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## NEGATIVE IMPACT OF MOTORWAY CONSTRUCTION ON THE BIOLOGICAL AND LANDSCAPE DIVERSITY

### ABSTRACT

*Apart from undoubtedly positive effects, the construction of motorways unfortunately brings along negative impacts as well, including the major one influencing the natural system of the region through which it passes. As such, a motorway represents a source of continuous emissions of various pollutants, causes permanent physical changes to the landscape and disturbs the natural conditions of the plant and animal communities. Therefore, in order to understand properly and integrally all the processes in the natural system, it is necessary, among other things, to analyse the impact of motorway construction on the landscape and biological diversity. The threat to the plant and animal natural habitats is expressed through four basic types of impact whose analysis results in a bio-ecological and landscape evaluation of a certain route with the aim of selecting the most acceptable one out of a set of variant solutions.*

### KEY WORDS

*motorway construction, natural habitats, environmental protection, evaluation of negative impact*

### 1. INTRODUCTION

Numerous human activities, i.e. human tendency to reach for artificial products due to the impossibility of satisfying their need in nature, result in constant re-

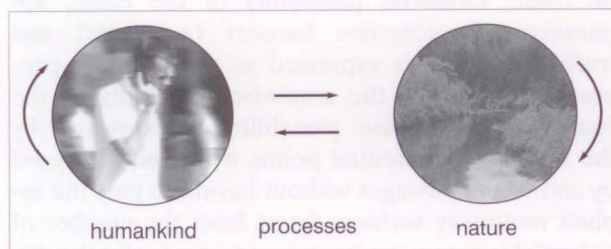


Figure 1 - Schematic presentation of the process between two systems (humankind - nature) and their interaction

duction of the variability of nature. This fact certainly brings to the fore the problematic of the human - nature relation, i.e. the significance of proper and integral consideration of all the processes that are carried out between these two systems, as well as within the systems themselves, and their possible negative and positive impacts.

Apart from the undoubtedly positive effects on the overall development of a certain area, the construction of traffic infrastructure with road routes playing an important part, unfortunately also brings a number of negative consequences. The direct impact on the natural system of the area through which the traffic route is passing is reflected through permanent physical (esthetical) changes of the landscape, and disturbance of the plant and animal natural habitats. Indirectly, the motorway represents a source of various pollutants being constantly emitted into the air, soil and water (exhaust gases, dust, aerosols, loss of transported goods, spillage of great amounts of harmful material, products generated by the wear of roadway and vehicle elements, etc.). The mentioned negative effects on the natural environment need to be reduced to a minimum.

### 2. ASPECTS OF THE THREAT TO BIOLOGICAL AND LANDSCAPE DIVERSITY

In order to consider integrally the consequences of negative impact of motorway construction on the environment, multidisciplinary solutions are required: geological, hydrological, meteorological, pedological, geo-technological, bio-ecological, traffic, etc. This paper will be limited to the analysis of negative impact generated by traffic routes on the biological and landscape diversity.



The threat to biological and landscape diversity from the motorway construction is reflected through four basic types:

**1. Complete destruction of natural habitats**



Figure 2 - Destruction of a natural habitat

By constructing a traffic route, the region completely changes its original purpose, and this inevitably results in complete destruction of the natural habitats (asphalt section of the road) or complete change of the natural habitat (the protective green area along the traffic route and the median). The destroyed part of the natural habitat depends on the width and length of the traffic route and it is proportional to the product of these two values and is expressed in square kilometres.

**2. Deterioration in quality of the remaining surrounding habitat**

It depends on the relief and the vegetation, and the quality itself is influenced by a number of factors:

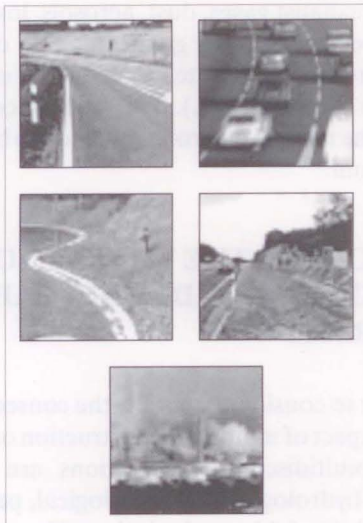


Figure 3 - Factors that cause deterioration in the quality of the surrounding habitat

noise, vibrations, vehicle movements, light, smell and chemical contamination. Deterioration in the quality of the remaining surrounding habitat is expressed as the product of the route length and the width of the affected area in square kilometres. The width of the affected area is determined in tables, and depends on characteristics of the landscape (relief, vegetation), average travelling speed and traffic frequency.

**3. Habitat fragmentation**

About 27,000 km of asphalted roads of different traffic density have been constructed in Croatia. Such big road network has fragmented many ecologically significant regions into small sections (Figure 4), so that many species and living communities are threatened by extinction. The situation becomes even more serious if forest roads and fire lanes are considered as well.

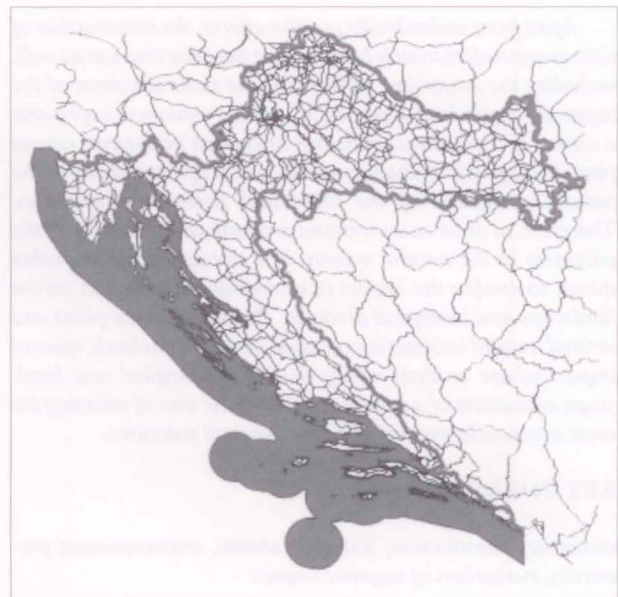


Figure 4 - Fragmentation of natural habitat by road network in Croatia

Motorways represent barriers to regular migrations and exchange of genetic material. The level of this impact depends on: the width of the traffic route, crosswise passability of the route, application of protective barriers (e.g. nets) and traffic load, and is expressed as the inversely proportional value of the crosswise passability of the route. The crosswise passability is expressed by the number of potential points which may be used by animals as passages without having to pass the asphalt motorway surface. Apart from the number of potential passages, an important factor is also the distribution of potential passage points i.e. their grouping.



#### 4. Injured and killed animals due to traffic

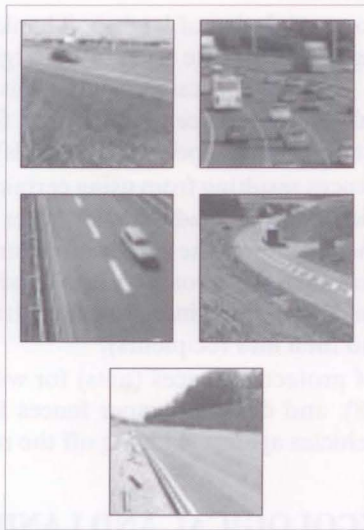


Figure 5 - Potential locations of traffic-caused animal casualties

Animals follow their natural instinct and use natural routes of their movements. At places at which these intersect with traffic routes there is the danger that the animal attempting to cross the road will get hurt in collision with vehicles. The fact that the regions along the roads have for some animal species become secondary habitats or even feeding places intensifies even more this danger. Injuring and killing of animals caused by traffic is almost impossible to estimate (it may only be measured), since it depends on the fauna composition, size of the animal population and bio-ecological engineering measures that are undertaken in design and construction of a motorway.

### 3. PROTECTION MEASURES

During design and construction of a traffic route special attention should be paid to the following:

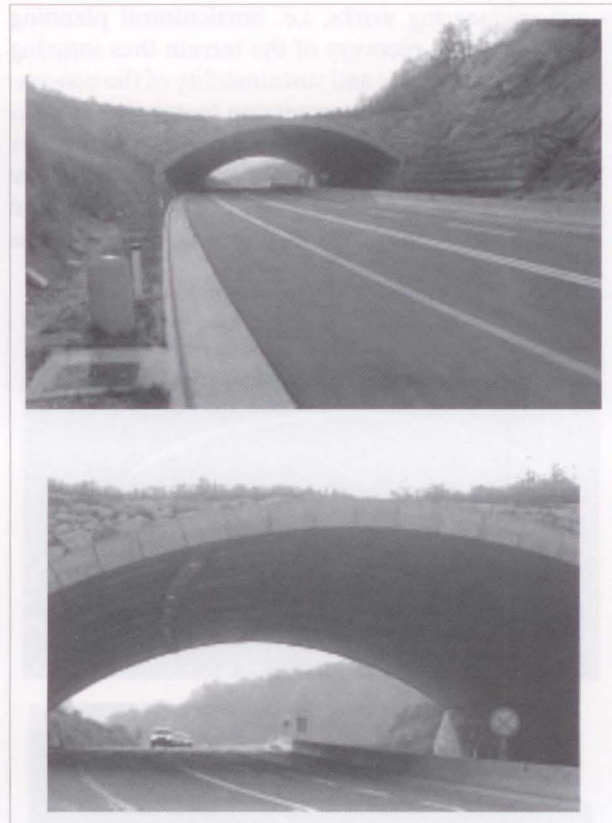


Figure 6 - Artificial passages for animals

- proper design of all sections of the motorway and its integration into the environment leaving a pleasant impression and increasing the traffic safety;
- protection and preservation of (authentic) space; forests, valuable landscapes, monuments;
- lesser fragmentation of habitats; therefore, detailed analysis is required regarding migration routes of animals and crosswise passability of the route, and insure a sufficient number of appropriate natural (streams, rivers, depressions, cuts), semi-natural (crossing of a motorway across a local road or railway line), and artificial passages for animals.

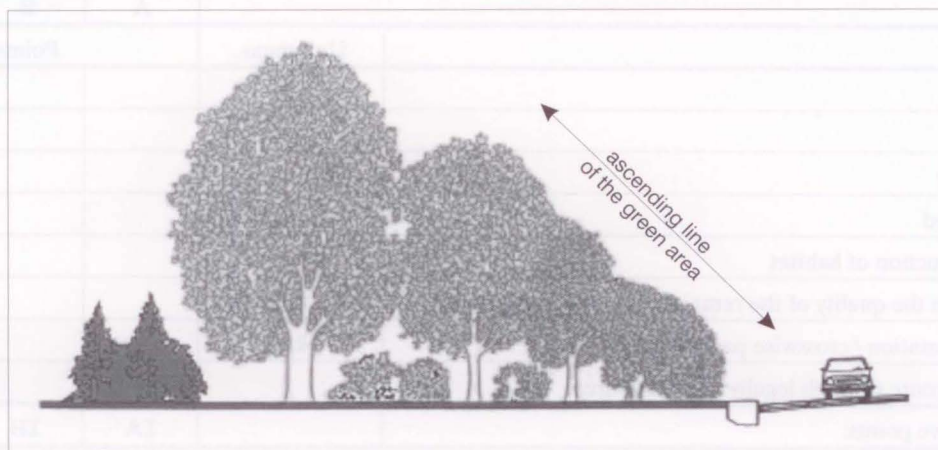


Figure 7 - Protection from noise and protection from air pollution by means of a green area



- eco-engineering works, i.e. horticultural planning and biological recovery of the terrain thus insuring biological diversity and sustainability of the eco-system as well as surface protection (cuttings, embankments, notches) against erosive damaging by water and wind; planting of trees and hedges along the road which reduces noise and provides protection against pollution from the motorway, thus

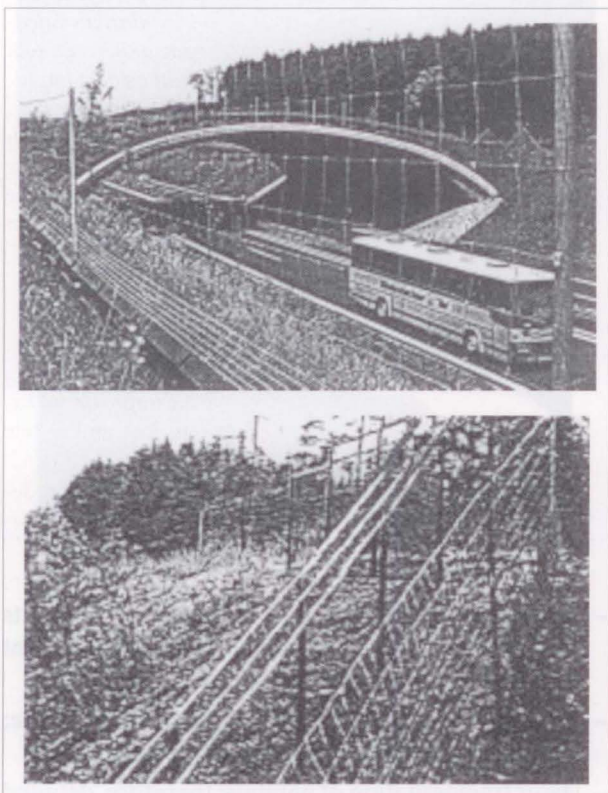


Figure 8 - Protective fences - nets for animals

significantly improving the quality level of the remaining habitat.

- calculation and design of land spoil banks; if material is dug out below the level of underground waters it is possible to design water oasis (puddles, ponds, lakes) i.e. replacement habitats for numerous water and swamp species (fish, birds);
- consequences resulting from using certain means to prevent icing of the roadway (salt water drains towards the edges of the roadway destroying the plants; water from the roadway and possible pollutants should be drained into the grease traps - separators and then into recipients);
- setting of protective fences (nets) for wild animals (Figure 8), and distant bumper fences for protection of vehicles against skidding off the road.

#### 4. BIO-ECOLOGICAL AND LANDSCAPE EVALUATION

According to the reasons given in the introduction, all negative effects of motorway construction on the bio-ecological system require development of bio-ecological estimation of a certain route. With the aim of finding the optimal motorway route it is necessary to select from a set of variant solutions the one that will prove to be the most acceptable. For this purpose a method of evaluating the influence of certain route parameters (length, width, traffic load, vehicle travelling speed) has been devised, as well as of their negative effects on the bio-ecological system (complete destruction of the habitats, deterioration in the quality of the remaining surrounding habitat, fragmentation of the habitats). According to this method every potential route regarding its parameters as well as negative

Table 1 - Parallel evaluation of potential routes compared to undesired effects on the bio-ecological and landscape diversity

Parameter	Unit meas.	Route		
		A	B	C
length	km			
route width	km			
traffic intensity	vehicles daily			
calculated speed	km / h			
complete destruction of habitat	km <sup>2</sup>			
deterioration in the quality of the remaining surrounding habitat	km <sup>2</sup>			
habitat fragmentation / crosswise passability	km			
passing of the route through legally protected area				
Total of negative points:		ΣA	ΣB	ΣC

MIN (ΣA, ΣB, ΣC)

→

The most acceptable route variant



effects is assigned negative points and in the end the most acceptable is the route with minimal number of negative points. In this way, with certain approximations, negative effects can yet be quantified, thus allowing comparison with variant solutions (Table 1).

As part of such bio-ecological evaluation of the effects on populations, habitats and eco-systems, the actual influence on the landscape has been analysed as well since the landscape cannot be treated exclusively as aesthetic category devoid of clear relation to the actual natural values of the environment in which the construction is taking place. The advanced approach to this problem increasingly links the anthropocentric concept of landscape with the bio-centric notion of eco-system taking into consideration that very often aesthetic does not mean ecologically valuable as well.

## 5. CONCLUSION

Although everything points out that the construction of roads as biological corridors only for one biological species - the humans, exerts negative effects on the natural environment, proper design, construction and development of a motorway can contribute to raising the quality of the natural environment.



Figure 9 - Proper evaluation of natural resources spent during motorway construction contribute to environmental protection

## SAŽETAK

### NEGATIVNI UTJECAJI IZGRADNJE AUTOCESTE NA BIOLOŠKU I KRAJOBRAZNU RAZNOLIKOST

*Izgradnja autoceste pored nesumnjivo pozitivnih učinaka, nažalost sa sobom nosi i niz negativnih utjecaja pri čemu je jedan od izraženijih onaj na prirodni sustav područja kojim prolazi. U tom smislu autocesta predstavlja izvor stalne emisije raznovrsnih zagađivača, uzrokuje trajne fizičke promjene krajolika, te narušava prirodne uvjete cjelovitog razumijevanja svih procesa u prirodnom sustavu potrebno između ostalog napraviti i analizu utjecaja izgradnje autoceste na krajobraznu i biološku raznolikost. Ugroženost staništa biljnih i životinjskih zajednica očituje se kroz četiri osnovna tipa utjecaja čijom se analizom izrađuje bioekološko i krajobrazno vrednovanje određene trase s ciljem da se iz skupa varijantnih rješenja odabere ono koje će biti najprihvatljivije.*

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