

RESEARCH ARTICLE

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Impact of vehicles on vertebrate wildlife on the urban and extra-urban infrastructure roadsALBERT KOPALI^{1*}, ELISON ROTA¹, SIMIR KRASNIQI² ARDIAN ZHUPAJ³¹Department of Agro-environment and Ecology, Agricultural University of Tirana, Tirana, Albania²Department of vocational education, Prizren, Kosovo³Regional Environmental Agency, Saranda, Albania**Abstract**

The main factor of damage to biodiversity is fragmentation of territory, due to various economic activities of man. One of these activities in the area is the construction of road infrastructures. However, their construction as well as in urban areas in those extra-urban, has led to significantly increase the impact of vehicle traffic on wild fauna and especially that of small vertebrate, with this apparent extra-urban areas, in agricultural and rural spaces. The impact becomes even greater in the absence of ecological networks, which will provide greater return flow antigenic sites on time animal populations, thus significantly limiting their dynamics. The possibility of intra and inter-specific exchange between animal populations can be achieved through ecological corridors, which remain single strategy for solving animal populations in terms of environmental fragmentation in particular from road infrastructures. The impact becomes even bigger in animal populations in case of presence of leaks forest ecosystems near roads, in eco-tonal generations. Expansion and improvement of the road network in Albania has grown significantly in the extent of the impact on small vertebrate fauna as in urban and extra-urban areas. The study was conducted at three different points in the road network in urban area and outside urban areas. The results of the study evidenced a high level of impact on animal fauna and the evident lack of ecological infrastructure that would facilitate the movement of animals, especially on their reproductive periods.

Key words: biodiversity, animal fauna, fragmentation, road infrastructure

1. Introduction

Towards the integration of the objectives of biodiversity conservation with development of the territory was among the priority objectives of the EU and in particular with regard to nature conservation. For the realization of these objectives is gradually shifted from conservation and protection of natural assets (vision of the '80s) in the eco-systemic vision that considers natural resource management as a necessary intervention for maintaining ecological balances in territorial systems. These interventions should be realized through the implementation of the integration objectives of preservation of nature in the process of territorial planning and evaluation of biodiversity. We policies of territorial planning, having the spotlight on European reality, concepts of ecological networks and continuity, are also spread to other countries in the EU and outside it, where can mention several policy initiatives (Albania, Denmark)[1]. Development of policy initiatives with national character constitutes a response to the directives CEE 9/409/EC (Birds Directive), CEE 92/43/EC (Habitat Directive) and programmer

EECONET (The European Ecological Network, 1991), belonging to the maintenance of biodiversity needs by preserving natural habitats, flora and fauna in the area. In general European trend that has been building networks of local ecological [2], integrating different types of binders (urban, local, territorial), while maintaining their functional attributes. Such plans are activated by "Conference Aalborg" (*Managing fragile ecosystems: sustainable mountain development, cap.13*) and (*Conservation of biological diversity, cap.15*) [3]. One of the main causes of damage to biological diversity is the process of fragmentation of the territory, which diminishes the vitality of animal populations, reducing territorial spaces available hindering the distribution of individuals in the area and the possibility of exchange flows antigenic sites. In particular, species which are very mobile and less adapted are not able to cope with environmental fragmentation [4]. In this process, the construction of large infrastructures (as is the case of roads, especially in those with the highest traffic flow of vehicles), causing considerable damage to biodiversity [5]. From the second half of the '90s is formatted a specific discipline "Road Ecology" [6] which addresses the

impacts that cause these infrastructures and their mitigation opportunities. Road Ecology [7], analyzes the interactions between organisms, the road environment, well, "Road Ecology" examines the links between the natural environment and infrastructure system, as the negative effects of the latter are large and among others, the fauna mortality. The goal is the design of these networks in order to mitigate negative impacts. Ecological effects are not only in the streets but also in parts of its side "*road-effect zone*" due to the modification of habitats used by mammals, amphibian and birds effects can be felt to 1500 m [8]. Effect distal brings a series of transformations of the structure of vegetation, micro-climate, and the land cover which cause direct or indirect effects on the distribution and density of animal species [9, 10]. The amount of this effect depends on a series of factors such as eco-systemic typology of passage, that of the landscape matrix, the type and degree of fragmentation and fragmentation period of time [11]. Vehicles kill a large number of animal species, rare to common. From studies [12] road mortality of wild fauna brings alarming figures (in Europe evaluated by between 10 to 100 million birds and mammals each year). According to a calculation procedure conducted in Sweden [13], for every 10 000 km a vehicle described by a bird found dead; probability for an amphibious vehicle with a flux 500 / hour is 18% and for micro-mammals 10%. Road mortality goes 1-4% of the population of common species, but can be up to 40% on sensitive species [14]. Species with numerically damaged by road mortality are hedgehog, frogs and robbers, the night like an owl, bats etc. [15]. Small size structures (nets, fences, small channels, etc.), have an impact on the wild fauna of small dimensions (insects, amphibious, micro-mammals) [16]. But should calculate the fact that, in the absence of special protections surrounding, mammals passing on the street as big deer etc, accidental consequences for drivers. Although Albania's road network has some characteristics different from those of the EU, sieges lack of roads, lack of signals etc., bring road mortality substantially free of the study.

2. Material and methods

The study, based also in other previous studies [17, 18, 19, 20], was carried out during 2012 by extending the observation space in three different spots, one in a highway within an urban space and two other points in extra-urban space; one road space was limited on both sides by agricultural activities and one

on a highway that is bordered by natural ecosystems. The axis of the road that extends the urban center is along the river side of "Lana" which crosses the city of Tirana, river which is populated by various species of vertebrates terrestrial, aquatic and avifauna, since it is an environment with a relatively rich biodiversity not only of fauna, but especially the flora (presence of leaks, the herbaceous components on both sides of the river and wood along the road which serve as shelter for many bird populations). The another axis is road to the airport, which is bordered on both sides by agricultural area cultivated and simultaneously by generations of wood shrub, and the proximity of the river of Tirana, have a rich biodiversity of vertebrate fauna. The third point is the observation axis lying in the highway Durrës - Kukës in the area of Nderfushes which is bounded on both sides by natural ecosystems and the presence of water flows to streams along the way and that is very rich in fauna of wild animal. Monitoring is carried out at about 2 km in the urban area axis and about 5 km outside the urban area with a three-day preview for a period of 60 days during the spring (April and May). It should be noted that during the last two axes missing for fencing and signs of wild fauna. Assessment is made, where it was possible, for vertebrate to species level. There were difficulties in evaluation if the impossibility of species stay on the road for several hours as well as the remains of individuals injured hinders their identification [21]. Or in the case of those birds or partially damaged by collision with vehicles have fallen away with the axis of the road, which makes it difficult to find and identify their. This organization requires more specialized observers to accurately identify all the individuals damaged small vertebrates.

3. Results and discussion

Given the aim of the study for the evaluation of road mortality for small vertebrate fauna an analysis of road environment in general to three axes studied, taking into account not only axis but also the surrounding space along the road or eco-tonal generations which creates habitat for populations of vertebrate attitude to take into consideration. Axis found in urban space bounded by the river flow "Lana" who has green spaces in its longitudinal flow. This space is populated by different animal species such as small mammals (rats), amphibious (frogs), reptilian (lizards), birds, other categories invertebrate and pets (cats, dogs). Continuous traffic during 24 hours is an almost insurmountable obstacle for many of these species. Traffic on this axis is consistent with

several hours "peak" morning (7³⁰ - 9⁰⁰) and afternoon (15⁰⁰ - 17³⁰). Most of the vehicles are small because of the large vehicles are obliged to circulate only at night. Pets have almost impossible over the side of the road on the other side, especially with the hours charged but during the night are great

risk given the speed of movement. Categories of animals that are well adapted to urban life are obliged providing food for them to move within range of their residence as rodents mammals (rats) capable of pets like cats free of dogs. The survey conducted at the time of determining the results:

Table 1: Categories of animals injured by road mortality in urban areas

Categories of animals observed					
Mammals (rodents)	Amphibious	Reptile	Birds	Cats	Dogs
17 %	18 %	22 %	13 %	16 %	14 %

Table 2: Some of the species categories affected of road mortality in urban areas

Categories of animals observed	Types of species damaged	The number of individuals found	Expressed in %
Mammals	Black rat channels (<i>Rattus rattus</i>)	17	27
	The brown rat channels (<i>Rattus norvegicus</i>)	12	19
	The house mouse (<i>Mus musculus domesticus</i>)	8	12
	Cat (<i>Felis catus</i>)	15	24
Amphibious	Dog (<i>Canis lupus familiaris</i>)	11	18
	Soak cow (<i>Bufo bufo</i>)	11	28
	Common green frog (<i>Rana balcanica</i>)	27	72
Reptile	The wall lizard (<i>Podarcis muralis</i>)	26	40
	Grass lizard (<i>Podarcis taurica</i>)	37	58
Birds	Tailed (<i>Testudo hermanni</i>)	1	2
	Bat ears small mouse (<i>Myotis blythii</i>)	13	17
	Swallows night (<i>Caprimulgus europaeus</i>)	9	12
	Sparrow (<i>Passer domesticus</i>)	25	38
	Sparrow (<i>Passer montanus</i>)	18	24
	Xinxamiu (<i>Troglodytes troglodytes</i>)	4	5
	Goldfinch (<i>Carduelis carduelis</i>)	3	4

We found axis that outer space was limited to urban and agricultural spaces Rinas road near the airport, we see that an increase in the presence of species that are typical in agricultural areas like a hedgehog, rabbits and have a decrease in animal crossing household, given that residential areas are relatively far from the highway. There is a greater presence of reptiles and amphibians with a greater damage to their long hours in the morning since they move more at night. Vehicle circulation is uninterrupted during the 24 hours and it should be noted that there is a significant increase in the average speed of vehicles, with a higher density of traffic during the morning hours. Recorded a relatively high damage of birds since it is an open area and characterized by their high mobility. We have restrictions on highway missing the big mammals but special restrictions for the small mammals. The survey recorded that there are several types of damage which falls in the eye injury hedgehog who have a relatively limited circulation on one side of the road and make obligatory passage for water resources that are located on the river side of the road. A similar situation is also for a large number of amphibians and reptiles where their movement is conditioned as food resource (in

search of seeds and planted them) but also on reproductive phenomena of these categories. Seen in this period, a higher level of mortality which relates to human concerns of this species in agro-ecosystems during various agricultural processes (moving, etc.) due to their greater mobility.

We axis was bounded by natural ecosystems and to extend the highway Milot - Kukes seen a greater presence of wildlife species typical of pre-mountainous areas where rodents are in the category of wild rabbits evidenced damaged, hedgehog, marten; we category of reptiles except snakes and lizards have been identified, but the injuries are present amphibians and some species of birds which are casual and are not used to the phenomenon of vehicle traffic. Frequency of movement in this axis is relatively high and with speeds up to 100 km/hour and it should be noted that this highway has no special protection with nets or other protection for categories of amphibians and reptiles. Also, there are not enough signs to warn leaders in countries where there is a higher presence of wildlife crossing. Highway on one side of her bordered by the river and it is a cause of movement on the other animals and other phenomena related to migration reproducing phenomena other

animal populations. It should be noted that we like dogs or cattle random injuries to small and big observed in this segment axis were found injured pets mammals injuries as equine.

Table 3: Categories of animals injured by road mortality in the extra-urban agricultural areas

<i>Categories of animals observed</i>			
Mammals (rodents)	Amphibious	Reptile	Birds
26 %	24 %	23 %	27 %

Table 4: Some of the species categories affected of road mortality in the extra-urban agricultural areas

<i>Categories of animals observed</i>	<i>Types of species damaged</i>	<i>The number of individuals found</i>	Expressed in %
Mammals	Hedgehog (<i>Erinaceus concolor</i>)	12	35
	Wild rabbit (<i>Lepus europaeus</i>)	3	8
	Reeds mice (<i>Micromys minutus</i>)	15	43
	Dog (<i>Canis lupus familiaris</i>)	5	14
	Soak cow (<i>Bufo bufo</i>)	15	30
Amphibious	Stream frog (<i>Rana graeca</i>)	13	26
	Common green frog (<i>Rana balcanica</i>)	17	34
	Tailed (<i>Testudo hermanni</i>)	5	10
Reptile	The Green lizard (<i>Lacerta viridis</i>)	5	15
	Grass lizard (<i>Podarcis taurica</i>)	16	50
	Viper (<i>Vipera ammodytes</i>)	5	15
	Large water snake (<i>Natrix natrix</i>)	3	10
	Bolla spotted (<i>Elaphe situla</i>)	3	10
	Goldfinch (<i>Carduelis carduelis</i>)	7	10
Birds	Sparrow (<i>Passer domesticus</i>)	15	22
	Field Sparrow (<i>Passer montanus</i>)	14	21
	Great horseshoe bat nose (<i>Rhinolophus ferrumequinum</i>)	6	9
	Nightingale field of reeds (<i>Acrocephalus arundinaceus</i>)	5	8
	Owl (<i>Bubo bubo</i>)	3	4
	White-tailed swallow (<i>Delichon urbica</i>)	7	10
	The white tail movers (<i>Motacilla alba</i>)	5	8
	Chesterfield eaters (<i>Carduelis cannabina</i>)	3	5
	Slippers (<i>Scolopax rusticola</i>)	2	3

Table 5: Categories of animals injured by road mortality in the extra-urban rural areas

<i>Categories of animals observed</i>			
Mammals (rodents)	Amphibious	Reptile	Birds
32 %	19 %	21 %	28 %

Table 6: Some of the species categories affected of road mortality in the extra-urban rural areas

<i>Categories of animals observed</i>	<i>Types of species damaged</i>	<i>The number of individuals found</i>	Expressed in %
Mammals	Hedgehog (<i>Erinaceus concolor</i>)	13	28
	Wild bunny (<i>Lepus europaeus</i>)	5	10
	Forest mouse (<i>Apodemus sylvaticus</i>)	12	25
	Rock rat (<i>Apodemus mystacinus</i>)	7	15
	Marten (<i>Martes foina</i>)	3	6
	Weasel (<i>Mustela nivalis</i>)	2	4
	Dog (<i>Canis lupus familiaris</i>)	6	12
Amphibious	Soak cow (<i>Bufo bufo</i>)	10	23
	Frog stream (<i>Rana graeca</i>)	8	18
	Common green frog (<i>Rana balcanica</i>)	13	29
	Reddish wood frog (<i>Rana temporaria</i>)	5	11
	Yellow belly frog (<i>Bombina variegata</i>)	3	7
	Tailed (<i>Testudo hermanni</i>)	5	11

Reptile	<i>Green lizard (Lacerta viridis)</i>	7	26
	<i>Grass lizard (Podarcis taurica)</i>	13	47
	<i>Viper (Vipera ammodytes)</i>	4	15
	<i>Viper stained (Vipera berus)</i>	3	12
	<i>Grouse (Alectoris graeca)</i>	3	12
Birds	<i>Swallows night (Caprimulgus europaeus)</i>	5	20
	<i>Quail (Coturnix coturnix)</i>	3	13
	<i>Mountain zborakes (Fringilla montifringilla)</i>	5	20
	<i>Blackbirds (Turdus merula)</i>	3	12
	<i>Tail mountain movers (Motacilla cinerea)</i>	6	23

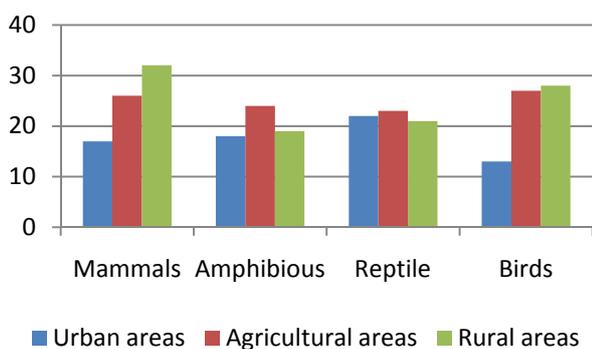


Figure 1: Categories of species damaged on urban road infrastructure, agricultural extra-urban and rural extra-urban

Seen from the above analysis that the population of damaged more by road accidents is populations of reptiles and rodents in urban axes, cattle populations in the areas of agriculture and mammals populations of amphibians in areas of natural eco-systems.

4. Conclusions

From the study the impact of human activities recorded on biodiversity (wild fauna) is substantial in road infrastructure. Given the level of impact, which leads to a reduction or even extinction of local populations in the wild fauna, required completion of these infrastructure protection measures for all categories damaged.

Interventions should aim at mitigating the impact of biodiversity and management of fauna near road infrastructure.

Besides interference mitigation of the environmental impact on biodiversity, based on the principles of its conservation, and other interventions required in terms of safety, landscape values of retraining, improvement of vegetation to create new units eco-systemic in ecosystems where they have suffered as a result of the created order of road infrastructures.

It is necessary that road axes outside urban centers filled with nets or enclosures with concrete barriers for small vertebrates such as amphibians etc.

and to reduce the direct impact of vehicles colliding with animals.

Should the design of bridge-established routes crossing that reduce the ecological impact of fragmentation.

Should be placed under-crossings fauna for different categories of animal, which would increase e.g., for amphibian's reproductive ability.

Other interventions would be the creation of shrub-tree spaces along roads which would serve as a resort for birds, but also to divert their flight curve for not crashing the vehicle.

These networks would serve as corridors for use by small animals like coleopterans, carbides, reptilian, etc.

The estimation of the impacts caused in road infrastructure should be included experts fauna (biologist) in order to assess the exact impact on wild fauna.

It is necessary to complete the road infrastructure needed for signaling the risk of injury to animals.

Should be included in educational programs to schools environmental education activities with the aim of sensitizing the importance of protecting biodiversity in particular wild fauna.

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