ANALYSIS OF EIA RESULTS FOR CONSTRUCTION OF ROAD TRANSPORT INFRASTRUCTURE

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Construction and use of transport infrastructure is one of the human activities that fundamentally affects the quality of the environment. The EIA process is a globally recognized tool used for planning and permitting transport infrastructure to prevent, mitigate, or compensate for negative environmental effects. However, its effectiveness is often debated. Post-project analysis is important to determine the level of effectiveness of EIA. In this research, 43 EIA processes for highway projects in the Czech Republic were studied in relation to accepted principles of EIA post-project analysis. Statistical methods were used to assess the proposals for follow-up monitoring and changes in follow-up monitoring design over time. The research results indicate limited learning from previous EIA processes, some increase in the intensity and coverage of follow-up monitoring over time, and inadequate design of specific follow-up monitoring measures.

sustainability, mitigation measures, decision-making process, impact assessment, environment, EIA follow up, monitoring, transport infrastructure

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INTRODUCTION

The Environmental Impact Assessment (EIA) process has undergone constant change since its introduction (Jha-Thakur, Fischer, 2016), and highway construction projects themselves have evolved (Busscher et al., 2015). However, the levels of its fulfilment vary considerably in individual countries (Fearnside, 2007). Due to research outcomes, detailed information has been obtained about the negative effects of highways on specific components of the environment (Borda-de-Água et al., 2017), which enables us to propose measures to mitigate them.

However, follow-up monitoring of the effectiveness of these mitigation measures after construction is still insufficient. The main reasons are lack of legislation, implementation costs and lack of enforcement (Jones, Fischer, 2016).

Therefore, the study investigated the design of follow-up monitoring programmes within the EIA processes of highway construction in the Czech Republic, looking at both the coverage of monitoring of specific environmental features and changes in the design of the monitoring measures over time.

The study aimed to determine whether follow-up monitoring has become required more often within EIA processes and, therefore, whether there has been an evaluation of real effects on the environment and the use of this acquired knowledge to propose more effective follow-up monitoring in subsequent EIA processes.

MATERIALS AND METHODS

Data collection

EIA documentation for 52 highway projects initiated between 2003 and 2022 in the Czech Republic (Central Europe) was studied. Of this, complete documentation was available for a total of 43 projects - only these projects were subject to finished EIA Reports (i.e. the entire EIA process was completed) and corresponded to the description defined in the Environmental Impact Assessment Act No. 100/2001 Coll., in Annex I points No. 47 ‘First and second class highways’- projects which shall be made subject to an assessment, always (Directive 2014/52/EU), and No. 48 ‘Road or local road of four or more lanes, including widening or reconstruction of an existing road or local road of two lanes or less so as to provide roads or local roads

of four lanes with a continuous length of established limit'. The established limit for projects belonging to Category I - projects which shall be made subject to an assessment (Directive 2014/52/EU) - is 10 km, and the established limit for projects belonging to Category II - projects for which the member states shall determine whether the project shall be made subject to an assessment (Directive 2014/52/EU) - is 2 km.

The data was obtained in the publicly available Information System of the EIA processes managed by the Czech Environmental Information Agency (CENIA), a subordinate organization of the Ministry of the Environment.

The research covered all types of follow-up monitoring proposed within the EIA reports. Follow-up monitoring refers to the subsequent detection or measurement of the state of a specific component of the environment, which could have been negatively affected by the construction and use of transport infrastructure. Follow-up monitoring types in the EIA reports studied included:

FM – measures: follow-up monitoring of measures to mitigate negative effects on wildlife, such as wildlife-vehicle collision (WVC) mitigation measures or anti-barrier effect mitigation measures.

FM – water: follow-up monitoring of the quality or amount of water in the area of interest.

FM – air: follow-up monitoring of air quality in the area of interest.

FM – noise: follow-up monitoring of noise levels caused by highway traffic.

FM – green: follow-up monitoring of the condition of modified or newly planted vegetation in the area of interest.

FM – bio: follow-up monitoring of the condition of wildlife living in the area of interest.

FM – soil: follow-up monitoring of soil quality in the area of interest.

FM – landslides: follow-up monitoring of slopes and terrain in connection with the construction of the highway; this monitoring was included in only one EIA report and, therefore, was not suitable for statistical analysis.

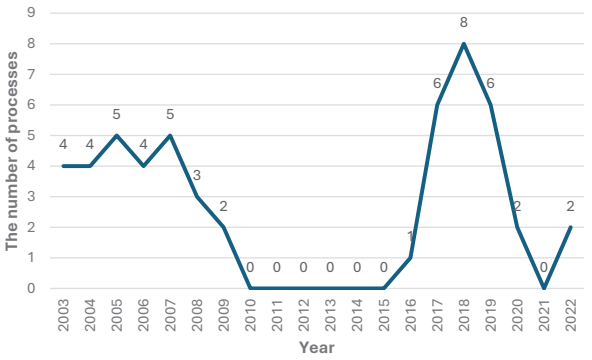

Fig. 1. Number of road transport infrastructure EIA processes initiated in individual years

Data analysis

The data analysis was divided into two parts. In the first, basic information about processes and proposed types of follow-up monitoring was investigated (Figs. 1, 2). The second part of the research dealt with changes in the design of monitoring types over time, specifically whether the designs changed depending on when the EIA process was started. A binomial logistic regression was used, with each EIA process being identified by the number of months from 1.1.2003 according to its start date. The results are presented in Table 1 and in Figs. 3-4.

In cases where the dependence between variables was proven, the 'breaking point' was taken to be when the analysis found 5% significance. In other words, this is when the number of months after which the probability that the specific observed follow-up monitoring would be proposed is greater than 50%. The results are shown in Table 2.

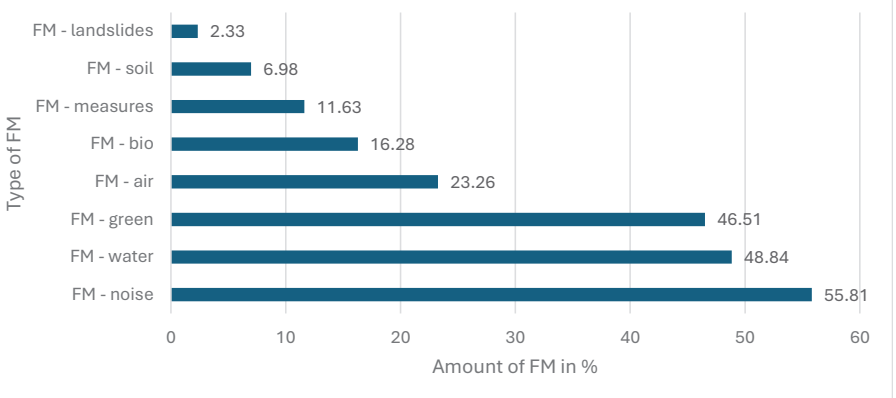

Fig. 2. Percentage expression of the number of individual types of follow-up monitoring required in the analysed EIA Reports

Table 1. Results of the binomial logistic regression tests for dependence of coverage of follow-up monitoring over time

Tested variable	Odds ratio	95% Confidence Interval		Binomial logistic regression testp =
		Lower	Upper	
FM - measures	1.04	0.984	1.10	0.160
FM - water	1.008	0.999	1.02	0.080
FM - air	1.001	0.9912	1.011	0.855
FM - noise	1.008	0.999	1.02	0.081
FM - green	1.010	1.001	1.020	**0.025**
FM - bio	1.03217	1.00	1.064	**0.042**
FM - soil	1.02868	0.986	1.07	0.191

Table 2. Breaking points for the dependence of follow-up monitoring over time

Tested variable	Binomial logistic regression test p =	The number of months from1.1.2003	Month and year when the breaking point occurred
FM - green	0.025	**164**	**08/2016**
FM - bio	0.042	**195**	**03/2019**

The breaking points occurred after 164 (FM-green) and 195 (FM-bio) from 01/2003.

RESULTS

Basic information about processes and proposed monitoring measures

43 EIA Reports initiated between 2003 – 2022 were analysed, ranging from 0.5 to 226 months after 1.1.2003. The length of individual sections of road subject to the EIAs varied between 1.7 and 161 km.

Fig. 1 presents the number of EIA processes initiated in the individual years of the study period. The processes were not initiated regularly, stopping completely between 2010 and 2015 and, in contrast, reaching a maximum between 2017 and 2019. The developer of intentions (Road and Motorway Directorate in the Czech Republic) is an organization managed by the Ministry of Transport. The initiation of a project depends on project readiness for construction and the allocation of funds in the state budget. The cessation of EIA processes between 2010 and 2015 was directly related to the global financial crisis at this time.

According to Fig. 2, the coverage of follow-up monitoring varied greatly according to its specific type, the most common being noise and the least common being landslides.

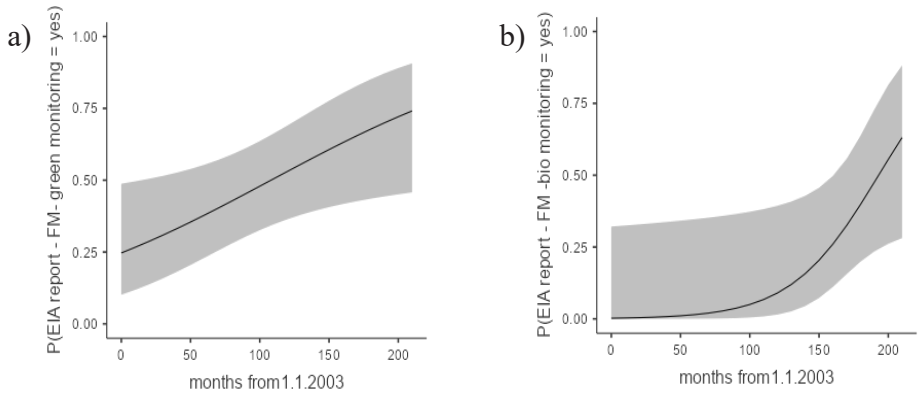

Fig. 3. The proven dependence of follow-up monitoring on the date of the EIA processes: a) FM green monitoring; b) FM bio monitoring

Changes in the design of follow-up monitoring over time

Table 1 shows that the number of measures for follow-up monitoring tended to increase for newer, more current EIA processes, provided that they were FM-green and FM-bio. For other monitoring types, the dependence of monitoring on the date of the EIA process was not proved.

The dependence or the failure to prove the dependence of individual variables on the date of the process is also presented in Figs. 3-4.

DISCUSSION

Road infrastructure affects the environment's biotic and abiotic components in varying ways (Walia et al., 2017). Air pollution levels vary depending on the traffic, highway location in the terrain, weather conditions (Baldauf et al., 2013), and traffic speed or time of day (Durant et al., 2010; Hays et al., 2011). Traffic noise can affect wildlife; the effects vary between species (Dooling, Popper, 2016; Grade, Sieving, 2016; Verzijden et al., 2010). Road transport adversely affects the soil environment near roads, including heavy metal enrichment. Wildlife and farm animals (Zhang et al., 2015), as well as people (Turer, Maynard, 2003), can be affected by the negative effects of highways. Highways also act as a migration barrier for most animal species (Alexander, Waters, 2000). Caldwell, Klip (2020) emphasize the need for subsequent monitoring of mitigation measures. Monitoring the death of wildlife can be carried out with the help of volunteers, with similar results to the involvement of experts (Paul et al., 2014).

The aims of the study were to evaluate whether there was an increase in the level of follow-up monitoring over time in specific EIA processes and whether there was learning from previous projects. Most EIA studies have focused on construction rather than highway operation (Qin et al., 2023). Even though environmental monitoring can help us effectively understand and manage environmental pollution and provide data to support environmental protection measures (Zhang et al., 2019, Keken et al., 2022; Zítková et al., 2022), deficiencies in follow-up monitoring are a globally widespread problem (Chang at al., 2018; Jones, Fischer, 2016). Approaches to follow-up monitoring differ from country to country (Nicolaisen, Driscoll, 2016). A careful review of environmental impact and the establishment of detailed terms and conditions are necessary for a successful follow-up. (Gallardo, Sánchez, 2004). The results of this

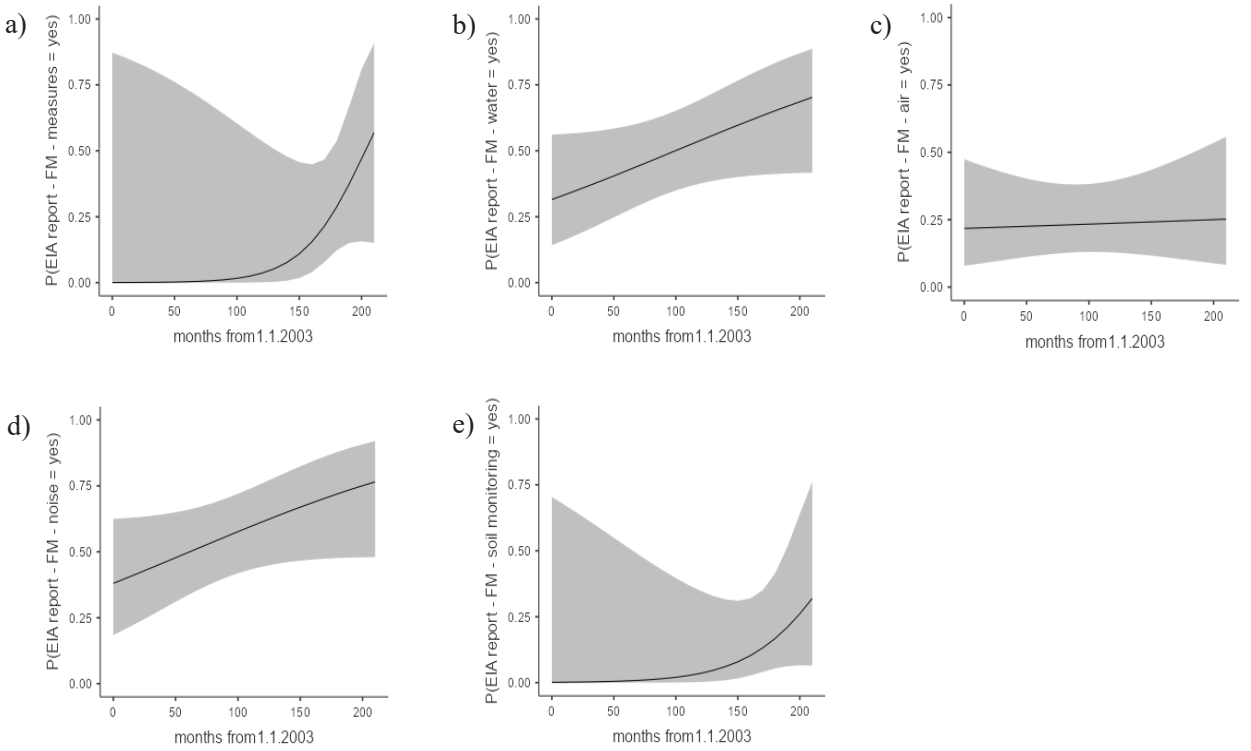

Fig. 4. The failure to prove the dependence of the coverage of follow-up monitoring on the date of the EIA processes: a) FM measures monitoring; b) FM water monitoring; c) FM air monitoring; d) FM noise monitoring; e) FM soil monitoring

study show that follow-up monitoring is not used regularly within the EIA process for highways in the Czech Republic, and its coverage differs significantly for specific features of the environment. Follow-up monitoring was suggested most often for noise (56%), vegetation (47%) and water (49%), and least for designed mitigation measures (12%) and soil (7%).

Within EIA follow-up, monitoring is an effective tool for reducing negative effects on the environment and additionally should enable learning from previous projects and strengthening environmental protection in subsequent projects (Gallardo et al., 2016; Wessels et al., 2015). However, the increase in the coverage of follow-up monitoring in the EIA reports analysed occurred only in green and biomonitoring. Therefore, it is not possible to confirm a general increase in the coverage of follow-up monitoring over time or significant learning from previous projects.

To increase the efficiency of the EIA process and protect the environment, we would recommend in future projects an increase in follow-up monitoring for most environmental components and the implementation of new knowledge obtained from scientific activity within the framework of previous projects.

CONCLUSIONS

The negative effects of highways on the environment have been known for a long time. The importance of follow-up monitoring after construction has also been pointed out many times. Nevertheless, the results show that the possibilities of incorporating comprehensive follow-up monitoring as part of EIA processes have not always been fully utilized in highway construction projects in the Czech Republic. Furthermore, no increase in follow-up monitoring over time has been demonstrated, except for 2 types of FM. This indicates that in the period from 2003 to 2022, not only was there little interest in ascertaining real environmental impacts, but also that there was no learning from previous EIA processes. However, even these results can serve as valuable data for the streamlining of future EIA processes, where greater emphasis will be placed on measuring real environmental impacts.

Author Contributions

Conceptualization; methodology; validation; investigation; resources; data curation writing—original draft preparation, Petra Dvořáková

Writing—review and editing; supervision, Zdeněk Keken

Validation; investigation, Tereza Hanušová

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Conflicts of Interest

The authors declare no conflict of interest. The funders had no role in the design of the study, in the collection, analyses, or interpretation of data, in the writing of the manuscript, or in the decision to publish the results.

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