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CASE REPORT

Environmental Impact Assessment of Onshore Wind Farms in the Region of Central Greece Using a Modified RIAM Method

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ABSTRACT

Wind energy is one of the most basic forms of renewable energy, which shows an increasing rate of development worldwide and also at the European level. However, this rapid deployment of wind farms makes the need for an impact assessment of this type of projects on the natural and man-made environment imperative. The present paper aims to identify and assess the environmental impacts of wind farm projects in the Region of Central Greece. A modified Rapid Impact Assessment Matrix (RIAM) method is used for this purpose. The methodology includes the identification of the existing onshore wind farm projects in the study area, the appropriate modifications of the RIAM method to respond to the characteristics of the projects and the study area, the qualitative assessment of their potential impacts during construction and operational phases and the computation of the Environmental Performance Grade (EPG) of projects based on the pro-posed modified RIAM method. The results reveal that although there are some slight negative impacts on the natural environment of the study area, the examined wind farms contribute positively both to the atmosphere and to the socio-economic environment of the study. This study extends the potential for using RIAM as a tool in environmental impact assessment studies of renewable energy projects.

Keywords: Environmental impact assessment; Environmental components; Region of central Greece; Rapid impact assessment matrix (RIAM); Environmental performance grade (EPG)

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1. Introduction

The systematic process of identifying, predicting, and evaluating the environmental effects of a proposed project or activity is widely known as Environmental Impact Assessment (EIA) [1]. The goal of an EIA is to identify and assess the impacts of a project or activity on the natural and anthropogenic environment, ideally from conception to decommissioning, and before any decision about its implementation. The output of the above process is the Environmental Impact Study or Statement (EIS). Phylip-Jones and Fischer [2] investigated the quality of EIS and its content regarding twenty wind farm projects in the United Kingdom and Germany and concluded that although there are some weaknesses, the information included in relevant studies strongly contributes to decision-making. One of the most complicated parts of the EIA process is the impact significance. There are several components and factors, that may vary from project to project, that should be considered when determining the significance of an impact, making comparisons among projects a challenging task [3].

The impact assessment is carried out using various qualitative and quantitative methods (i.e. overlapping maps, checklists, matrices, mathematical models). Descriptive characterizations, colour gradations, numerical ratings, Likert rating scales or a combination of the above can be used in the impact assessment. The simplest methods of determining impacts involve using a list of impacts (checklists, impact matrices) to ensure that all impacts have been considered in the analysis. For example, Kaldellis et al. [4] present an indicative list of impacts that the development of an onshore wind farm may cause. There are also more complex impact assessment methods, which use numerical values to derive a composite value for the impacts of projects/activities. Zolfagharian et al. [5] assess the environmental impacts of construction projects in Malaysia by determining the hazard of their impacts. Several more complex applications can be also found in the literature, which integrate multicriteria analysis into evaluation matrices. An example of such an application is the Rapid Impact Assessment Matrix (RIAM) [6,7]. The RIAM matrix was initiated by Pastakia [6] and Pastakia and Jensen [7], who present a summary impact assessment matrix, in their attempt to transparently incorporate subjective judgments into the environmental impact assessment process. Examples of applications of the RIAM method in the environmental impact assessment process appear frequently in the international literature.

Pastakia and Bay [8] performed an initial environmental evaluation (IEE) to evaluate potential development options to preserve or enhance the Rupa Tal lake and valley in Nepal. Four different alternatives were considered, and the IEE was able to specify a number of crucial elements for their comparison, while the Rapid Impact Assessment Matrix illustrated the of impacts that each alternative would cause. Kuitunen et al. [9] compared the social and environmental impacts of various projects, plans, and programs carried out in the same geographic area using RIAM. Shakib-Manesh et al. [10] evaluated a number of solutions for the restoration of the water system in Eastern Finland using a combination of a straightforward MCA approach, RIAM, and an Expert Panel. Suthar and Sajwan [11] used the RIAM to assess the site suitability of a possible new municipal solid waste disposal site for the city of Dehradun (India), considering ecological, social, cultural and economic components in the decision-making process. Vagiona [12] uses a modified Rapid Impact Assessment Matrix as an online tool to calculate the degree of environmental performance of fourteen (14) different projects in Greece.

Although the RIAM method was originally deployed for the comparison of alternatives within one project, this paper illustrates the use of RIAM as a tool for the sustainability assessment of onshore wind farms in the Region of Central Greece. A comparison of the Environmental Performance Grade (EPG) of the existing onshore wind farms is performed for this purpose.

The advantages of the proposed approach in impact assessment can be summarized as follows: (i) it can be easily applied in practical evaluation of environmental impacts of developmental projects; (ii) it presents flexibility and adaptability in environmental components as well as assessment criteria; (iii) it is simple in computations and understandable in the interpretation of results; (iv) it provides numerical values although it is considered a qualitative approach and (v) provides a holistic approach to sustainability. The results suggest that the modified RIAM can be a reliable tool to identify the suitability and sustainability of wind farm project deployment.

The remainder of this paper is organized as follows. Section 2 presents the main environmental impacts of onshore wind farm installations. Section 3 describes the methodological approach developed for the EPG of onshore wind farm projects, while in Section 4, the results from the application of the modified RIAM method on the existing wind farm projects in the Region of Greece are presented. The main conclusions of this research are revealed and discussed in Section 5.

2. Onshore wind farm projects and impact assessment

Wind energy systems are regarded as being eco-friendly [13] and are constantly improving regarding compatibility with human life and wildlife among all renewable systems [14].

The main environmental impacts that are discussed frequently are related to acoustic-noise pollution [15], visual pollution [16], disturbances or wildlife safety for birds [17], disturbances or wildlife safety for bats [18], local climate change [19], soil erosion and deforestation [15], lightning from towers [15], and electromagnetic interferences and radiation [15].

More specifically, during the construction phase of a wind energy facility, certain activities, such as excavation and associated road works, may affect the soil characteristics and natural environment of the study area. With the deforestation of the land, the surface is exposed both to strong winds and climatic conditions with consequent soil erosion. Sewage and various oils from the construction site can cause soil erosion. Additionally, the use of heavy machinery during the construction phase may disturb the local ecological balance.

Although wind farms have a relatively low impact on the environment compared to conventional power generation facilities, the negative impacts of onshore wind farms in the operational phase focus on: the aesthetics-visional features (landscape alteration), the acoustic environment (noise pollution) and the impacts in fauna (bird strikes).

The visual nuisance and aesthetics of a wind farm installation is a subjective factor, which depends on the condition of a wind farm, as well as on the observer's view and judgement. Noise, which is the consequence of the operation of wind turbines, depends both on the level of acoustic emissions due to the operation of the wind turbine and the distance of the wind farm from the nearest residential area.

High noise emissions are usually caused by large wind turbines. However, in these cases, the height of the turbines exceeds 100 meters and therefore does not affect humans and wildlife [15]. In many cases wind farm proposals may face strong social reactions from people living near the proposed projects who support that noise from wind turbines will disrupt their quality of life [20–22].

Regarding the potential negative effects of wind turbines on avifauna, many studies have indicated that wind turbines do not pose a threat to birds, given that their mortality from this cause is only a small percentage of their total mortality. Statistically, the possibility of bird deaths associated with wind energy projects is significantly lower compared to bird deaths caused by other factors such as collisions with tall buildings, infrastructure networks (electricity, telecommunications) and public utility projects, cats, vehicles, pesticides [23].

Few cases of bird mortality have been reported for wind turbines under 50 meters in height, while isolated problems have been pointed out in wind farms located on migratory bird routes. The strict restrictions that have been established in recent years for the installation of anthropogenic activities in environmentally sensitive areas (e.g. NATURA zones, RAMSAR areas), but also the integration of the criterion of the distance of a wind farm installation from migratory bird routes in the sitting process should contribute to the protection from collisions.

Finally, according to research by Sengupta, D.L. [24], the electromagnetic radiation produced by wind farms can distort or even change the signal from nearby television or radio stations and affect nearby navigation and microwave communication.

3. Methodological framework for environmental performance grade of onshore wind farm projects

The proposed methodological framework includes the identification of the existing onshore wind farm projects within the study area, the determination of the environmental components as well as the assessment criteria based on the project's features and the characteristics of the study area, the qualitative assessment of their potential impacts during the construction and operational phases, and the computation of the projects' Environmental Performance Grade (EPG).

Appropriate modifications of the RIAM method to reflect the environmental impacts of the selected type of projects and the characteristics of the environment of the study area are performed. The qualitative evaluation of their potential effects during the construction and operational phases contributes to the computation of the projects' EPG that is based on the proposed modified RIAM method.

3.1 The study area

The Region of Central Greece is one of the thirteen Regions of the country and consists of five Regional Units (Boeotia, Evia, Evrytania, Phthiotis, Phocis). The Region of Central Greece is located in the central continental part of the Greek territory and is the second largest region of the country with a total area of 15,554 km², representing almost 11.8% of its total area. The total population of Central Greece has declined over a decade. Specifically, in Boeotia, Phtiotis, Evrytania and Phocis there is a decrease of 10.1%, 12.9%, 13.2% and 10.3% respectively, while Evia is the only one where the population remains stable [25].

According to the statistical data from Hellenic Wind Energy Association [26] the Region of Central Greece has the largest wind power potential in the country. The existing onshore wind farm projects are located in the Regional Units of Evia, Boeotia, Phocis and Phtiotis of the Region of Central Greece and are depicted in **Figure 1**.

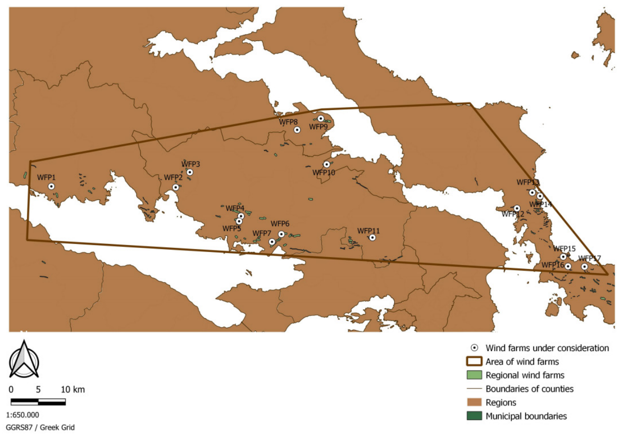

Figure 1. Existing Wind Farms in the Region of Central Greece.

Historical cultural environment

In the study area, there is a wealth of important archaeological sites and discoveries from the prehistoric, classical, byzantine and modern periods through which tourism is enhanced throughout the year. In addition, it has an important cultural heritage which consists of remarkable Neolithic findings as well as sites of the post-Byzantine period (1453–1830). The cultural heritage of the region includes a wealth of folklore (museums, galleries, cultural events, folklore centers). A basic example of the cultural wealth of the Region, apart from the above archaeological sites, are the traditional settlements (one in Boeotia, three in Evia, four in Evrytania, two in Phthiotis and seven in Phocis), the castles and the fortresses.

Climatic characteristics

In the Central Greece, during the year there are variations in temperature, with some months being colder or warmer than others. More specifically, according to the recordings of all four meteorological stations closest to the wind farms (Aliartos, Lamia, Skyros, Tanagra), the lowest temperatures are recorded in January with the average temperature ranging from 7–10 ^{o}C and the warmest month is July with temperatures of 25–27 ^{o}C.

Morphological topological characteristics

According to the Regional Climate Change Adaptation Plan (RCAP) [27], the Region of Central Greece, due to its large area, presents complex morphological and landscape characteristics which divide it into two parts, the continental part of Central Greece (Evrytania, Phocis, Phthiotis, Boeotia) and the islands (Skyros, Evia). Although the length of its coastline is quite significant (1682 km), it is one of the most mountainous regions of the Greek territory as its mountainous character (47.4%) dominates its total area. In particular, the main mountainous part of the region is located in the Regional Units of Evrytania and Phocis, where the southern side of Pindos extends to the Gulf of Corinth. The largest part of the area (49.02%) is characterized by flat to slightly sloping relief (0°–10° slope), followed by 35.29% of the area which consists of strongly sloping to steeply sloping relief (10°–30° slope), and finally, 15.69% consists of extremely steep relief (> 30° slope).

Natura 2000 and other protected areas

The Natura 2000 aims at preserving the natural European environment and the long-term protection of endangered species (divided into two categories: Special Areas of Conservation—SAC and Special Protection Areas—SPA). In the study area, there are 27 areas covered by the Natura 2000, of which 10 are located in Evia, 7 in Phocis, 6 in Phthiotis, 2 in Boeotia and 2 in Evrytania. Other protected areas that can be found in the study area are: (i) Biodiversity Protection Areas and (ii) National Parks, Wildlife Sanctuaries, Protected Landscapes and Protected Natural Formations.

3.2 Environmental components

According to the existing Greek legislation [28] the present condition of the environment of the study area includes the description of the following aspects of the environment: climate, bioclimate, morphology, aesthetics/visional features, geology, tectonics, soils, natural environment, land uses, built environment, historical and cultural environment, socio-economic environment, infrastructure, air quality, acoustic environment-noise, vibrations, radiation, surface waters and groundwater.

Initially, the construction and operation of the wind farms are not expected to have any direct impact on the climatic and bioclimatic characteristics of both the immediate as well as the wider study area. The studied wind farms are mainly located on the ground, which makes it difficult to change the geological and tectonic characteristics of the area. Furthermore, the wind facilities are located at distances in accordance with the existing legislation from settlements and residential areas [29], so that they do not cause disturbances in the residential environment. In addition, the installation areas of the wind farms under study as well as their accompanying projects are located outside of declared archaeological sites and consequently no effects on the historical-cultural environment of their construction area are expected. No electromagnetic interference problems are identified from the installation and operation of the wind farms, as the national legislation in the context of the licensing is framed by a series of measures (e.g. observance of minimum distances from telecommunications or broadcasting stations) according to which the selection of their optimal location is performed. During the construction and operational phase of the wind facilities, the surface and underground waters of the area are not expected to be affected and any effect is considered negligible.

Therefore, in this paper, the environmental assessment focuses on specific Environmental Components (EC) that are defined through the process of scoping and cover all potential environmental impacts of the examined projects (**Table 1**).

The importance of the eight environmental factors is qualitatively rated, based on a five-point scale as follows: 1 = not important, 2 = slightly important, 3 = moderately important, 4 = very important, and 5 = extremely important.

Table 1. Environmental components.

Environmental Component (EC)	Description
Morphology (EC1)	Study of landforms, including their nature, origin, development processes, and composition of materials
Aesthetics/Visional Features (EC2)	Shape, texture, colours and appearance of land
Natural Environment (EC3)	Flora and fauna, protected areas
Land Uses (EC4)	The distinction of land use types in zoning
Socio-economic Environment (EC5)	Features of the population, changes in the population, employment, occupation, education, and income trends
Infrastructures (EC6)	The technical structures such as road network, water supply network, sewage facilities, electrical grids, telecommunications
Air Quality (EC7)	The concentration of air pollutants such as CO, SO_2, NO, NO_2, O_3 and total suspended particulates that mainly contributes to the quality of atmospheric environment
Acoustic Environment (EC8)	The noise level in the study area from various sources

3.3 Assessment criteria and computation of environmental performance grade

The scoring scales and the assessment criteria used to evaluate each component are based on the original RIAM method as initiated by Pastakia and Jensen [6] and modified by Vagiona [12].

Two Primary Assessment Criteria (PAC) and three Secondary Assessment Criteria (SAC) are used to calculate the EPG: impact importance (PAC1), magnitude (PAC2), permanence (SAC1), reversibility (SAC2) and cumulatively (SAC3). The first two can individually change the EPG obtained, while the rest three should not individually be capable of changing the EPG obtained. These assessment criteria are evaluated using the scales presented in **Table 2**.

The impact significance of each environmental component is calculated as follows (Equation 1):

$$\alpha ij=PC1ijxPC2ijx(SC1ij+SC2ij+SC3ij) \quad (1)$$

Table 2. Environmental components.

	Assessment Criteria	Scale	Description
PAC1	Nature	1	positive impact (improvement) in status quo
		0	no change in status quo
		–1	negative impact in status quo
PAC2	Magnitude	1	low impact
		2	moderate impact
		3	significant impact
SAC1	Permanence	1	short term
		2	medium term
		3	long term (almost permanent)
SAC2	Reversibility	0	not applicable
		1	reversible
		2	partially reversible impact
		3	irreversible
SAC3	Confrontability	0	not applicable
		1	confrontable
		2	partially confrontable
		3	unconfrontable

where, i = 1,2, denotes the two basic phases of a project's life cycle, namely, construction phase (i = 1) and operational phase (i = 2) and j = 1,…,8, corresponds to the jth environmental component.

The EPG of each examined wind farm project is derived using the weighted sum model. The total score, Aij, of each j-th, j = 1,…,8, environmental component and for each i-th, i = 1,2, phase of the project life cycle, (construction phase (i = 1), the operational phase (i = 2)), is calculated as follows (Equation 2):

$$A_{ij} = \frac{a_{ij} w_j}{\sum_{j=1}^{8} w_j} \quad (2)$$

where, wj, j = 1,…,8, is the qualitative weight of the j-th environmental component and aij, i = 1,2, j = 1,…,8, is the impact significance as obtained from Equation (1). It should be noted that the minimum value of the impact significance between the construction and operational phases is used in Equation (2).

The EPG of each wind farm project is, finally, derived by the aggregation (sum) of all the environmental components' scores.

4. Results

4.1 Qualitative environmental impact assessment of WFP2

WFP2 is located in the Municipality of Karystos with a total installed capacity of 19.8 MW. Moderate effects of local extent and partial reversibility on the soil morphology occur during the construction phase of the project with mild to very weak effects during its operation. The installation and operation of the WFP2 have little impact on the landscape and the aesthetic environment as it is quite far away from the nearest settlement (almost 1.2 km) and the disturbances caused by the machinery are considered to be temporary and fully reversible. The wind farm abstains 5km from a Special Protection Area (SPA-GR2420012) which makes the impacts on the natural environment of the area weak and partially manageable. Due to the advanced technology of wind turbines, no particular impacts on the natural environment are caused during its operation. The construction of the project causes weak and partially reversible impacts on land uses. The installation and operation of the project are not expected to have a negative impact either on the social and economic environment of the area or on the existing anthropogenic activities. On the contrary, it positively affects the economic and social environment of the region. The transfer of the necessary mechanical equipment and machinery to the installation site of the wind farm project will increase the traffic in the area, contributing to heavy traffic during peak hours and causing problems in the acoustic environment.

The modified Rapid Impact Assessment Matrix for each one of the onshore wind farm projects have been developed and the individual scores for each environmental component are indicatively presented for WFP2 in **Tables 3 and 4** for the construction and operational phase respectively.

Table 3. Individual score for each environmental component in the construction phase for WFP2.

Environmental Component	PC1	PC2	SC1	SC2	SC3	a1j
EC1	–1	2	2	2	2	–12
EC2	–1	2	1	1	1	–6
EC3	–1	1	3	3	2	–8
EC4	–1	1	1	2	2	–5
EC5	1	2	2	3	2	14
EC6	–1	2	2	2	2	–12
EC7	–1	2	3	2	2	–14
EC8	–1	3	2	2	2	–18

Table 4. Individual score for each environmental component in the operational phase for WFP2.

Environmental Component	PC1	PC2	SC1	SC2	SC3	a2j
EC1	–1	1	2	2	2	–6
EC2	–1	2	2	2	2	–12
EC3	–1	1	2	2	2	–6
EC4	–1	1	2	2	1	–5
EC5	1	3	3	3	2	24
EC6	–1	2	1	1	1	–6
EC7	1	3	3	3	3	27
EC8	–1	2	2	2	2	–12

4.2 Computation of EPG

The impact significance of environmental components in construction and operational phase for all wind farm projects has been calculated using Equation (1) and presented in **Tables 5 and 6** respectively. Positive and negative aij values indicate, from a physical perspective, that the proposed wind farm project has, throughout its i-th phase, a positive or negative impact on the j-th environmental component, respectively. Higher absolute aij values in the negative range indicate more significant negative effects, while higher positive aij values indicate more significant positive impacts.

Table 5. Impact significance of environmental components in the construction phase.

	EC1	EC2	EC3	EC4	EC5	EC6	EC7	EC8
WFP1	–12	–15	–16	–3	24	–12	–14	–18
WFP2	–12	–6	–8	–5	14	–12	–14	–18
WFP3	–18	–10	–18	–4	24	–10	–12	–4
WFP4	–18	–18	–6	–3	18	–8	–16	–10
WFP5	–14	–10	–6	–3	14	–18	–16	–8
WFP6	–12	–6	–7	–3	14	–10	–16	–5
WFP7	–14	–6	–16	–3	14	–9	–16	–6
WFP8	–5	–8	–8	–3	14	–12	–8	–8
WFP9	–18	–12	–24	–3	14	–12	–24	–12
WFP10	–12	–18	–16	–10	16	–15	–24	–12
WFP11	–14	–12	–16	–3	16	–21	–14	–12
WFP12	–21	–6	–5	–3	14	–12	–16	–8
WFP13	–21	–6	–16	–6	14	–18	–16	–12
WFP14	–16	–15	–27	–3	12	–18	–16	–18
WFP15	–14	–14	–6	–3	16	–18	–14	–14
WFP16	–12	–10	–5	–6	14	–9	–21	–10
WFP17	–12	–6	–6	–3	16	–18	–18	–8

Table 6. Impact significance of environmental components in the operational phase.

	EC1	EC2	EC3	EC4	EC5	EC6	EC7	EC8
WFP1	–12	–18	–14	–5	24	–10	27	–12
WFP2	–6	–12	–6	–5	24	–6	27	–12
WFP3	–6	–4	–27	–4	24	–6	27	–12
WFP4	–6	–12	–6	–6	24	–6	27	–6
WFP5	–5	–12	–7	–5	24	–12	27	–12
WFP6	–6	–6	–8	–6	24	–12	27	–6
WFP7	–6	–12	–16	–5	24	–12	27	–12
WFP8	–6	–6	–7	–6	24	–12	27	–6
WFP9	–18	–12	–16	–6	24	–12	27	–18
WFP10	–6	–14	–24	–12	27	–10	24	–12
WFP11	–12	–18	–14	–6	27	–8	27	–12
WFP12	–12	–10	–5	–10	27	–10	27	–12
WFP13	–18	–12	–16	–12	27	–12	24	6
WFP14	–16	–12	–16	–8	27	–16	27	–12
WFP15	–7	–12	–6	–5	27	–16	24	–12
WFP16	–18	–7	–6	–12	27	–10	27	–14
WFP17	–14	–10	–6	–10	27	–12	27	–12

The final EPG of each wind farm project, based on Equation (2), is presented in **Figure 2**.

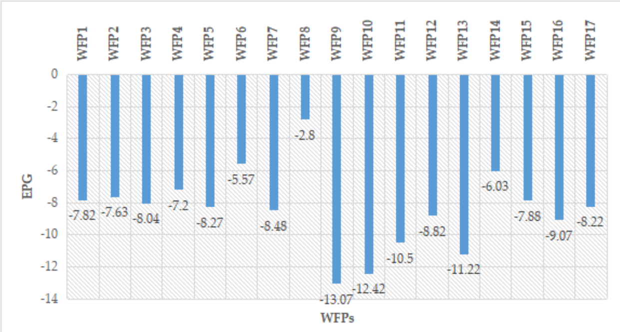

Figure 2. EPG scoring for WFPs.

The wind farms of the present research have a negative impact in terms of the natural and anthropogenic environment of the study area. WFP6, WFP8 and WFP14 cause weak negative effects on the natural and anthropogenic environment of the area, followed by eleven (11) stations which cause moderate negative effects and finally three (3) stations (WFP13, WFP10 and WFP9) cause the most significant negative effects. WFP9 received one of the highest negative grades as during its installation and operation the environmental components related to the morphology of the ground, the aesthetic and acoustic environment are strongly affected, as the nearest settlement with visual contact to the wind farm is only 0.55 km. The impact of WFP9 on the natural environment of the area is characterized as high intensity due to its proximity to the Wetland (Glaukos River Estuary). WFP10 has the second-highest EPG due to its impact on the natural and aesthetic environment of the surrounding area. The installation and operation of WFP13 significantly affect the environmental components related to the terrain morphology and the technical infrastructure due to new road construction and the extension of the existing road network.

However, the construction and operation of all WFPs positively affect specific environmental components. More specifically, their installation and operation contribute to the socio-economic environment of the study area as new jobs are created and employment is increased, while during their operation, cheaper electricity is ensured, and regional development is enhanced. In addition, during the operational phase of the examined wind farms, their greatest positive effect concerns the atmospheric environment of the study area as their main goal is the production of renewable "green" energy and the minimization of emissions of harmful pollutants into the atmosphere.

5. Discussion and conclusions

Wind farm installations like all forms of Renewable Energy Sources (RES) contribute to solving the problems created by the climate crisis as they produce electricity with zero harmful gaseous pollutants during their construction and operational phases. Wind energy should be deployed in compliance with the constraints and limitations set by the existing legal framework in order not to negatively affect the natural and anthropogenic environment and to promote sustainable development. Therefore, the aim of this paper is the evaluation and assessment of the environmental impacts of the existing wind farms in the Region of Central Greece, which was carried out through a modified RIAM method.

The RIAM method is a quantified impact calibration system. In this work, a modified RIAM is used which is applied for the construction and operational phase of the selected projects. Initially, the potential impacts of onshore wind farm facilities on the natural and anthropogenic environment during the construction and operational phase are analyzed. The environmental impact assessment is further enhanced by the computation of the EPG. The EPG could provide an innovative indicator for assessing the overall environmental impacts of a project, including environmental, economic and social dimensions.

The initial stage of the methodology includes the mapping of the existing wind farms and the analysis of the current state of the environment of the Region of Central Greece. Information related to the natural and the anthropogenic environment which either affects or is affected directly or indirectly by the installation and operation of the wind farms is provided. The environmental components that are affected by wind farm projects are identified and the individual score for each environmental component for each examined WFP is provided both in construction and operational phase. Impact significance of environmental components in both phases of the life cycle is then calculated and the EPG is finally computed.

From the application of the proposed methodology, it emerged that the negative impacts during the construction phase of the WFPs are mainly related to the morphology of the ground, the technical infrastructures and the atmospheric environment of the study area. The necessary work for the installation of such projects causes important impacts on the morphology of the soil, such as the destruction of the soil relief as well as the destruction of the soils that have been created by natural processes. The transfer of the necessary construction materials has as a consequence to increase the traffic of heavy vehicles in the area causing intense traffic load during peak hours. Finally, the atmospheric environment is directly affected by the installation of the WFPs as several pollutants are emitted from the gases produced by vehicles and mechanical equipment as well as from the diffusion of dust within the construction site.

However, during the operation of the WFPs, the most important positive impacts are related to the socioeconomic and atmospheric environment of the study area. The WFPs, during their operational phase, create new job opportunities and support local communities while at the same time contributing to the energy autonomy of the region and consequently of the entire country. Finally, the WFPs produce electricity without emitting greenhouse gases and other harmful pollutants to the atmosphere, which makes their influence on the atmospheric environment extremely important.

Author Contributions

Conceptualization, O.K. and D.V.; methodology, O.K. and D.V.; software, O.K. and D.V.; validation, O.K. and D.V.; formal analysis, O.K. and D.V.; investigation, O.K. and D.V.; resources, O.K. and D.V.; data curation, O.K. and D.V.; writing/original draft preparation, O.K. and D.V.; writing/review and editing, D.V.; visualization, O.K. and D.V.; supervision, D.V. All authors have read and agreed to the published version of the manuscript.

Conflict of Interest

The authors declare no conflict of interest.

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