwide.

Table 2. Crops on arable agricultural land in thousands of hectares by region [31].

Area	**2015**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**% Change 2015–2022**
Ipeiros	28.7	29.1	30.8	30.4	28.4	29.4	28.5	−0.70%
Dytiki Ellada	133.5	131.2	131.0	133.2	100.2	101.1	112.1	−16.03%
Ionioi Nisoi	8.4	6.0	6.9	7.0	2.4	4.2	2.8	−66.67%
Peloponnisos	41.0	36.8	36.3	35.0	26.7	25.5	29.6	−27.80%
Greece	1737.1	1720.1	1719.5	1698.9	1614.3	1617.9	1638.2	−5.69%

Obviously, the construction of the Ionian Road had a negative effect in terms of the use of arable agricultural land in the regions under consideration. The construction of motorways requires expropriations mainly for uneven junctions. A comparison of the Antirio hub area before and after the construction of the Ionia Odos is demonstrated in the following aerial photos where the effect on agricultural land is presented (Figures 6 and 7):

Figure 6. Antirio hub area in 2003 [34].

Figure 7. Antirio junction area in 2020 [34].

Similarly, in the case of the Gavrolimni junction, the improvement of the side road network achieved in the old National Road of Rio-Agrinio in the Chania area resulted in less arable land (Figures 8 and 9):

Figure 8. Gavrolimni hub area in 2003 [34].

Figure 9. Gavrolimni junction area in 2019 [34].

4.2.2. Replacement of Agricultural Land by Industrial/Handicraft

Part of the agricultural land along the Ionian Road was replaced for the establishment and operation of new businesses in accordance with the zoning plan and environmental conditions. Figures 10 and 11 show two businesses whose sites replaced agricultural land but which contribute to the economic development of the area and the creation of jobs.

Figure 10. Car service station in the Evinochori area [34].

Figure 11. Industrial factory of a multinational firm at Preveza junction [34].

4.3. Natural Environment

In 2020, an environmental impact study by the European Commission [35] revealed a negative environmental burden index after the construction of the Rio–Antirio Bridge.

4.3.1. Noise from Construction and Operation

The evaluation indices and the maximum permissible limits of environmental noise originating from the operation of transportation projects are determined in accordance with European Directive 2002/49/EC and relevant harmonized Greek legislation. The limits of road traffic are determined according to specific evaluation indicators based on which noise limits were generally not exceeded.

4.3.2. Air Pollution

The air pollution limits have not been exceeded to date at any of the three measuring stations (Evinochori, Philippiada and Episkopiko).

4.3.3. Local Flora, Fauna and Water Pollution

Sampling was carried out in the environmentally sensitive areas of each section of the Ionian Sea, and according to the results of the analyses, the following statements can be made:

- There was no excessive cadmium, lead or arsenic concentration during any cycle or in any sample.
- There were no excessive iron concentrations, while in several cases, even the drinking water limit was met.
- There was no excessive BOD (biochemical oxygen demand) or COD (chemical oxygen demand) in the cases of rivers and lakes under the direct influence of the highway.
- There was no exceedance of the limits of sulfate, chloride, ammonia, fluoride, phosphate, nitrate or nitrite ions in the case of rivers and lakes under the direct influence of the highway.

4.3.4. Flood Phenomena

No flood phenomena have been recorded to date.

4.4. Economic Effects

4.4.1. Increase in Production Activity

a. Production capacity

Table 3 shows the gross domestic product (GDP) values from 2017 to 2021 for the regions of Dytiki Ellada, Ipeiros, Peloponnisos and the Ionian Islands, which are most affected by the effects of the two mega projects under study. As a means of comparison, GDP figures for the entire country and the region of Attica are also recorded.

Table 3. GDP by region in billions of euros [31].

Area	2017	2018	2019	2020	2021	% Change 2017–2021
Ipeiros	3.87	3.94	3.96	3.60	3.95	+2.07%
Dytiki Ellada	7.84	7.95	8.05	7.32	8.01	+2.17%
Ionioi Nisoi	3.05	3.16	3.24	2.53	2.93	−3.93%
Peloponnisos	8.06	8.06	8.28	7.50	8.17	+1.36%
Attiki	84.54	85.69	87.94	79.59	86.88	+2.51%
Greece	176.90	179.56	183.35	165.02	181.50	+2.60%

From the above data, it can be concluded that the regional GDP most affected by the operation of the Rio–Antirio Bridge and the Ionian Road shows an increase of around 2% over time, which is less than that of the country as a whole and Attiki. Conversely, the Ionian Islands showed a decline of around 4%. Therefore, no significant positive effect on the regional GDP can be reported.

b. Commercial activity

Commercial activity in terms of exports and imports for the period 2015–2021 as recorded by the (Greek) Institute of Export Research and Studies (IERS) [36] is demonstrated in Tables 4 and 5:

Table 4. Exports by region in millions of euros [36].

Area	2015	2016	2017	2018	2019	2020	2021	% Change 2015–2021
Ipeiros	316.0	263.9	267.6	306.7	323.8	350.6	413.1	+30.73%
Dytiki Ellada	514.9	548.3	510.8	564.7	553.2	567.3	722.4	+40.30%
Ionioi Nisoi	97.1	86.4	109.2	115.9	91.6	85.4	224.1	+130.79%
Peloponnisos	3666.6	3386.8	4309.1	5243.6	4518.0	2994.2	5383.3	+46.82%
Attiki	12,440.6	12,408.2	13,961.6	16,838.5	17,862.7	16,810,2	20,735.8	+66.68%
Greece	25,428.4	25,150.0	28,496.9	33,087.6	33,419.1	30,400.0	39,382.8	+54.88%

Table 5. Imports by region in millions of euros [36].

Area	2015	2016	2017	2018	2019	2020	2021	% Change 2015–2021
Ipeiros	198.2	235.5	289.7	294.2	268.8	270.3	293.6	+48.13%
Dytiki Ellada	450.4	403.1	388.5	437.7	408.6	396.8	560.1	+24.36%
Ionioi Nisoi	43.3	40.4	48.6	51.7	52.6	37.5	53.9	+24.48%
Peloponnisos	4335.7	3754.3	4711.1	6054.0	5598.3	3766.9	6430.8	+48.32%
Attiki	29,327.0	30,375.1	31,294.0	35,664.1	37,351.7	33,580.2	44,059.6	+50.24%
Greece	42,634.7	43,124.2	46,133.7	52,774.0	54,219.5	47,527.5	63,730.6	+49.48%

From the above tables, it can be seen that in the RIP and the RDE, through which the Ionian Road passes, there is a significant increase of 30.73% and 40.30% in exports and of 48.13% and 24.36% in imports, respectively. This element can contribute to documenting the positive effects of the Ionian Road on the economy of these regions.

c. Road freight transport

The transport work is calculated in ton-km, i.e., the product of the tons of goods multiplied by the distance traveled in km. Table 6 shows the evolution of the transport work of road freight transport trucks, for private and public use, in thousands of ton-km.

Table 6. Transport of products/goods by road freight trucks, in ton-km [31].

	2016	2017	2018	2019	2020	% Change 2016–2020
Transport work	24,560,154	28,418,052	29,278,725	28,196,955	25,386,537	+3.36%

As can be seen, from 2016 to 2020, there was an increase in transportation of more than 3%. This increase can also be justified by the completion and operation of the major road projects of Ionia Odos and Olympia Odos in 2017. It was also anticipated that there would be a reduction of transport work, as well as most economic activities during the years of the pandemic (2019 and 2020). Regarding the distribution of agricultural products, especially perishable ones, an important issue is the short time of disposal. The time savings achieved with the Ionian Road and especially with the Rio–Antirio Bridge are important for this type of products.

d. Mobility of ports

The mobility of the ports of Patras from 2019 to 2023 and of Igoumenitsa from 2013 to 2021, expressed in foreign traffic of both departures and arrivals, is reflected in the following Tables 7 and 8 [37,38]:

Table 7. Port of Patras, foreign traffic in thousands (departures and arrivals) [37].

Traffic Type	2019	2020	2021	2022	2023	% Change 2019–2023
Passengers	484.5	216.1	300.6	380.6	365.3	−24.60%
Autos	100.5	46.2	80.6	95.7	90.0	−10.45%
Trucks	118.5	108.2	111.2	100.6	83.1	−29.87%

At the port of Patras, there is a significant decline in all types of traffic. A decline also applies to the port of Igoumenitsa, with the noticeable exception of truck traffic, which more than doubled after 2017, i.e., the year of the completion of the Ionian Road.

Table 8. Igoumenitsa Port, foreign traffic in thousands (departures and arrivals) [38].

Traffic Type	2013	2014	2015	2016	2017	2018	2019	2020	2021
Passengers	893.8	896.1	799.7	822.2	918.1	953.2	955.7	408.2	624.0
Autos	221.5	212.2	187.0	199.0	221.0	231.9	236.5	92.7	159.7
Trucks	138.7	149.8	153.8	158.7	174.9	177.3	175.8	171.3	207.9
Annual Change in Truck Traffic (%)	−1.67%	+7.99%	+2.74%	+3.12%	+10.17%	+1.45%	−0.88%	−2.57%	+21.40%

4.4.2. Attracting New Investments/Innovation

a. Building activity

Table 9 shows the significantly increased number of private building activity permits issued from 2016 to 2023 in the areas under study.

Table 9. Number of private building activity permits by region, 2016–2023 [31].

Area	2016	2017	2018	2019	2020	2021	2022	2023	% Change 2016–2023
Ipeiros	405	468	544	583	669	907	838	908	+124.20%
Dytiki Ellada	1009	1190	1222	1066	1230	1656	1528	1504	+122.22%
Ionioi Nisoi	675	813	1012	1242	1276	1539	1567	1923	+184.89%
Peloponnisos	1400	1311	1331	1316	1484	1896	1991	2043	+45.93%
Attiki	2398	2712	3068	3625	3933	5291	5801	5974	+149.12%
Greece	12,640	13,741	15,164	17,229	18,747	23,807	24,913	26,698	+111.22%

b. Businesses of local interest in Rio–Antirio and surrounding areas

The operation of the bridge with the development of the surrounding area contributed to the creation of new businesses and new jobs, especially in the service sector (restaurants, recreation, etc.). In a questionnaire to population samples in Patras, Nafpaktos and Messolonghi, the answers lead to the conclusion that the operation of the bridge is a positive factor for starting a new business. In the same survey, catering, leisure and day tourism businesses in the areas around the bridge believe that the bridge is used to a very large extent by their daily visitors–customers [39].

c. Ferry operations

Another economic impact is the reduction in the cost of crossing with the use of ferries due to their competition with the Rio–Antirio Bridge. This impact can be negative for ferry owners and their workers, but positive for citizens who want a more economical crossing and for trucks that do not transport perishable agricultural products, in which case they may prefer the more economical alternative.

4.4.3. Increase in Tourism

a. Tourist traffic

Between 2018 and 2023, the increase in tourist traffic in Ipeiros has been impressive (108%). However, for the same period, tourist traffic in Dytiki Ellada showed an approximate 20% decrease (Table 10).

b. Tourism employment

There is also an increase in employment in tourism services. Table 11 presents relevant data from the Report on Employment in Accommodation and Catering and other Sectors of the Greek Economy, 2010–2019 [40], showing the increase in employment in accommodation and catering services activities.

Table 10. Tourist visits in thousands, by region [40].

Area	2018	2019	2022	2023	% Change 2018–2023
Ipeiros	823	1033	1083	1712	+108.02%
Dytiki Ellada	699	817	582	564	−19.31%
Ionioi Nisoi	3162	3048	3176	3378	+6.83%
Peloponnisos	886	899	891	732	−17.38%
Attiki	5681	5923	5624	7889	+38.87%
Greece	30,123	36,643	31,367	36,136	+19.96%

Table 11. Employment in accommodation and catering services activities in thousands [40].

Area	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	% Change 2010–2019
Ipeiros	12.8	9.7	8.7	8.8	9.5	9.7	8.7	12.1	14.5	13.2	+3.13%
Dytiki Ellada	16.2	15.3	14.0	14.9	15.9	19.8	16.8	18.3	20.4	18.3	+12.96%
Ionioi Nisoi	12.5	11.4	12.8	10.8	12.1	14.7	17.4	19.4	22.4	19.4	+55.20%
Peloponnisos	16.9	15.8	13.3	14.4	16.3	17.5	17.2	20.5	17.5	20.8	+23.08%
Attiki	90.2	82.0	78.1	71.8	85.8	90.1	97.5	91.7	98.1	114.2	+26.61%
Greece	308.5	295.7	272.1	259.2	297.1	325.5	341.2	350.7	361.7	381.9	+23.79%

c. Development of cultural tourism

Visits to museums and archaeological sites showed a corresponding increase. Figures from the Institute of the Greek Tourism Confederation (INSETE), presented in Tables 12 and 13, show an increase in visitors to museums from 2011 to 2019, which are particularly high for the RI and the RDE, at 61.5% and 234.3%, respectively. Accordingly, visitors to archaeological sites increased by 172.3% for the RI and by 14.18% for the RDE. These significantly increased rates can be attributed to the operation of the two projects under consideration.

Table 12. Visitors to museums by region in thousands [40].

Area	2011	2012	2013	2014	2015	2016	2017	2018	2019	% Change 2011–2019
Ipeiros	22.6	32.9	46.6	50.0	56.1	54.3	58.4	65.3	59.1	+61.5%
Dytiki Ellada	66.8	96.7	147.3	173.8	174.7	169.4	199.7	214.7	223.3	+234.3%
Ionioi Nisoi	68.9	60.8	70.7	60.0	61.1	67.1	70.6	78.7	80.9	+17.42%
Peloponnisos	49.8	59.2	74.3	73.2	69.2	81.0	94.9	100.0	102.6	+106.0%
Attiki	1825	1660	1743	2162	2295	2155	2518	2733	2784	+52.55%

Table 13. Visitors to archaeological sites by region in thousands [40].

Area	2011	2012	2013	2014	2015	2016	2017	2018	2019	% Change 2011–2019
Ipeiros	32.5	42.5	46.4	81.1	80.7	81.2	79.7	91.1	88.5	+172.3%
Dytiki Ellada	466.0	453.5	504.6	514.4	486.4	482.3	549.6	557.5	532.1	+14.18%
Ionioi Nisoi	120.5	122.0	173.2	226.9	236.9	225.2	185.7	206.6	236.9	+96.60%
Peloponnisos	753.3	793.5	995.1	1375	1442	1388	1638	1886	1922	+155.14%
Attiki	2119	2318	2772	3618	4145	3960	4910	5612	6234	+194.20%

Road projects can reveal a multitude of archaeological findings. In the case of the Ionian Road, such findings, combined with the existing cultural heritage but also with the new comfortable, fast and safe access guaranteed by the highway, can contribute to the development of a type of tourism called *cultural*. According to the World Tourism Organization (UN Tourism), which is the United Nations agency responsible for the promotion of responsible, sustainable and universally accessible tourism, cultural tourism includes the movement of people motivated to study art, attend cultural events and festivals, visit monuments and experience nature. The magnitude of cultural tourism is also demonstrated by the relative statistical assessment of the OECD, which states that tourism activities throughout Europe concern culture, at a rate of more than 50% [41]. A typical example of cultural tourism development is the cultural route of the ancient theaters of Ipeiros involving journeys to five archaeological sites and their theaters (Figure 12) [42].

Figure 12. Cultural route of the ancient theaters of Epirus [42].

4.5. Social Effects

4.5.1. Population Changes

According to Table 14, the two major projects could not be considered drivers of population growth at the regional level. While between the 2001 and 2011 censuses, the population of Ipeiros remained unaltered, that of Dytiki Ellada showed a decrease of 5.73%. The reduction in the population of the RDE continued from 2011 to 2021; however, it was slightly less (4.64%). Conversely, the population of the RIP showed a significant decline of 5% from 2011 to 2021. Thus, it may be concluded that the infrastructure construction has resulted in no positive effect as far as regional population growth is concerned.

Table 14. Population changes by region [31].

Area	2001	2011	% Change 2001–2011	2021	% Change 2011–2021
Ipeiros	336,392	336,856	+0.08%	319,991	−5.00%
Dytiki Ellada	721,541	679,796	−5.73%	648,220	−4.64%
Ionioi Nisoi	209,608	207,855	−1.50%	204,532	−1.60%
Peloponnisos	597,622	577,903	−2.62%	539,535	−6.64%
Attiki	3,894,573	3,828,434	−2.11%	3,814,064	−0.37%
Greece	10,934,097	10,816,286	−1.34%	10,482,487	−3.09%

4.5.2. Improving Health Quality

According to POADEP's relevant report in 2017, the modern Ionia Odos provides faster and safer access to hospitals and health centers. Especially for serious and urgent cases, the critical transport time from Aitoloakarnania to the major hospitals of Achaia has been significantly reduced [29].

4.5.3. Improving Quality of Education

Faster and safer access to the educational institutions of the urban centers of Dytiki Ellada and Ipeiros is a quality positive factor for education and especially for the academic institutions within these regions. The Rio–Antirio Bridge and Ionia Odos projects have contributed to the improvement of accessibility and the mobility of students and educators to and from the educational campuses.

4.5.4. Increase in Employment

The distribution of the employed persons nationwide and specifically in the regions under consideration for the period 2010–2022 is presented in Table 15:

Table 15. Distribution of all employed persons by region in thousands, 2010–2022 [31].

Year	Area					
	Ipeiros	**Dytiki Ellada**	**Ionioi Nisoi**	**Peloponnisos**	**Attiki**	**Greece**
2010	134.49	277.21	93.81	238.59	1823.82	4706.43
2011	132.24	267.95	88.83	231.72	1725.03	4505.14
2012	128.32	253.88	89.54	226.53	1636.04	4325.83
2013	128.30	247.08	89.73	230.30	1628.22	4300.67
2014	130.92	253.14	90.87	235.50	1704.32	4453.73
2015	126.27	244.33	88.06	229.06	1649.50	4432.57
2016	128.01	252.11	90.89	234.48	1713.07	4469.51
2017	127.12	250.47	91.11	235.71	1690.99	4446.63
2018	131.88	259.25	96.76	244.63	1775.80	4650.34
2019	133.07	262.04	96.64	244.90	1800.80	4691.10
2022	120.10	238.60	71.90	212.70	1580.70	4135.20
% change 2010–2022	−10.70%	−13.93%	−23.36%	−10.85%	−13.33%	−12.14%

Employment figures in the RIP and the RDE seem to follow the downward trend of employment nationwide during the economic crisis, which has been on the rise since 2017and followed by a recent decline again in 2022. Overall, declines of 10.70% and 13.93% have been respectively recorded from 2010 to 2022. It could then be argued that there is no positive effect on regional employment levels that could be attributed to the production and operation of the two major infrastructure projects under study.

4.5.5. Individual and Social Well-Being

A characteristic indicator of well-being is the regional household budget, i.e., the monthly average purchases of households which are presented in Table 16.

As can be seen, the household budget has declined nationwide between the years 2014–2023, with the exception of Attiki, with an increase of nearly 25%. This decline can be explained by the financial crisis and the general climate of insecurity due to the pandemic. The RIP and the RDE seem to follow this negative trend. The decreased value of 16.34% for Ipeiros is significantly lower than the declined value for the whole country (6.28%). The negative value of 11.73% for Dytiki Ellada is closer to the above national percentage change.

These results show that apart from major infrastructure delivery, additional development actions are needed so that inhabitants in Ipeiros and Dytiki Ellada can reach the higher living standard of inhabitants in Attiki. However, the factors that contribute to individual and social well-being are not only financial. Due to the improvement in accessibility and mobility through infrastructure development, the following benefits may be achieved:

- Development of stronger social and cultural prefectural ties between the populations of Peloponnisos and Dytiki Ellada, especially between Achaia and Aitoloakarnania.
- Facilitating travel for leisure and short-term tourism.
- Easy access and travel planning to and from ports and airports of the wider Peloponnisos and Dytiki Ellada.

Table 16. Value of monthly average purchases of households by region in euros [31].

Area	2014	2015	2016	2017	2018	2019	2020	2023	% Change 2014–2023
Ipeiros	1573	1617	1578	1637	1603	1577	1420	1316	−16.34%
Dytiki Ellada	1773	1613	1668	1539	1440	1513	1383	1565	−11.73%
Ionioi Nisoi	1582	1783	1997	1893	1813	1754	1655	1523	−3.73%
Peloponnisos	1926	1679	1745	1624	1603	1586	1391	1416	−26.48%
Attiki	1558	1911	1840	1933	1973	2070	1974	1944	+24.77%
Greece	1798	1762	1733	1761	1787	1836	1698	1685	−6.28%

4.6. Synopsis of the Descriptive Analysis Results

Table 17 summarizes the percentage changes for the RIP, the RDE and the RIN, as well as the per regional averages of the RIP and the RDE, for the positive or negative impacts for which statistical data are available. A comparison is also made with the corresponding national changes. The higher positive regional average percentages come from the increase of 147.90% in the number of visits to museums from 2011 to 2019 and from the increase of 123.21% in the number of private building activity permits between 2016–2023. The higher negative regional average percentages are the decrease of 14.00% in household budget from 2014 to 2023 and the reduction of 12.32% between 2010–2022 to employed inhabitants in the regions. These values are greater than country's total percentages (52.55%, 111.22% and 6.28%, 12.14% respectively). Negative average changes can also be found in arable agricultural land (2015–2022) with 8.37% and in regional population (2011–2021) with 4.82%.

Table 17. Summary of positive and negative impacts results by region and regional average.

Impact per Subsection (+) or (−)	Description	Period	% Change by Region (+)/(−)				% Change Country Total (+)/(−)
			RIP	RDE	RIP + RDE Average	RIN	
4.1.1.c (+)	Reduction in road traffic accident fatalities (TAF)	2013–2022	−48.97	−30.38	−39.68	−11.66	−21.78
4.2.1 (−)	Reduction in arable agricultural land (AGL)	2015–2022	−0.70	−16.03	−8.37	−66.67	−5.69
4.4.1.a (+)	Increase in Gross Domestic Product (GDP)	2017–2021	+2.07	+2.17	+2.12	−3.93	+2.60
4.4.1.b (i) (+)	Increase in commercial exports (EXP)	2015–2021	+30.73	+40.30	+35.52	+130.79	+54.88
4.4.1.b (ii) (+)	Increase in commercial imports (IMP)	2015–2021	+48.13	+24.36	+36.25	+24.48	+49.48

Table 17. *Cont.*

Impact per Subsection (+) or (−)	Description	Period	% Change by Region (+)/(−)				% Change Country Total (+)/(−)
			RIP	RDE	RIP + RDE Average	RIN	
4.4.2.a (+)	Increase in private building activity permits (BAP)	2016–2023	+124.20	+122.22	+123.21	+184.89	+111.22
4.4.3.a (+)	Increase in tourism visits (TRV)	2018–2023	+108.02	−19.31	+44.36	+6.83	+19.96
4.4.3.b (+)	Increase in tourism employment (TRE)	2010–2019	+3.13	+12.96	+8.05	+55.20	+23.79
4.4.3.c (i) (+)	Increase in visits to museums (VMU)	2011–2019	+61.50	+234.3	+147.90	+17.42	+52.55
4.4.3.c (ii) (+)	Increase in visits to archaeological sites (VAS)	2011–2019	+172.30	+14.18	+93.24	+96.60	+194.20
4.5.1.a (+) or (−)	Change in Population (POP)	2011–2021	−5.00	−4.64	−4.82	−1.60	−3.09
4.5.4 (+)	Increase in Employment (EMP)	2010–2022	−10.70	−13.93	−12.32	−23.36	−12.14
4.5.5 (+)	Increase in household budget (HHB)	2014–2023	−16.34	−11.73	−14.08	−3.73	−6.28

4.7. Quantitative Analysis (AHP)

The analytic hierarchy process (AHP) provides a structured approach for determining the scores and weights for a multicriteria evaluation model [43,44] and has previously been used for socio-economic evaluation of transport infrastructure, e.g., [45]. Assuming that the three regions of the RIP, the RDE and the RNI are the candidates to be assessed and that the thirteen impacts in Table 17 (abbreviated as TAF, AGL, GDP, EXP, IMP, BAP, TRV, TRE, VMU, VAS, POP, EMP and HHB) represent the evaluation criteria, the following Table 18 can be used to create a pairwise comparison matrix for each candidate regarding each criterion.

Table 18. Scale for pairwise comparisons between different criteria.

Value	Relative Importance Between Pairs of Criteria	% Diff. (Table 17)
1	Equal Importance	0.00–12.49
2	Equal to Moderate Importance	12.50–24.99
3	Moderate Importance	25.00–37.49
4	Moderate to Strong Importance	37.50–49.99
5	Strong Importance	50.00–62.49
6	Strong to Very Strong Importance	62.50–74.99
7	Very Strong Importance	75.00–87.49
8	Very Strong to Extreme Importance	87.50–99.99
9	Extreme Importance	>100.00

The matrix of pairwise comparisons is normalized by first calculating the sum of each column in the pairwise comparison matrix and then by dividing each entry in the matrix by its column sum. Figure 13 shows the normalized matrix for the TAF criterion. The average of each row in the normalized matrix is used as the score for each candidate on the criterion under consideration. For example, the average scores regarding the TAF criterion for the RIP, the RDE and the RIN are 0.539, 0.297and 0.164, respectively. These scores indicate the relative benefit (or cost) of the three alternatives with respect to their TAF impact. The score for the RIP indicates that this region is the candidate that has benefitted the most with respect to reducing the number of road traffic accident fatalities. The RDE has also more benefitted than the RIN. These scores must reflect the scale values selected (i.e., 3, 2 and 2) in the pairwise comparison matrix based on the relative percentage changes of Table 17. Note that values below the diagonal are the reciprocals of the values above the diagonal (e.g., 0.333 = 1/3).

TAF	Pairwise Comparisons		
	RIP	RDE	RIN
RIP	1.000	2.000	3.000
RDE	0.500	1.000	2.000
RIN	0.333	0.500	1.000
Sum	1.833	3.500	6.000

	Normalised Comparisons			TAF	Consistency
	RIP	RDE	RIN	Scores	Measure
RIP	0.545	0.571	0.500	0.539	3.015
RDE	0.273	0.286	0.333	0.297	3.008
RIN	0.182	0.143	0.167	0.164	3.004
Sum	1.000	1.000	1.000	1.000	3.009
				Consistency Ratio	0.0079 < 0.10

Figure 13. Normalized comparison matrix with scores for TAF impact.

A critical issue in AHP application is that there should exist consistency in the ratings given in the pairwise comparison matrix [46]. Thus, before using the scores derived from the normalized comparison matrix, these ratings must be checked for consistency. A consistency measure for each candidate is a fraction obtained as follows: the numerator multiplies the scores from the normalized matrix by the ratings given in one of the rows of the original pairwise comparison matrix; the products are summed and then divided by the score for the candidate in question. For the TAF criterion and the RIP candidate, this consistency measure is calculated thus: $(0.539 \times 1 + 0.297 \times 2 + 0.164 \times 3)/0.539 = 3.015$ (see Figure 13). Provided that the amount of inconsistency is not excessive, the scores obtained from the normalized matrix will be reasonably accurate. To determine whether the inconsistency is excessive, the following measures should be calculated, where λ = the average consistency measure for all alternatives and n = the number of alternatives:

$$\text{consistency index (CI)} = (\lambda - n)/(n - 1) \quad (1)$$

$$\text{consistency ratio (CR)} = \text{consistency index (CI)}/\text{random index (RI)} \quad (2)$$

The random index (RI) in Equation (2) is the average value of the consistency index (CI) if all the entries in the pairwise comparison matrix are chosen at random, and it takes values according to [47]. If the CR is equal to or less than 0.10, the degree of consistency in the pairwise comparison matrix is satisfactory. However, if the CR is much greater than 0.10, serious inconsistencies might exist and AHP might not yield meaningful results. The value of approximately $0.008 < 0.10$ for CR in Figure 13 (with RI = 0.58 for n = 3) indicates that the pairwise comparison matrix for TAF criterion is reasonably consistent and accurate. However, similar calculations for the other criteria resulted in two unsatisfactory CR values and, as a result, the impacts regarding VMU (0.199) and VAS (0.302) were excluded from the subsequent analysis. GDP and POP criteria were also excluded because they are assigned the same value of 1 (equal importance) in all cases. The same applies to impact IMP but for a value of 2 (equal to moderate importance).

Before the scores for each criterion can be used in the overall scoring model, criteria weights must be determined to indicate their relative importance to the final assessment. The previous pairwise comparison process is used to generate these weights (Figure 14).

The BAP (0.470) and EXP (0.207) impacts appear to be the most significant. The CR value of 0.12 is very close to 0.10 and, considering the size of the matrix (n = 8), is satisfactory [48].

Pairwise Comparisons	TAF	AGL	EXP	BAP	TRV	TRE	EMP	HHB
TAF	**1.000**	1.000	0.200	0.111	0.200	0.200	1.000	2.000
AGL	1.000	**1.000**	0.250	0.111	1.000	1.000	1.000	3.000
EXP	5.000	4.000	**1.000**	0.167	5.000	5.000	6.000	7.000
BAP	9.000	9.000	6.000	**1.000**	9.000	9.000	9.000	9.000
TRV	5.000	1.000	0.200	0.111	**1.000**	1.000	1.000	2.000
TRE	5.000	1.000	0.200	0.111	1.000	**1.000**	5.000	0.500
EMP	1.000	1.000	0.167	0.111	1.000	0.200	**1.000**	1.000
HHB	0.500	0.333	0.143	0.111	0.500	2.000	1.000	**1.000**
Sum	27.500	18.333	8.160	1.833	18.700	19.400	25.000	25.500

Normalised Comparisons	TAF	AGL	EXP	BAP	TRV	TRE	EMP	HHB	Criterion Weight	Consistency Measure
TAF	0.036	0.055	0.025	0.061	0.011	0.010	0.040	0.078	0.039	8.586
AGL	0.036	0.055	0.031	0.061	0.053	0.052	0.040	0.118	0.056	9.144
EXP	0.182	0.218	0.123	0.091	0.267	0.258	0.240	0.275	0.207	9.525
BAP	0.327	0.491	0.735	0.545	0.481	0.464	0.360	0.353	0.470	9.844
TRV	0.182	0.055	0.025	0.061	0.053	0.052	0.040	0.078	0.068	9.035
TRE	0.182	0.055	0.025	0.061	0.053	0.052	0.200	0.020	0.081	8.818
EMP	0.036	0.055	0.020	0.061	0.053	0.010	0.040	0.039	0.039	8.782
HHB	0.018	0.018	0.018	0.061	0.027	0.103	0.040	0.039	0.040	9.776
Sum	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	9.189
									Consistency Ratio	0.12

Figure 14. Criterion weight determination.

The last AHP step is to calculate the weighted average scores for each region (alternative) based on the impact (criterion) weights. According to these scores, which are shown in Figure 15, the candidate RIN (0.513) is by the region which has benefitted the most overall from the major infrastructure projects examined in the research, followed by the RIP (0.140) and the RDE (0.077) alternatives. However, as with any structured multicriteria decision analysis, this ranking recommendation should not be strictly followed but carefully evaluated prior to its use by decision makers.

	Region (Alternative)			Criterion
Impact (Criterion)	RIP	RDE	RIN	Weights
TAF	0.539	0.297	0.164	0.039
AGL	−0.103	−0.174	−0.723	0.056
EXP	0.094	0.097	0.809	0.207
BAP	0.138	0.130	0.732	0.470
TRV	0.809	0.097	0.094	0.068
TRE	0.149	0.161	0.690	0.081
EMP	−0.261	−0.328	−0.411	0.039
HHB	−0.411	−0.328	−0.261	0.040
Weighted Avg Score	0.140	0.077	0.513	1.000

Figure 15. Final scoring model.

5. Conclusions

The effects of large infrastructure projects and their relationship with regional development have been the subject of many studies and discussions over time. This paper attempts to contribute to the existing literature focusing on two major road projects in Greece: the Rio–Antirio Bridge and the Ionian Road. Infrastructure in Greece has been significantly affected by the economic crisis that the country has been facing over the last fifteen years; the recession in several productive sectors due to the COVID-19 pandemic; and the energy crisis due to the recent war in Ukraine. These are inhibiting factors both in the performance of transport projects and in regional development.

The two main aids for the development of the work were as follows: the study of part of the existing relevant literature and the utilization of statistical data by the competent authorities. The statistical data used came mainly from ELSTAT but also from other bodies, such as institutes, organizations and regions. The relationship between infrastructure and regional development was examined through the study of the positive and negative effects of these two major road projects in the regions of Ipeiros and Dytiki Ellada. The research framework was based on the herein proposed categorization of the different effects of road infrastructure as described in the third section of the paper: (i) road network and transport; (ii) land use changes; (iii) natural environment; (iv) economic effects; and (v) social effects.

Positive effects involve transport time savings and road safety improvement; increased commercial imports plus exports activity; increased building activity; increased tourist traffic and employment; and intensified truck traffic at the port of Igoumenitsa. Negative impacts include less arable agricultural land; increased whilst tolerable environmental pollution; and a general reduction in all types of traffic at the port of Patras.

From the quantitative analysis using the AHP, it emerged that the Ionian Islands are by far the region that benefitted most overall from the construction and operation of the two mega infrastructure projects, followed by Epirus and Western Greece. However, this ranking should be carefully considered prior to its use for decision making.

From the analysis of both the statistical data and the qualitative characteristics of the examined regions, the general conclusion seems to coincide with that of the theoretical approaches and related studies. Transport infrastructure projects are a condition but not a guarantee of regional development. Regional development planning, whether carried out by the EU, by state governments or by regional authorities, should include the exploitation of the comparative advantages and possibilities of the economically weaker regions connected by a transport project before and after its construction and measures to support the economically weaker regions, such as the granting of loans, subsidies and tax exemptions.

The research is delimited by the lack of statistical data for the environmental impacts. Future work should address this limitation in order to obtain more reliable conclusions concerning the regions under consideration.

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