

How Green Are Romania's Motorways? An Analysis of the Impact Avoidance and Mitigation Measures Proposed for Motorway Projects in Romania

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Abstract. *The development of infrastructure, particularly motorway infrastructure has been one of the main goals of Romania after 1990. However, the sustainable development of this type of infrastructure has only become an issue in the last few years. In this paper are presented the results of a literature review and analysis of the environmental impact mitigation measures which were proposed for motorway and express road projects in Romania within their Environmental Impact Assessments. The paper analyses whether appropriate measures have been proposed in the Environmental Impact Assessment Reports and how consistently they were proposed in different EIAs done in Romania. It analyses how much the measures proposed address impacts such as habitat loss, habitat alteration, fragmentation, species disturbance, and mortality*

So far, there is no known analysis on this topic Romania, although these types of projects have been implemented for many years. The hypothesis for this analysis is that the measures proposed for motorway and express road projects are not completely adequate for addressing identified impacts and that they are not in accordance with best practices.

The results of the analysis indicate important gaps in the implementation of measures, particularly in regards to maintenance of ecological connectivity, as a response to potential fragmentation, and light pollution mitigation. It also highlights the lack of available data on the effectiveness of implemented mitigation measures, indicating the need for rigorous post-implementation monitoring and assessment of effectiveness. The paper proposes a more comprehensive and consistent approach to environmental impact mitigation in infrastructure projects, and for the public availability of post-implementation evaluation results.

Keywords: motorways, express roads, infrastructure, mitigation, EIA, sustainability.

Introduction

The development of transport infrastructure in Romania is a strategic priority for the country as assumed through the General Transport Master Plan in 2015 (Romanian Government, 2023).

Linking the port of Constanța with the Western neighboring countries of Romania, as well as to the country's historical regions is seen as a necessity for ensuring economic growth and further economic investments in areas where development has been stalling after 1990.

The development of infrastructure, particularly road infrastructure, is however linked to environmental impacts, both in relation to biodiversity and ecosystems, as well as in relation to the socio-economic component of the environment. For ecosystems, the development of infrastructure can lead to: habitat loss, habitat degradation (or alteration), the creation of barriers for free movement of fauna and to animal mortality (Ament et al., 2023).

Infrastructure developers in Romania have faced difficulties due to the country's extensive natural landscapes. Much of the land remains undeveloped from a socio-economic point of view, having high landscape connectivity and little to no human intervention. This allows easier wildlife

movement and more resilient ecosystems. But this also increases the difficulty in implementing development projects, and in developing Environmental Impact Assessments. Firstly, it imposes a need for a strategic approach regarding the location for the implementation of proposed new infrastructure, because of the need to avoid especially sensitive areas. Secondly, it requires the need for adequate and ambitious impact avoidance and mitigation measures to be implemented at the level of each individual project, in order to mitigate the impacts that each of the projects is capable to generate.

This paper represents a literature review, which analyzes the level in which impact avoidance and mitigation measures were proposed for road infrastructure development projects in Romania thus far. At the time of writing, most newly proposed motorways and express roads have already finalized their pre-construction study stage and are approaching construction, with an estimate for finalization around 2030-2032.

The topic of road ecology is a relatively new one in research, with very little preoccupation for it in Romania. Thus, the hypothesis formulated for this analysis is that the measures proposed for motorway and express projects are not completely adequate for addressing identified impacts and that they are not in accordance with best practices.

The paper is based on a literature review of the Environmental Impact Assessment studies developed during the last 10 years in Romania, and the regulations obtained for motorway and express road projects on the environment topic. Firstly, the paper presents the most important impact avoidance and mitigation measures, that are usually proposed for these types of projects, based on each type of impact. Then, it shows spatially for which projects each type of measure was proposed, in relation to all the other projects analyzed. The paper then presents a discussion and conclusions based on the findings presented previously. Unfortunately, due to the lack of background data, no analysis can be done on the sufficiency of these measures in relation to the assessed impacts, the paper only showing whether measures were implemented, but with no way of indicating their effectiveness.

Literature review

Motorway impact avoidance and mitigation measures

The implementation of motorway and road projects generates environmental impacts, which require certain measures for avoidance or mitigation if these impacts. The types of impact avoidance and mitigation measures can be categorized based on the type of impact they address and the effects which lead to the impact.

Habitat loss and alteration

In terms of habitat loss, the main measures that can be proposed usually relate to changes in the siting of the project, to avoid intersection of protected areas or areas with certain important habitats. Another alternative is related to technological solutions, such as opting for a bored tunnel, rather than an embankment in order to maintain the existent habitats above the tunnel (Iuell et al, 2003)

For habitat alteration, several effects have to be addressed through avoidance and mitigation measures. These are related to:

- the potential *spread of invasive plant species*, which can colonize areas of disturbed land, such as that left after the construction of a motorway. Addressing this effect requires measures for managing the spread of invasive species (Ament et al., 2023);

- the potential for *pollution and spread of waste*, following the construction works and during operation, which can be addressed through the use of specific technologies during construction and through an adequate waste management system (Benitez-Lopez et al., 2010);
- the *changes in land use* following the temporary use of a certain area of land, which can occur due to the installation of invasive species, accumulation of water or waste, erosion or other reasons. This can be addressed through measures for controlling invasive species, as well as rehabilitation of temporarily affected areas (Benitez-Lopez et al., 2010).

Habitat fragmentation

The construction of linear infrastructure can contribute to fragmentation:

- of *habitats themselves*, resulting in the creation of multiple sections of the habitat, which have a reduced resilience and, in time, can be lost. This effect can be addressed through the maintenance of natural habitat areas in certain section of the project, such as underneath bridges or viaducts or rehabilitation works for restoring habitat connectivity; (IENE, 2023)
- of *favorable habitats* or *ecological corridors* for species of fauna, which can reduce gene exchanges in a population, and make the population more sensitive to further impacts. The measures that can be proposed for this effect are green bridges or ecoducts, in the case of large species, or underpasses, for smaller species (Ministry of Agriculture, Food and the Environment, 2016);

Species disturbance

The disturbance of species can occur due to:

- an increase in the *level of noise* generated during construction and operation of the project, which can be addressed by the proposal of noise panels (IENE 2023a);
- an increase in artificial light, which can lead to changes in the behavior of nocturnal species, such as species of invertebrates, birds or bats. This effect can be addressed through the use of directional light or low temperature lights, which are less attractive for species (La Sorte et al., 2022);

Species mortality

Species mortality can occur due to a number of reasons, but it is most commonly associated with *animal-vehicle collisions*, both during construction and operation of a project. This impact can be addressed through the use of specific measures, such as the implementation of anti-collision panels and fencing, as well as management of traffic and avoidance of traps during the construction of the project (IENE 2023b);

Available information on the motorway projects in Romania

The results of the Environmental Impact Assessment Reports for motorway projects in Romania is publicly available online, either on the website of the National Environmental Protection Agency, or on the county level EPAs. The Environmental Approval documents for the projects are also available publicly.

Methodology

The analysis of the impact avoidance and mitigation measures was done based on the publicly available documents regarding each project, such as the Environmental Approval or the Environmental Impact Assessment Reports. These documents were collected from the websites of the National Agency for Environmental Protection or the websites of the county-level Agencies for Environmental Protection. Publication of these documents is a legal obligation under Law 292/2018 regarding the assessment of impacts of certain projects on the environment, in order to allow public consultations on the implementation of the project.

The spatial data regarding motorway projects in Romania is also publicly available under the General National Transport Masterplan, as a shapefile. The information was downloaded from the official sources (Ministry of Transportation, 2024) and processed in spatial analysis software, such as ArcMap 10.8 and ArcGIS Pro. The data was cleaned and filtered to only showcase motorway and express road projects for which EIA Reports and/or Environmental Approvals were identified, as described above. Additionally, the shapefiles were modified through the addition of attributes in the attribute table indicating information regarding the measures proposed for these projects.

For analyzing the impact avoidance and mitigation measures proposed for each project, the different types of measures were categorized in accordance to the impacts they address (Table 1). This information was included in the shapefile attribute table for the spatial analysis, allowing the spatial features to be categorized differently in accordance to the presence or absence of each type of measure.

Table 1. Typical measures that are usually proposed in EIA Reports / Environmental Approval for the types of impacts generated by motorway or express road development projects

Type of impact	Type of measures proposed
Habitat loss	Restriction of constructed areas
Habitat alteration	Prevention of spread of invasive species
	Prevention of pollution (air, water, soil)
	Appropriate waste management
	Habitat rehabilitation
Habitat and ecological corridor fragmentation	Maintenance of connectivity for habitats
	Ecoducts or green bridges
	Underpasses for fauna
Species disturbance	Noise reduction panels
	Light reduction measures
Fauna mortality	Anti-collision panels
	Traffic management measures (including on adjacent infrastructure)
	Prevention of fauna traps
	Inspection and relocation of individuals/microhabitats
	Appropriate fencing

Source: Authors' own research.

The proposal of impact avoidance and mitigation measures related to the types of impact presented above was analyzed for each project in turn, and noted in the geodatabase. Based on the geodatabase, the results were shown as individual maps, showing all the analyzed projects and highlighting the projects for which each type of measure was proposed.

Results and discussions

The analysis included 22 motorway and express road projects proposed in Romania, selected as having their feasibility studies completed and thus having the environmental impact assessment stage finalized. These projects are under varying degrees of implementation, with some in preparation for construction, some under construction, and others already finalized and in operation. It should be noted that motorway sections which were finalized a long time ago, such as Bucharest – Pitești, were not included in the analysis, as they did not go through the environmental assessment procedure. Figure 1 shows the different implementation stages of the analyzed projects.



Legend

- Implementation stage
- Finalized project
- Project under construction
- Project in pre-construction

0 20 40 80 Kilometers

Figure 1. Map of the motorway and express road projects included in the analysis

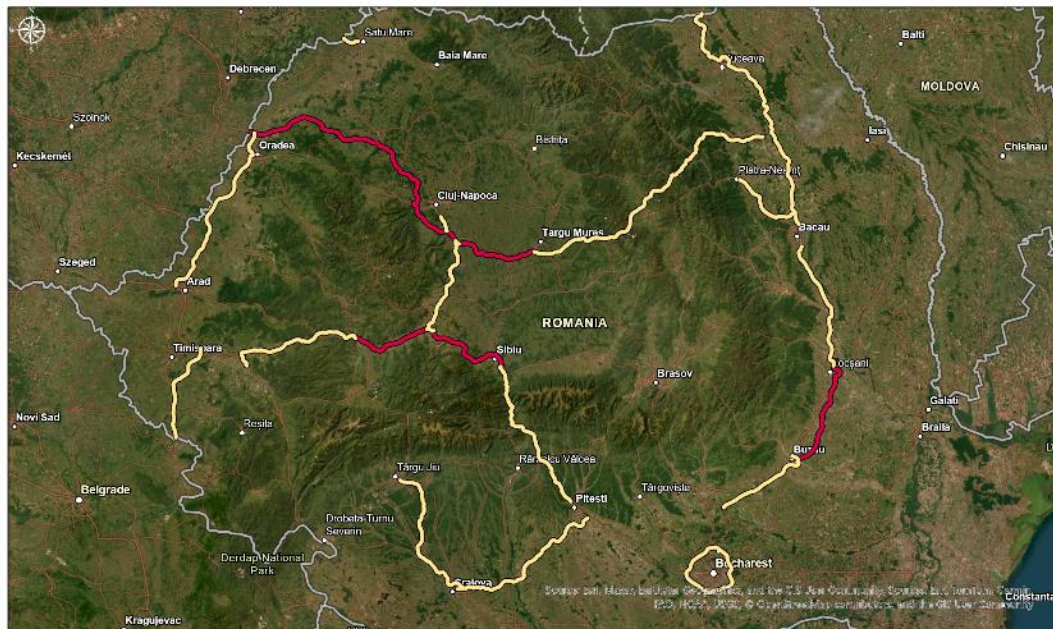
Source: Authors' own research.

Measures for habitat loss and habitat alteration

In terms of habitat loss, most of the analyzed projects include measures for restricting the construction works strictly to the area assessed in the EIA Report as habitat loss. The implementation of avoidance measures for habitat loss, for instance by choosing a different route for the project, is difficult to assess, as the multi-criteria analysis process through which route selection is done is not part of the EIA procedure and thus the background data is not publicly available.

In terms of habitat alteration, most of the analyzed projects include measures aimed at mitigating the effects of accidental pollution or waste generation during construction and operation. For addressing the potential establishment and spread of invasive species, most projects include

measures for these effects, but not all of them. Figure 2 shows the projects for which measures to address the potential spread of invasive species were proposed.



Legend

- Projects with measures for the management of invasive species
- Projects without measures for the management of invasive species

0 20 40 80 Kilometers

Figure 2. Map of the projects for which measures for the management of invasive species were proposed

Source: Authors’ own research.

Measures for habitat and ecological corridor fragmentation

For this type of impact, the most important measures which can be proposed relate to the implementation of green bridges (or ecoducts) or underpasses for fauna. While underpasses are useful in all areas, as they address small fauna, green bridges are necessary in areas of ecological corridors. In order to analyze the proposed measures from this point of view, Figure 3 was elaborated using the ecological corridors identified in the ConnectGREEN project as a basemap.

The results indicate that most of the projects proposed in areas important for ecological connectivity, such as the Lugoj – Deva motorway, the Sibiu – Piteşti motorway and the Târgu Mureş – Târgu Neamţ motorway include measures for maintaining connectivity. Issues become apparent for projects such as the Sibiu - Deva motorway or A3 Transylvania motorway, which intersect areas of connectivity and can contribute to fragmentation, but do not propose measures to address these impacts.

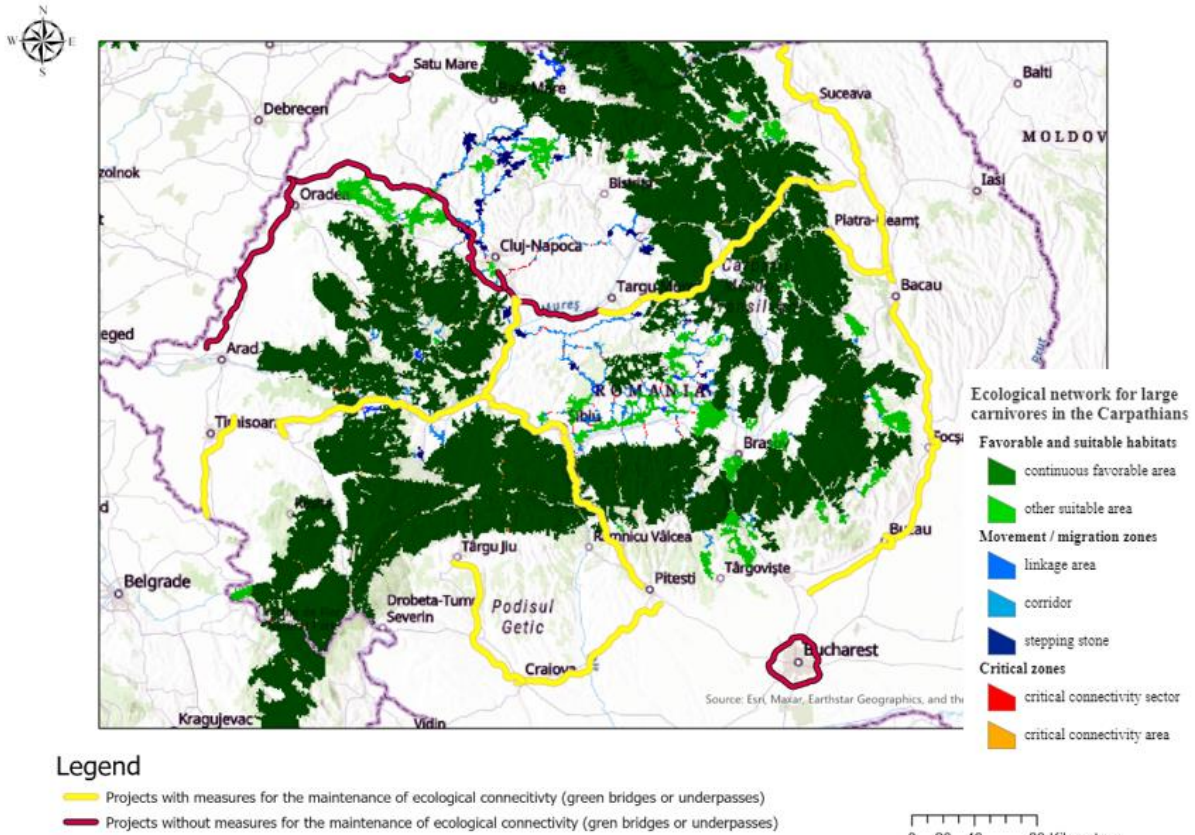


Figure 3. Map of projects for which measures for habitat fragmentation were proposed, and the ecological corridors identified within the ConnectGREEN project (ConnectGREEN, 2021)

Source: Analysis results superimposed on the map resulting from the ConnectGREEN project.

Measures for species disturbance

Species disturbance occurs mostly due to the increase in noise level or artificial light. The most common measures to address these types of impacts are the implementation of noise reducing panels and a lighting system which directs light only to the necessary area. The results of the analysis on the motorway projects in Romania indicate that most projects include measures for addressing noise, but not as many include measures for reducing artificial light. Figures 3 and 4 indicate these projects.

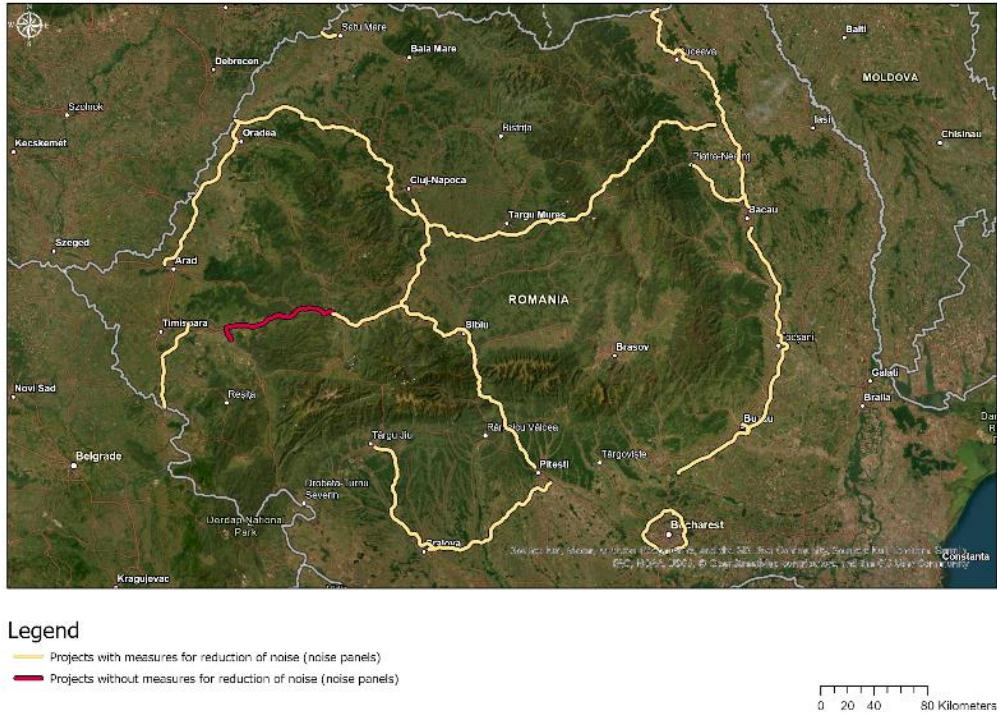


Figure 4. Map of projects with for which measures for the reduction of noise were proposed
Source: Authors' own research.

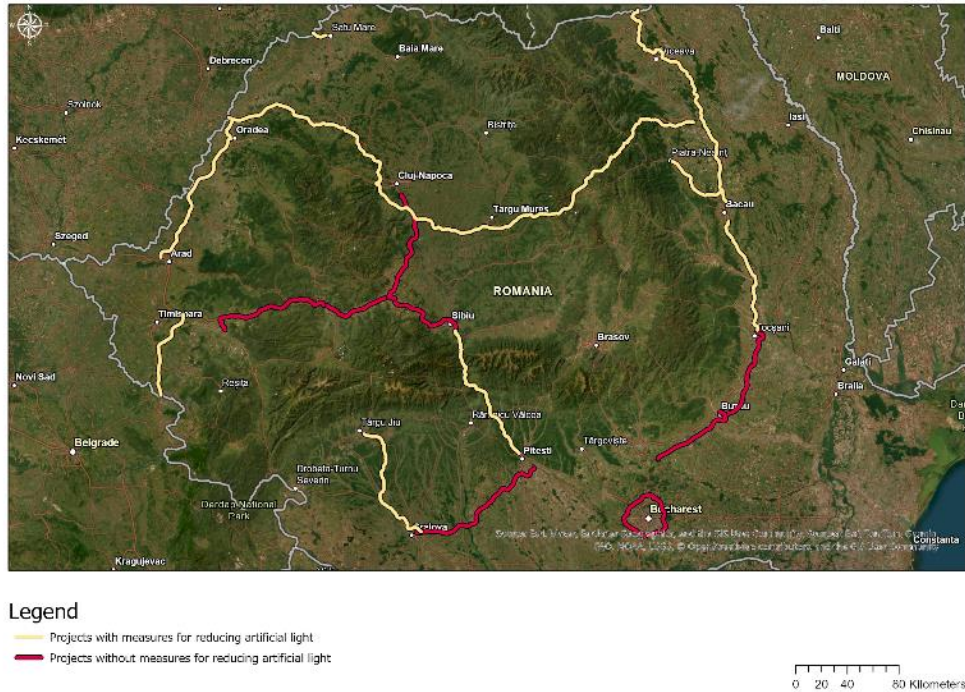


Figure 5. Map of projects with for which measures for the reduction of artificial light were proposed
Source: Authors' own research.

Measures for species mortality

Regarding species mortality, the most important measures that can be proposed relate to the use of anti-collision panels and adequate fencing around the infrastructure. Additional measures, such as avoidance of traps or temporary fencing during construction are also important, but their implementation is temporary, restricted only to construction.

Anticollision panels are of particular importance for flying species, such as birds, bats or certain invertebrates, while fences are addressed to other land species.

The analysis shows that in terms of anticollision panels, while many of the projects include them as measures, there are situations where these types of panels were not included, even though the projects are located either inside or close to protected areas designated for bird protection. Figure 6 shows these projects and their proximity to Natura 2000 sites designated for bird species (Ministry of the Environment, 2024).



Legend

- Projects with measures for reducing mortality (anti-collision panels)
- Projects without measures for reducing mortality (anti-collision panels)
- Natura 2000 sites designated for bird protection

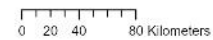


Figure 6. Map of projects with for which measures for the reduction of mortality risk (anti-collision panels) were proposed

Source: Authors’ own research.

Regarding fences, the analysis addressed in particular the implementation of special fences to the ones that are obligatory on motorways. These include reinforced fences for protection against larger animals, additional fences for small fauna or changes to the regular fence, with the aim of increasing its effectiveness.

The results indicate that fences are proposed at least for the motorways located in the most sensitive areas of the Carpathians. However, inadequate fencing exists on the Sibiu – Timișoara sector, an area known for the presence of large fauna, including bears. This is an issue that could pose a danger for the operation of the project. Figure 7 shows the projects for which additional fences were proposed in the environmental studies.

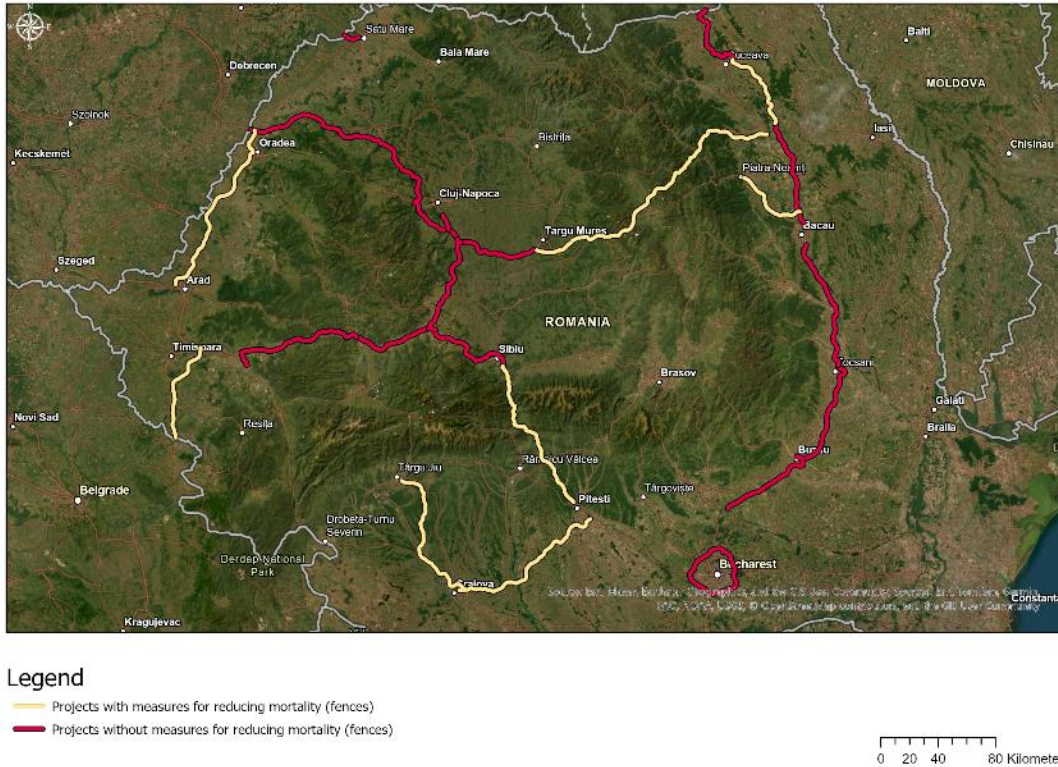


Figure 7. Map of projects with for which measures for the reduction of mortality risk (fences) were proposed

Source: Authors' own research.

Discussion

The environmental impact of road infrastructure development is a pressing issue, particularly in regions like Romania that are rich in biodiversity and natural landscapes and which are also striving for economic growth. It's crucial to have a nuanced understanding of the diverse impacts these projects can have on the environment, from habitat loss and fragmentation to species disturbance and mortality. This analysis offers important insights into the measures proposed in Environmental Impact Assessments (EIAs) for motorway and express road projects in Romania.

One issue to note in this regard, as a limitation of this analysis, is that Romania deals with a general problem regarding availability of data, an issue which is evident here as well. While the legislation requires environmental studies to be publicly available, it should be noted that not all of the EIA Reports for all motorway projects were identified on the Environmental Agencies websites. In order to address this limitation, where possible, the analysis used the official Environmental Permits issued for the projects, as these provide a more final set of measures than the EIA Reports, which can change after being put under public consultation.

The findings reveal several key issues. On the issue of habitat fragmentation, a major environmental concern associated with linear infrastructure development, the analysis shows that this is not adequately addressed in all projects. Notably, there are projects intersecting areas of ecological connectivity that do not propose measures to maintain this connectivity. This could lead to the interruption of vital ecological corridors, with significant negative impacts on biodiversity.

Regarding species disturbance measures, these are more commonly proposed in relation to noise reduction than light reduction. This suggests a potential oversight in EIAs, as light pollution is a known disruptor of wildlife behaviour, particularly for nocturnal species.

In terms of species mortality, measures such as anti-collision panels and appropriate fencing are crucial, but not all projects include these provisions. This raises concerns about the potential for increased wildlife-vehicle collisions and other forms of direct harm to wildlife.

The analysis also highlights an important gap in data regarding the effectiveness of the proposed mitigation measures. This lack of monitoring and evaluation data underscores the need for more rigorous post-implementation assessments. These assessments would provide insights into the actual impact of the measures and inform future infrastructure development projects.

Conclusion

The analysis of the impact avoidance and mitigation measures proposed for motorway and express road projects in Romania reveals several key conclusions regarding the environmental impact assessments and the development of these projects, from an environmental point of view.

The main conclusion that can be elaborated from the analysis is that most of the analyzed projects do include impact avoidance and mitigation measures, which address most of the identified impacts. In terms of the adequacy of these measures, however, the results indicate that the spatial extent and adequacy of these measures are not consistent across all projects. The measures do not cover all of the projects that they should and have gaps in important topics, such as not addressing impacts related to fauna mortality in areas with large animal populations.

The results of the analysis are in accordance to the formulated hypothesis, indicating that indeed, the measures proposed for motorway and express road projects in Romania are not completely adequate for addressing the identified impacts. However, it is unclear if the proposed measures are in accordance with best practices. This is due to the limitations related to this analysis, particularly in terms of information availability and lack of public data regarding the post-implementation effectiveness of the measures.

Another limitation that should be noted in regards to this paper is that related to lack of information about the projects themselves and their state at the beginning of the construction stage. It should also be noted that although the legislation requires EIA Reports and their supporting documents to be made available for public consultation, some of the documents are difficult to identify online, especially if the projects are older, or were implemented at a local level (e.g. the environmental procedure was run by a county level environmental protection agency). The implementation of this legislative requirement also does not mean that the EIA publicly available online in relation to a project is the final document, as it can undergo changes following public consultations and other requirements from the different authorities, without the modified version being subsequently posted again for the public. This issue was addressed in this analysis by using the Environmental Permits, instead of the EIA Reports, as the final documents issued by the Environmental Protection Agencies. However, this also doesn't guarantee that all proposed measures were implemented at the construction stage in the way they were initially proposed, as the Environmental Permits can be changed at the start or during construction, usually through a shorter environmental procedure, that does not include public consultations and whose documentation is not easily available for the public.

In conclusion, while the incorporation of impact avoidance and mitigation measures in the Environmental Impact Assessments of these projects is a positive step towards developing an

infrastructure which is more sustainable, the findings of this analysis suggest that there is still significant room for improvement. Specifically, there is a need for more comprehensive and consistent inclusion of mitigation measures across all projects, with particular attention to all relevant environmental impacts. Moreover, post-implementation monitoring and evaluation of the effectiveness of these measures should be implemented, with evidence of the results made available to the public, in order to inform and bring to the forefront the importance of these measures both for wildlife, and for road users as well.

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