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Landscape and Road Integration in Greece

K. Hadjibiros[1] and D. Argyropoulos[2]

1. Department of Civil Engineering, National Technical University of Athens, Zografou 15780, Greece

2. Environmental Consultants, Tinou 2 Holargos 15562, Athens Greece

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Abstract: This paper concerns the Strategic Environmental Assessment of the construction of some major Greek motorways: the Ionia Motorway, the Peloponnese Motorway and the Athens-Lamia Motorway. In the beginning the natural and cultural diversity of the Greek landscape as well as its conservation needs are discussed. The landscape impact assessment methodology consists of the identification of environmental goals, of sensitive landscape parameters, of environmental indicators and of acceptable impact thresholds. The selection of alternative solutions as well as of mitigation measures has been studied, on the basis of relevant environmental indicators. The developed methodology may constitute a tool for the environmental management of other road programs of great scale.

Key words: Motorway, landscape parameters, indicators, thresholds, alternative solutions, mitigation.

1. Introduction

The Greek natural environment shows an extensive diversity of natural landscapes [1, 2]. Greece is a relatively small European country, with an area of 132,000 km^2 and a population of about 10 million inhabitants. A large part of its area is mountainous, only 35% of it is covered by agricultural land, while 60% is covered by natural forests and shrub vegetation. The greatest part of the country is surrounded by sea and the length of the coastline reaches 18,000 km, while the land's geological structure is relatively young; therefore, small catchment areas and landscapes dominated mainly by small valleys have been formed. Geomorphological factors combined with climate variability have created a great landscape and seascape diversity, as well as a variety of ecological habitats, resulting in the existence of a great number of important biotopes and an exceptional biodiversity. The number of natural sites with significant ecological or aesthetic value reaches several thousands. These sites include forests, wetlands, sea coasts, islands, alpine zones, rivers, lakes, ravines, springs, caves etc.. Nevertheless, most sites of special environmental interest are characterized as being small in scale and vulnerable, a fact which increases their sensitivity to anthropogenic change.

A first record of Greek biotopes was undertaken in the context of the CORINE European network; 430 sites of international or national ecological importance with a total estimated area of 34,395 km^2 (26.1% of the country's terrain) and about 200 additional sites which also constitute important biotopes for threatened species have been identified; a more detailed record would end up noting thousands of sites of local ecological importance [1]. Later, the NATURA 2000 European network included about 300 sites (most of which were also CORINE biotopes), covering more than 20% of the country's terrain. Although Greece is bound to EU policy for its NATURA 2000 sites, nature site protection is generally not adequate.

The country is also characterized by an exceptional cultural wealth, which contributes to the formation of valuable landscapes. Natural and cultural landscape

Corresponding author: K. Hadjibiros, associate professor, main research field: environmental management. E-mail: k.hadjibiros@hydro.ntua.gr.

characteristics, often interconnected, are found in a great number of environmentally important sites [3]. One can realize, for example, that archaeological and ecological landscape characteristics occur, to some extent, at the same sites. Registering sites of special natural and cultural interest, contributes to the development of a system of protection zones. On the other hand, conservation of a generally common everyday landscape constitutes an important issue, too. Reliable information on areas of natural and cultural value may contribute to this target, as it helps improving environmental impact assessment for projects involving construction work or various industrial/agricultural activities taking place in sensitive parts of everyday landscapes. However, Greece lacks of specific and coherent landscape management policy; the country signed the European Landscape Convention in 2000 but it ratified it almost ten years later. In practice, landscape protection is rather fragmented and indirect, since it is partially applied through legislation concerning specific protection of archaeological sites, traditional settlements, cultural monuments, ecological habitats and natural monuments, or through environmental impact assessments of various activities.

During the 1960s and the 1970s, according to laws concerning archaeological heritage, a number of Sites of Outstanding Natural Beauty (SONB) had been designated. They mainly included archaeological and historical sites, as well as traditional settlements. Later on, this list has been reviewed and completed, including 449 sites of natural and cultural interest covering a total area of 6,270 km^2 or 4.8% of the country's terrain [1]. The new list has not yet been officially regulated. The SONB have remarkable aesthetic chracteristics and they may include either natural landscapes exclusively, or a mixture of both natural and built landscapes. The SONB, Corine and Natura 2000 site lists are part of the "Data Bank for the Natural Environment of Greece" (www.itia.ntua.gr/filotis), a program operating since 1990. In the framework of it, descriptive and geographical data from registered sites has been collected and organized. Filotis data is derived from various bibliographic sources, not published data, as well as field-work research.

During the last decades, Greek economy and environmental status have been greatly influenced by European Union (EU) policies. EU funding input determines to a large extent the country's development planning. Environmental legislation has also undergone significant EU influence, although many legislative regulations are implemented in a more or less ineffective manner. Economic growth is the country's primary national goal, but the large diversity of the Greek natural and cultural environment inevitably means that almost every construction activity is bound to influence an important landscape [1]. Specifically, large infrastructure projects such as motorway construction may significantly shrink landscapes in form and function [4-7]. Negative impacts can either be magnified or minimized depending on construction characteristics and the choice of appropriate alternative solutions. In Greece there is a large number of existing road networks (motorways, national, local, urban, agricultural and forest roads) as well as a number of motorway projects either in planning or construction phase (see Fig. 1). According to legislation, new construction projects or activities have to fulfill certain environmental requirements, which are set during the process of environmental impact assessment. In the case of motorway programs, great attention should be given on the issue of selecting appropriate alternative solutions. Strategic Environmental Assessment (SEA) can be very useful during this process.

The 2001/42/EC Directive on SEA [8, 9] involves environmental control over plans and programs. This directive completes European policy on environmental impact mitigation of economic development, which first began with the 1985/337/EC and 1997/11/EC

Fig. 1 Major motorway projects of Greece.

Directives on environmental impact assessment of construction projects. It should be noted that European legislation still lacks environmental control of development policies (e.g. for agriculture, industry, tourism, energy, transportations etc.). Nevertheless, there are some concerns about the level of detailed control that can be reached during planning, given the fact that natural/ecological processes as well as development/social processes involve many complex parameters that cannot be easily foreseen [6].

Specifically, a SEA addresses the general impacts of a project in order to examine and select the appropriate alternative solutions on a wider scale, and to develop an effective environmental mitigation strategy by taking restoration measures. It is often useful to assess impacts while comparing them with the do-nothing scenario, namely the possible future landscape development without the proposed project. Moreover, SEA can help in finding threshold values of acceptable and non acceptable environmental impacts. Absolute quantification is usually impossible, though a qualitative approach can be used, such as characterizing the importance of each impact as very serious, serious, medium, small, minor. A project's SEA study and preliminary plan or program have to undergo a public hearing. Their content should be available and open to authorities and the public, who must have an early and real chance — within a reasonable time period — to openly express their opinion before any plan or program approval.

2. Methodology

A motorway, when it is the sum of different road construction projects, constitutes a program and is subjected to SEA [10-12]. In this paper, SEA analysis is presented on some major Greek motorways [13, 14]: (1) the Ionia Motorway and the Peloponnese Motorway (Korinthos-Tripoli-Kalamata-Sparta), which are now in planning or construction phase; the axis routing process for these motorways had already progressed based on technical and economic criteria, thus the alternative solutions examined were limited to a zone of about ten kilometers on either side of the axis; and (2) the upgrading into a motorway of the existing PATHE highway (Athens-Lamia), as shown in Fig. 2. The analysis focuses on environmental impact prevention e.g. axis routing correction based on environmental impact mitigation criteria and post construction landscape restoration wherever this is possible. The assessment methodology followed [15] consists of the identification of environmental goals, environmental indicators and acceptable impact thresholds. We assume that the impact magnitude of a motorway on the landscape basically depends on the following environmental parameters: landscape aesthetics, biodiversity, soil, water, the acoustic environment, agricultural activity, the cultural environment. Possible impacts include visual intrusion and landscape consumption, disturbance or fragmentation.

Environmental goals are set for each parameter, and this can be achieved by using an environmental indicator approach. An environmental goal expresses the environmental parameter's desirable state/condition, while indicators are generally

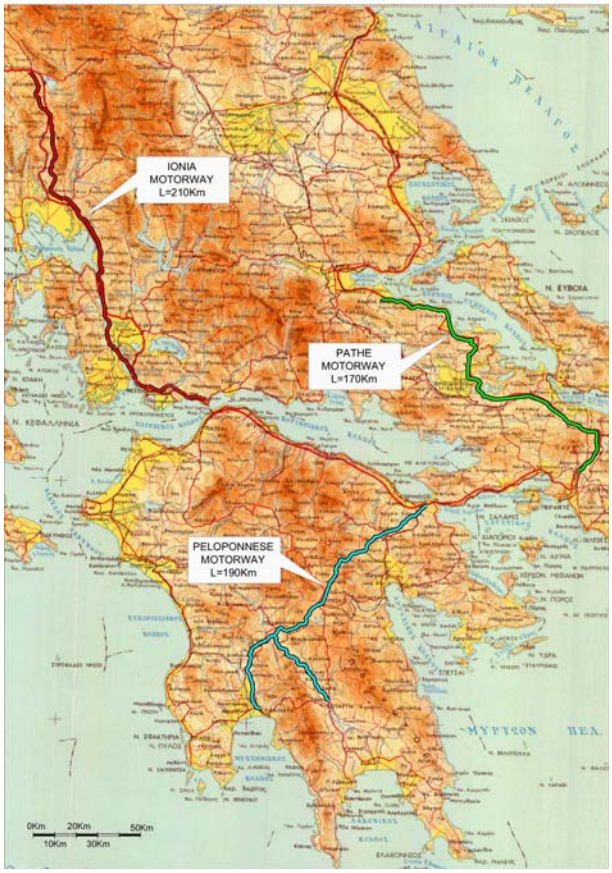

Fig. 2 The study's motorway program: the Ionia motorway, the PATHE motorway and the Peloponnese motorway.

measurable quantities that represent the goals. The following environmental goals were examined for each parameter mentioned above:

(1) Aesthetics: Many areas with remarkable landscape aesthetics and designated Sites of Outstanding Natural Beauty (SONB) within the motorway broader area. Goal: general landscape quality conservation and non degradation of scenery;

(2) Biodiversity: Many important biotopes with protected NATURA and CORINE sites within the motorway broader area. Goal: avoiding vegetation, flora and fauna degradation;

(3) Soil: Parts of the axis routing passing through sensitive geological formations or areas with a rough terrain. Axis routing through these formations might cause large excavations or embankments resulting in alteration of the terrain's morphology or stability. Goal: soil stability conservation and avoiding conditions of imbalance;

(4) Water: Important and sensitive water bodies within the motorway broader area. Goal: surface water (freshwater and seawater) and ground water pollution mitigation, maintainting a good ecological quality of water bodies;

(5) Acoustic environment: Noise degrades landscape quality. Goal: avoiding natural and cultural landscape exposure to high noise levels;

(6) Agricultural activities: Axis routing passing through valleys might disrupt agricultural and rural activities. Goal: activity conservation;

(7) Cultural environment: Many areas of archaeological, historical or cultural interest within the motorway broader area. Goal: conserving protected archaeological sites, non degradation of other sites with cultural value.

Indicators are given quantitative values based on their map depiction and the road's distance from sensitive zones or with the use of conceptual models (e.g. for noise). The relative importance of different indicators is assigned with weighting coefficients. The score for each alternative solution is calculated based on the sum of the indicators' arithmetic values and thus a comparative approach can be achieved in order to select an alternative axis routing. However, if a particular impact on some environmental parameter surpasses a threshold, it is characterized as non acceptable; this alternative solution is then rejected even if its score based on the remaining goal indicators is not low.

3. Examples of Environmental Goal Indicators and Mitigation Measures

The selected environmental indicators for the "aesthetics", "biodiversity", "water", "agricultural activity", "cultural environment" parameters are the axis routing lengths passing: (1) through or very close to sites of high sensitivity; (2) at an intermediate distance from sites of high sensitivity; (3) through or very close to sites of medium sensitivity; and (4) at an intermediate distance from sites of medium sensitivity.

It was also assumed that the impacts of an axis routing length within great distance from sensitive sites are marginal. Of course, “the motorway broader area”, as well as “very close”, “intermediate distance” and “great distance” assessments depend on the vulnerability or the environmental parameter considered each time; for example for water bodies a distance of 0 to 200 m was assumed as “very close”, a distance of 201 to 500 m was considered as “intermediate”, while a distance of over 500 m was assumed to have marginal impacts. In the case of “soil” parameter, the environmental indicators chosen were only the axis routing lengths passing through geological formations of high and medium sensitivity. In the case of the “acoustic environment” parameter, the area subjected to noise levels greater than 60 dB (A) was selected as an environmental indicator. In the cases of the “aesthetics” and “agricultural activity” parameters, the axis routing length which does not follow already existing roads and thus causes new landscape or agricultural land consumption, was selected as an added environmental indicator for these parameters. Sensitive site mapping using GIS preceded site characterization process, as well as the selection of sensitivity criteria related to parameter vulnerability and the value of environmental factors disturbed. Setting threshold values for each environmental indicator was based on existing legislation, bibliography or the study team’s judgement.

Figs. 3 and 4 depict the vast landscape vulnerability and complexity at particular locations in the motorways

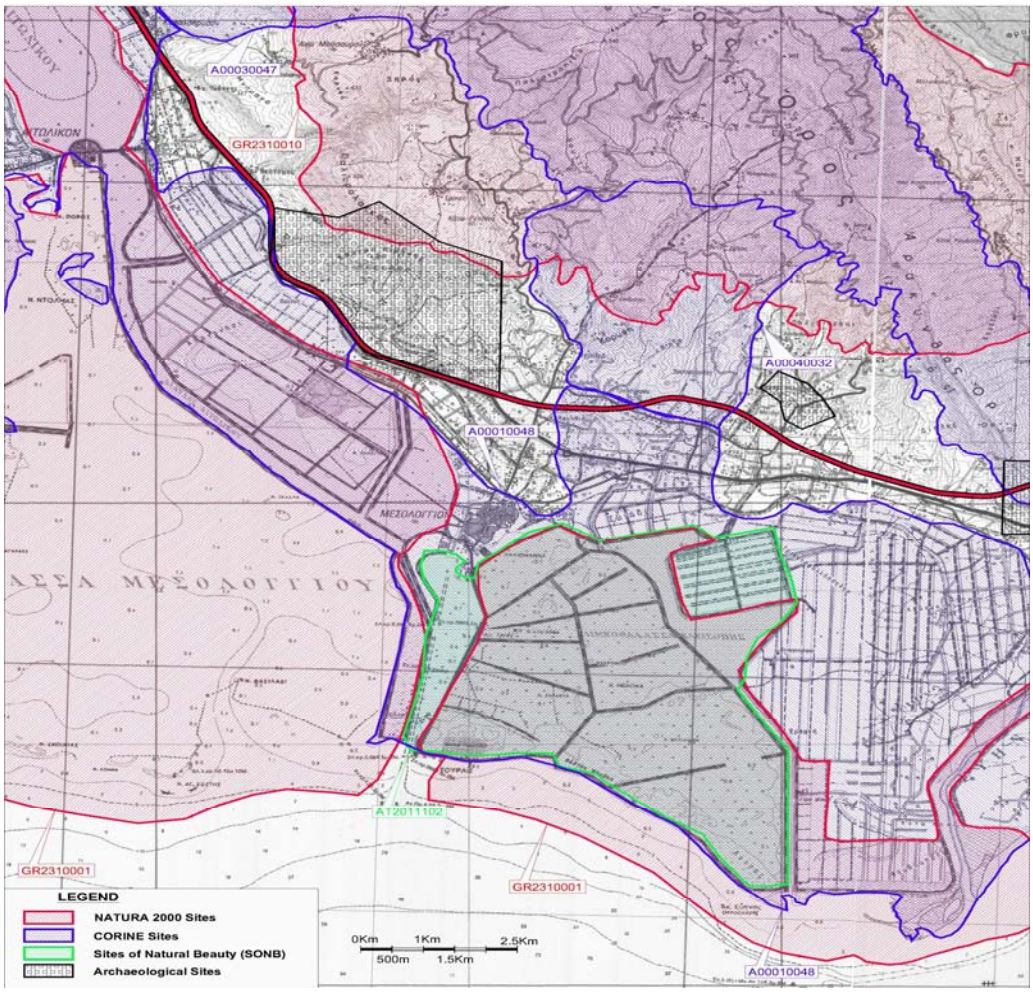

Fig. 3 Ionia motorway axis passing through the Messolongi area. Natura, Corine, SONB and protected archaeological sites are present.

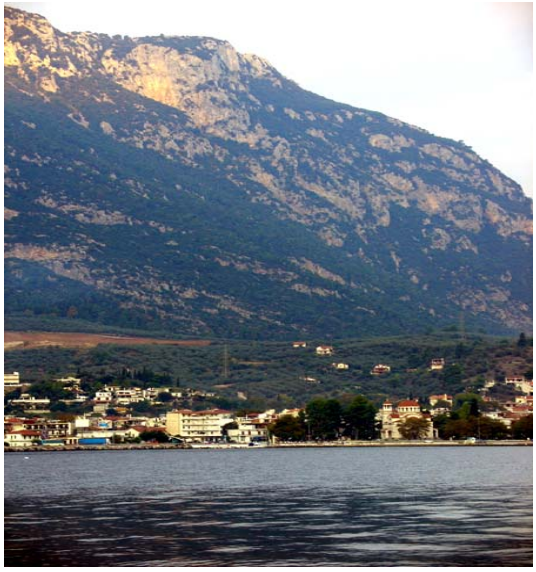

Fig. 4 The PATHE highway passes through the SONB "Area of Aghios Konstantinos/Kammena Vourla".

zones. The following data is indicative of the vast number of sensitive and protected areas (it should be noted that many of these areas partially overlap each other) that had to be taken into consideration during the SEA for Ionia, PATHE and Peloponnese Motorways:

(1) Ionia motorway broader area: 8 Natura sites and 2 special protection areas, 18 Corine sites, 2 Ramsar sites, 12 SONB, 6 wild life shelters, 19 protected archaeological sites;

(2) PATHE motorway broader area: 6 Natura sites and 4 special protection areas, 9 Corine sites, 1 national park, 2 Ramsar sites, 7 SONB (Fig. 4), 14 wild life shelters, 19 protected archaeological sites, 11 not protected archaeological sites;

(3) Peloponnese motorway broader area: 7 Natura sites, 7 Corine sites, 5 SONB, 6 wild life shelters, 3 natural monuments, 4 protected archaeological sites.

The choices of restoration measures must fulfill various criteria (in some cases partially contradictory). They need to be: economically feasible, appropriate for impact elimination, technically correct and applicable based on available means and experience, aesthetically acceptable, easily maintained, without serious side effects. In particular, landscape restoration measures for motorways should include: balancing excavations and embankment in order to minimize transportated materials during construction, shaping excavation and embankment slopes, reducing slope erosion, careful construction, planting vegetation, noise mitigation, avoiding animal corridor disruption, minimising road mortality of animals, being careful with temporary parking areas, managing the roadside advertisements appropriately, avoiding continuous landscape concealment perceived by the motorway users.

4. Discussion

Road construction and traffic in environmentally sensitive areas produce significant negative effects [8] on wildlife populations and ecosystems; they may lead to a large scale loss of natural landscapes or reduction in quality of the remaining ones. Evaluation of these effects should be a part of an EIA document, but environmental impact assessments focus mainly on rather small-scaled, local effects. Some environmental impacts should be considered at a higher level of decision making, in a strategic environmental assessment concerning policies, plans and programs at a regional or even a national scale [15]. In many cases, however, landscape evaluations cannot be fully documented and have to be based upon expert judgements, because no much relevant experience exists and new data cannot easily be gathered within short time limits. When analytical methods for landscape evaluation are not available, assessments should focus at the descriptive level [6], i.e. to consider lists of vulnerable species, habitats or landscape features.

The SEA analysis results for the three motorways (Ionia, Peloponnese and PATHE) were considered by authorities together with other related studies, during the compilation of construction specifications. However, during this time when the study was complete, authorities insisted on immediate promotion of all these projects and therefore the study's environmental assessments and analysis methods were

not fully reclaimed. Nevertheless, many of the SEA study's suggestions were taken into consideration during the formation and selection of the projects' alternative solutions [13, 14]. Furthermore, contractors overall considered these studies together with their own detailed Environmental Impact Assessment Studies and the approved Environmental Terms for each project, when they started applying landscape protection measures during construction. Moreover, the study's analysis methodology with the approaches used such as environmental indicators, the use of GIS, the application of simplified conceptual models and the quantitative weighted environmental indicator scoring had an significant impact on the way authorities, contractors and consultants would henceforth compile major motorway program studies (as well as other types of projects) and ultimately on the application of landscape protection and mitigation measures.

5. Conclusion

Landscape fragmentation caused by motorways construction is particularly important when the natural and cultural environment is small in scale, diverse and vulnerable [5]. The SEA methodology developed in this paper could contribute in mitigating the most significant negative effects on the outstanding natural and cultural scenery and in avoiding non acceptable environmental impacts; the conservation of sensitive parts of the common everyday landscape could also be partially achieved, however, it constitutes an issue that needs much further analysis.

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