

Car access to mountain resorts - advantages and disadvantages. Case study: Parâng Resort

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Abstract. Tourism stimulates economic growth and the development of local communities. The mountain areas, as points of tourist attraction, represent real treasures in terms of the spectacular landscapes, the specific geological and floristic elements and the diversity of sports and activities that can be practiced. Problems such as long distance from areas of interest (localities), difficult access, harsh climatic conditions, vulnerability to natural disasters prevent the development of mountain resorts and mountain tourism. Access to mountain resorts is one of the most discussed issues. While some are making sacrifices to find sustainable solutions to give tourists access to the resorts, others apply simpler solutions, such as building roads and allowing public traffic. The existence of modernized access roads supports the development of a mountain resort in the sense that tourists can get comfortably, safely and as close as possible to the existing objectives using their personal car, without depending on other means of transport. However, this comfort is accompanied by a number of advantages and disadvantages, which are analyzed in this paper and highlighted by the case study method. For this purpose, the county road DJ709F, recently modernized, which provides car access to Parâng Resort, located in Parâng Mountains, was studied.

1 Introduction

In Romania, tourism focuses on natural landscapes, historic heritage, religious architecture, medieval cities, castles and preserved traditions.

In Jiu Valley, the geological, floristic and landscape elements, specific to the surrounding mountains, offer spectacular landscapes, so that hiking on mountain trails is done regardless of the season, and Parâng Resort is one of the best starting points for activity. Thus, tourism has developed in Parâng Resort, and in addition to hiking, you can also practice sports such as alpine skiing, cross-country skiing, snowboarding, mountain biking, mountain running, paragliding, etc.

Transition from mining to tourism activities seems to be the most suitable way for the sustainable development of Jiu Valley, an area with a rich mining history. In Jiu Valley, the tourist development of Parâng resort aims to improve the local economy and the evolution of local communities.

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In order to improve mobility, more and more transport networks are being developed, with traffic growing all over the world. Access to mountain areas, that have become important points of tourist attraction, is one of the most controversial discussions. On the one hand, people are looking for peace, but on the other hand, they are looking for comfortable and safe solutions for travel, so that most prefer to get as close as possible to the existing objectives with their personal vehicle, without depending on other means of transportation. However, this comfort implies both advantages and disadvantages and the main objective of this paper is to analyse them.

If the advantages are represented by easy and safe access, the disadvantages mainly refer to pollution and environmental impact. Road transport is one of the anthropogenic activities with a major negative impact on the environment and human health and it is an important source of noise and air pollution [1, 2].

Air pollution refers to the presence in the atmosphere of substances foreign to its normal composition, which depending on the concentration and time of action cause disturbances in the natural balance, affecting human health and comfort or the environment of flora and fauna. [3]

Noise pollution is a physical pollution being caused by the emission of sounds (harmonic oscillations) and noises (non-harmonic oscillations or mixture of discordant sounds). The main sources of noise pollution are: land and air transport, construction sites, industrial complexes and platforms, etc. [3].

The relationships between noise and other environmental components are determined by the effects generated on them, especially on ecosystems, fauna, and the anthropic environment (sanitary system and territorial system). Noise, as an impact factor, can itself become, in some cases, the target of interfering factors, such as traffic, anthropogenic manifestations, or wildlife, which can be regarded as sources of noise [4, 5].

Other effects of transport on the environment refer to the production of vibrations, occupation and change of land use, visual and ecological impact and last but not least, the occurrence of accidents.

2 Materials and methods

The Parâng massif is located in the Southern Carpathians, being delimited to the north by the Șureanu Mountains by the East Jiul River, to the west by the Retezat Mountains through the Petroșani locality, and by the Vâlcan Mountains through the Jiu Gorge, to the east by the Cindrel, Lotru, Latorița, and Căpățânii Mountains through the Olteț River, and to the south the delimitation is made by the Bumbăști-Jiu, Novaci, and Baia de Fier depressions.

The flora and fauna of Parâng are specific to the high mountains: alpine meadows, junipers, larch, cranberry, blueberry, dense coniferous and deciduous forests, black goat, bear, fox, wolf, viper, rodent, and more, developed by specific levels of climatic conditions.

Numerous tourist chalets were built both in the mountains, in the resort itself, and at the base of the mountain (Rusu - Petroșani area).

Parâng resort is located about 10 km from Petroșani, and the connection between them is made by DN7A and DJ709F. The county road DJ709F is located in the built-up area of Petroșani and has a length of 12.6 km (modernized and not modernized).

2.1 The road before and after modernization

The county road DJ709F (figure 1), on the sector from km 0 + 000 (intersection with DN7A) to km 6 + 600 (Rusu chalet) was built decades ago and modernized over time as needed, being a road with permanent clothing, open to public traffic, providing easy access. From km 6 + 600 to km 12 + 600 (end of the road; making satellite observations and

measuring the road we found that it ends on Baciú peak) the road was made up of dirt, difficult to access, temporarily arranged for the transport of equipments, materials for the construction of cable transport facilities, for the construction of cabins, the UNEFS sports base (the National University of Physical Education and Sports, initially IEFS). Subsequently, the road sector km 6 + 600 - km 11 + 425 was circulated mainly by cabin crews for the purpose of supply, and in recent years it began to be circulated by tourists who came to the area so that slowly but surely, it was outlined the need to modernize this section. The road continues from km 11 + 425 to km 12 + 600, but this sector is closed to public traffic.



Fig. 1. County road DJ709F as divided in working sections.

Traffic, although banned, began to grow. So, if initially, the destination of the road was for the transport of construction materials, then it was used by the cabin owners to supply their cabins with food and other necessary materials, and in recent years tourists, generally with off-road vehicles, but not only, travelled on this road either to get to the destination faster and more conveniently (the duration of a chairlift ride is 25 minutes), or because they reached the chairlift outside the operating hours.

At the end of the road, there are no tourist cabins and no parking possibilities and yet there are individuals who travel by car, motorcycle, or ATV to the top of Parângul Mic (2074 m), wrongfully understanding that this means ecotourism and hiking.

The road had bumps, cracks, and fissures. Rainwater catchment and drainage channels were missing, and stagnant water was on the edge or surface of the roadway, thus favoring surface water infiltration and erosion. Local erosion occurs upstream and downstream of undersized bridges, during periods of heavy rainfall, when torrents form.

The road has serpentes and steep slopes. The elevation in the Rusu Chalet area is 1168 m and reaches an altitude of 1550 m (the area of the Krisztian Pension or the Parâng weather station). The road did not ensure traffic in optimal conditions in both directions in some parts, the visibility in curves being sometimes reduced.

Consequently, the county road had an inadequate technical condition and negatively affected traffic in terms of speed, comfort, and safety.

The current condition of the section km 6 + 600 - km 10 + 325, following the recent rehabilitation, is very good.

For the modernization of this section, having a length of 3.725 km and being the most difficult section, works were carried out to widen the roadway up to 4 m, 4525 lm (linear

meters) of concrete gutters were arranged, 23 bridges were built, 2211 lm of concrete and cement retaining walls, 1249 lm of gabion retaining walls, and 2562 lm of safety parapets, asphalt coverage was poured, two tunnels were built over which the ski slopes pass for sports to be practiced in best conditions and road signs have been installed (figure 2).



Fig. 2. County road DJ709F; a. 1972-1973 – transport of construction materials; b. 2022 – modernized sector; c. 2022 – unmodernized sector (Photo sources: [6] and personal portfolio).

The current condition of the section km 10 + 325 - km 11 + 425 is unchanged, but the necessary approvals are awaited for the start of its modernization. Although this section has a very steep slope and is affected by erosion, traffic exists, and as a result of its rehabilitation it is expected an increase in the number of vehicles that will circulate and park in the area of km 11 + 425 or above.

In this study, two sections of DJ709F were analyzed, namely km 6 + 600 - km 10 + 325 (3.725 km) and km 10 + 325 - km 11 + 425 (1.100 km). Discussions will be conducted separately for the two sections given that the first section is newly modernized and put into use, while for the second section the procurement procedure are to be completed in order to be modernized (design and execution services).

2.2 Pollution caused by road traffic

The main types of pollution caused by road traffic are: noise pollution and air pollution.

The noise produced by road transport affects to a greater or lesser extent both humans (tourists and residents) and the local fauna in the sense of creating a state of discomfort and daily stress, which is amplified during busy periods, respectively on weekends and holidays.

Emissions of dust and powder, emissions such as carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), volatile organic compounds (VOCs), etc. are added to the noise emissions which have a high negative impact on air quality and human health, flora and fauna health.

If during the rehabilitation works of the county road DJ709F the emissions came mainly from the working equipment (dump trucks, excavators, bulldozers, etc.), with the completion of the project and the opening of public traffic on the section km 6 + 600 - km 10+ 325, the noise and gas emissions result from the circulation of private vehicles. The increasing traffic also implies a higher risk of accidents and car gems in certain periods (in weekends and during winter holidays).

Being a mountainous area, with serpentine and steep slopes, unprepared with parking spaces, and dangerous in winter due to the fact that it is difficult to clear the snow, this road was closed to public traffic in the winter season 2021-2022, respectively from 15.11.2021 to 31.03.2022, access being allowed only to residents.

If there will be no optimal snow removal solutions and parking spaces, it is very possible that this road will be closed every year during the winter, so that the sources of

pollution in winter will be represented by several off-road vehicles (4x4 and equipped with chains), ATVs, snowmobiles, etc. belonging to the locals.

2.2.1 Noise pollution

Noise is any unwanted sound or sound that is undesirable because it interferes with speech or listening, is loud enough to disturb listening, or is annoying.

Noise sources, atmospheric conditions, distance from the source and obstacles influence the propagation of sound. The limit of human tolerability for noise is approximately 65 dB. In Table 1 the intensities of the sounds of some usual activities are rendered.

Table 1. The intensity of the sounds of different activities [7].

Source	Sound intensity (dB)	Source	Sound intensity (dB)
Hearing threshold	0	Truck	80
The sounds of nature	10	Pneumatic hammer	90
Library	20	Motorcycle starting	100
Conversation	30	Modern jazz orchestra	112
Noise in an office	40	The engine of a jet plane	120
Vacuum cleaner	50	Plane with a take-off reaction	130
Train	60	Painful threshold	> 140

The SR 10009:2017 standard establishes the admissible limits of the ambient noise level, differentiated by functional areas and spaces, as they are defined in the specific technical regulations on systematization of localities and environmental protection [8]. According to this standard, the permissible noise limit in recreation areas is 45 dB.

Car noise varies depending on several factors:

- Street sounds;
- The slope of the road;
- Vibrations;
- Friction of mechanisms;
- Power and mass;
- Flow circulation (heat, air);
- Tire performance;
- Driving style (aggressive, calm, sporty, eco) etc.

The noise emission of off-road vehicles is higher than that of vehicles running under typical conditions (on-road). The predominant noise in vehicles running at an average speed of less than 45 km/h is produced by the engine and the engine exhaust system. The predominant noise in vehicles traveling at an average speed of more than 45 km/h comes from driving and wind. These noises occur regardless of the type and power of the engine.

In the last decades of the twentieth century, the noise produced by the engines of new cars was reduced, but, on average, the power and weight of the engines increased.

Monitoring points and measurement conditions have been established as follows:

- 4 monitoring points have been set up (marked A, B, C, and D) near the road (figure 1), in areas where the movement of wild animals is negatively affected and/or in the area of properties, locals, and tourists being affected by noise during the day and even at night, but especially during the mornings and evenings. Over 50% of the properties are built in the area of points C and D. The noise is loud and is caused by the excessive acceleration of the vehicle engines being a steep road. The noise produced during the mornings and evenings is annoying both for those who live in the area and those who come to relax in the tranquility of nature, as well as for wild animals.

- Days and time intervals of interest for the study:

- Saturday: 07:00 – 11:00 and 17:00 – 19:00;
 - Sunday: 07:00 – 11:00 and 17:00 – 19:00.
- Time intervals in which measurements were made according to monitoring points:
- Point A – 07:00 – 08:00 and 17:00 – 17:30;
 - Point B – 08:00 – 09:00 and 17:30 – 18:00;
 - Point C – 09:00 – 10:00 and 18:00 – 18:30;
 - Point D – 10:00 – 11:00 and 18:30 – 19:00.
- Measurements were carried out on 5 weekends, respectively on 21-22 May, 28-29 May, 04-05 June, 11-12 June and 18-19 June 2022. From May to September the number of tourists and the number of vehicles on this road increases considerably compared to other periods. This is even the most intense and interesting period for this study. The end of the week often brings more tourists than the beginning and middle of the week. In general, hundreds of tourists frequent the resort during weekends, and the modernization of the road has led to an increase in the number of cars in the resort.
- The CEM-DT 815 portable sound level meter was used;
 - The height of the measuring point was set at 1.5 m above ground level, and the distance from the source of 4-5 m (this being the average distance between some cabins and the road/noise source);
 - The weather conditions of interest (wind direction and speed, precipitation, temperature, humidity) were monitored during the measurement periods (figure 3);
 - The number of vehicles in circulation (ascent/descent) was monitored;
 - The incident sound was taken into account and interference with the sounds reflected by the cabins facades was avoided.

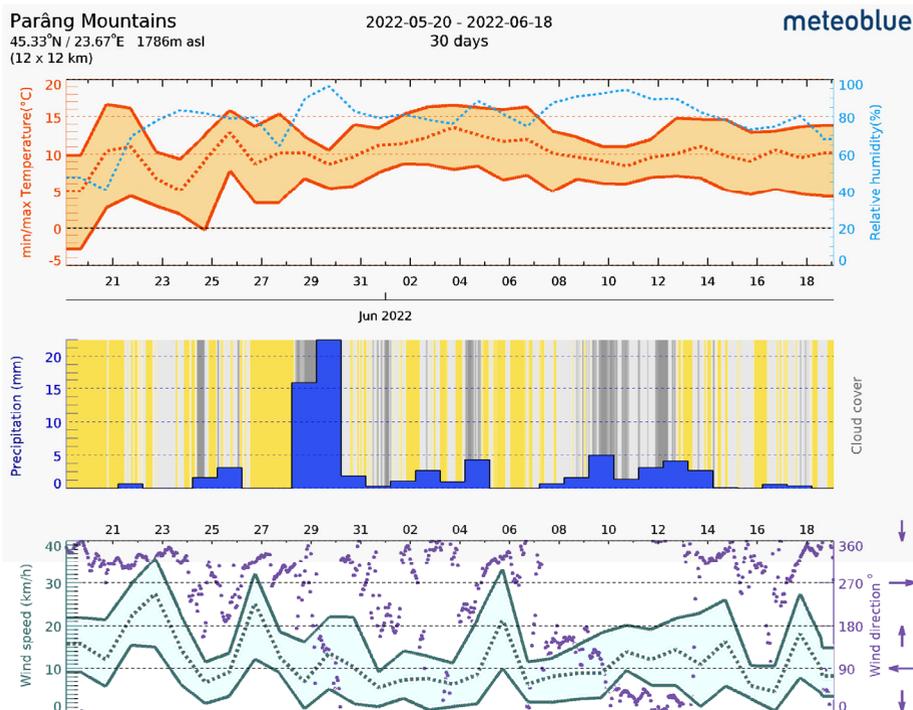


Fig. 3. Weather archive - Parâng Resort weather station elevation [9, 10].

Table 2 shows the limits of the values obtained according to the types of vehicles encountered.

Table 2. Noise level depending on different types of vehicles.

Types of vehicles	Noise level (dB)	
	Min	Max
cars	55	62
4x4 cars	57	76
commercial vehicles (trucks)	70	82
ATVs	75	83
motorcycles	69	88
vehicles ascending	76	81.7
vehicles descending	48.1	75.6

During the monitoring period (monitoring duration 52.5 hours/10 days), 585 vehicles were registered in circulation (ascent/descent), on average 11-12 vehicles/hour or 1 vehicle every 5-6 minutes. The recordings were made during five weekends of May-June when the resort is crowded as are all weekends of the summer season.

2.2.2 Air pollution

According to the European Environment Agency, transport is responsible for about a quarter of total EU CO₂ emissions in 2019, and of these, over 70% came from road transport. The amount of CO₂ emissions from passenger transport varies significantly depending on the means of transport (figure 4). Private cars pollute the most, emitting approx. 60% of total CO₂ emissions from European road transport. In 2019, most road transport in Europe used diesel (66.7%), followed by gasoline (24.55%) [11].

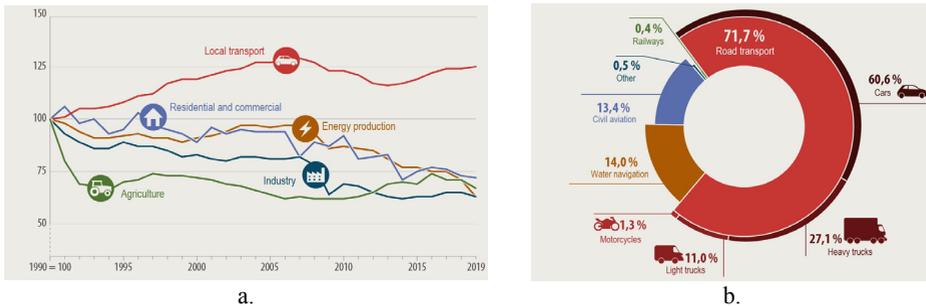


Fig. 4. a. Emissions changes in the EU since 1990 (CO₂ equivalent) by sector (excluding the United Kingdom) (2019) [12]; b. Greenhouse gas emissions by mode of transport (2019) [12].

Road traffic affects the environment by eliminating pollutants as a result of incomplete combustion of petroleum products. Complete combustion should result in carbon dioxide and water vapor, which are non-toxic gases, but due to additives and engines that do not provide complete combustion results in emissions such as carbon monoxide, sulfur oxides, volatile organic compounds (VOC), unsaturated and polycyclic aromatics hydrocarbons, their radicals, as well as various products of their oxidation such as peroxides, aldehydes, etc. Some of the nitrogen in the air, which reaches the engine cylinders, partially oxidizes, forming various nitrogen oxides. In addition to carbon dioxide (CO₂), automobiles produce methane (CH₄) and nitrous oxide (N₂O) from the tailpipe and hydrofluorocarbon emissions

from leaking air conditioners. The emissions of these gases are small in comparison to CO₂ (figure 5) [3, 4, 11].

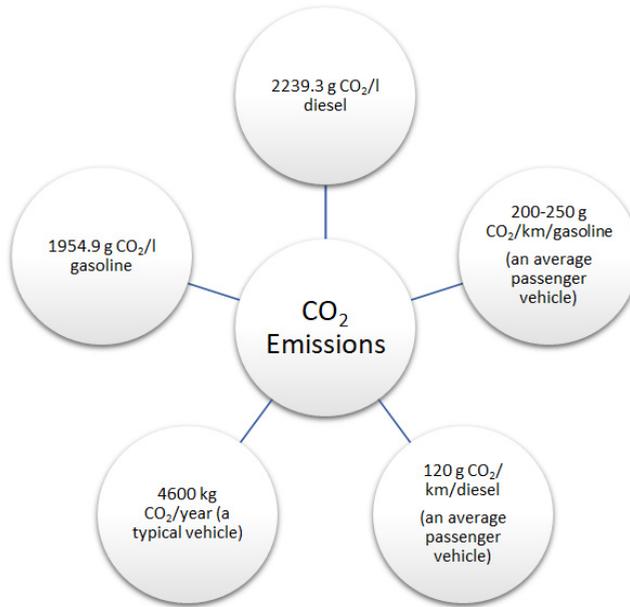


Fig. 5. Emissions of CO₂ [11].

The EU's current targets are primarily aimed at reducing CO₂ emissions, as it is the most important greenhouse gas and contributes to a 60% increase in the greenhouse effect. Given these, in this study we focused on assessing CO₂ emissions.

Switching to electric or hybrid cars, streamlining vehicles, changing fuel, using public transport, bicycles or walking can reduce emissions.

3 Results and discussions

Considering that once the noise level of a vehicle was recorded at one of the monitoring points and that it was already traveling on a part of the road or continuing on its way, it produced or will produce noise, an average value of the noise level, of 68.8 dB, was calculated.

In certain situations, such as in quiet areas in open spaces, in areas with a relatively small number of sound events, in areas where the noise source operates periodically, etc., additional/special noise indicators may be used. In Parâng Resort, being a recreation area, it was considered that noise can be measured and evaluated during periods when traffic is more intense [7]

Thus, the equivalent noise level for the weekends corresponding to each monitoring point was calculated taking into account the following (Table 3):

- Time intervals during which measurements were performed;
- Average noise level values for the time intervals and days on which the measurements were made;
- The equivalent noise level was calculated using Formula 1.

$$L_{ech} = 10 \lg \left[\frac{1}{T} \sum_{i=1}^n T_i \cdot 10^{(L_{ech,i}/10)} \right] \quad (1)$$

Table 3. Equivalent noise level.

Point	Time (i)	Noise level (dB) Medium value $L_{ech,i}$	Equivalent noise level in the morning $L_{ech, morning}$	Equivalent noise level in the evening $L_{ech, evening}$
A	07 ⁰⁰ - 08 ⁰⁰	66.5	69.854	70.25
	17 ⁰⁰ - 17 ³⁰	67.6		
B	08 ⁰⁰ - 09 ⁰⁰	65.8		
	17 ³⁰ - 18 ⁰⁰	64.4		
C	09 ⁰⁰ - 10 ⁰⁰	70.0		
	18 ⁰⁰ - 18 ³⁰	71.2		
D	10 ⁰⁰ - 11 ⁰⁰	73.1		
	18 ³⁰ - 19 ⁰⁰	73.7		

The Occupational Safety and Health Administration (OSHA) and the World Health Organization (WHO) allow exposure to noise levels based on volume (decibels) and duration (in hours) (figure 6); the higher the volume, the shorter the time allowed for exposure without hearing protection [13, 14].

According to the World Health Organization, the effects of noise on health depending on the level of noise and the duration of exposure.

For the assessment of noise pollution in the analyzed area, comparisons were made with the values presented in the Table 1 and Figure 6.

For resort employees, road traffic noise does not cause adverse health effects, according to OSHA and WHO [15, 16] as both exposure time and noise levels are within permissible limits, but residents and tourists may be affected as the limit of recreation areas (45 dB) are exceeded by 55% and even the human tolerability limit (65 dB) is periodically exceeded.

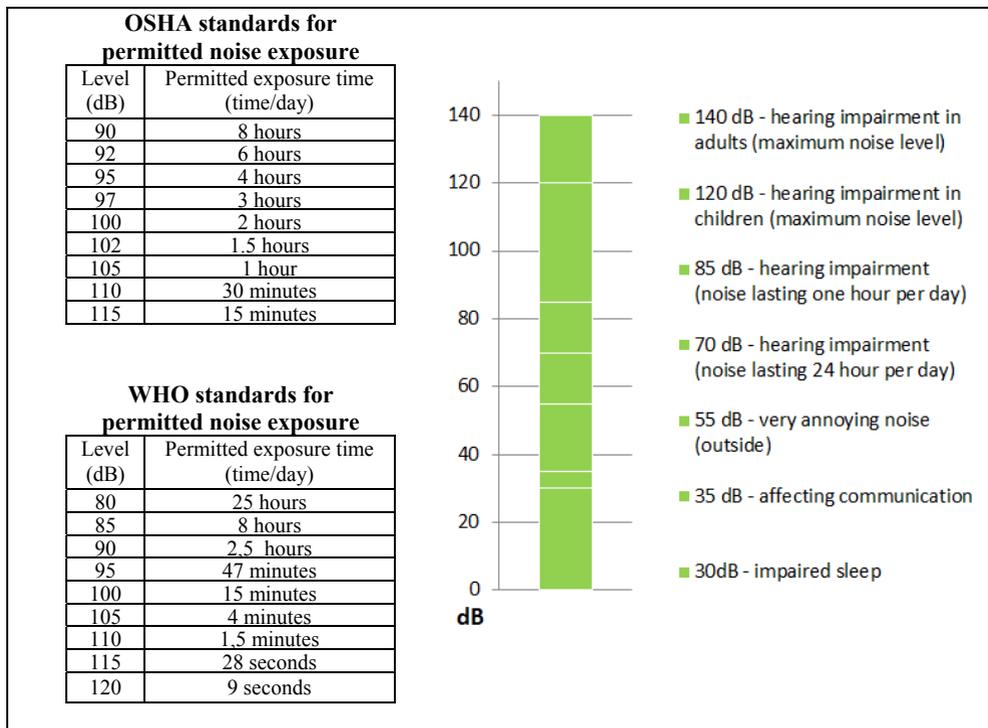


Fig. 6. Standards for permitted noise exposure and effects of noise on health [13-16].

According to the results obtained and the effects on health, Parâng Resort, due to the noise produced by road traffic, falls into an area where the noise is annoying, affects the well-being, peace and relaxation of people and wildlife and can affect mental health and their behavior, but does not cause hearing damage or other dangerous effects on physical health.

Out of 585 vehicles registered during the monitoring period, 3 were electric vehicles, and the rest on gasoline and diesel. Respecting the ratio of 2.72 diesel vehicles: 1 gasoline vehicle, we determined a number of 425 diesel vehicles and 157 gasoline vehicles.

Considering the recorded data and the average values of CO₂ emissions, in Table 4 we presented the results of the calculations of the emissions resulting from vehicles in circulation in Parâng Resort, during the studied period.

Table 4. CO₂ emissions in Parâng Resort.

Vehicles/time	g CO ₂ /km		g CO ₂ /tronson 4.825 km	
	gasoline	diesel	gasoline	diesel
1 vehicle /5-6 minutes	225	120	1085.625	579
11-12 vehicles/hour	≈ 7200 - 7850		≈ 34740 - 37876.25	
585 vehicles/52.5 hours	86325		416518.125	
100 vehicles	14756		71197.7	

Following the analysis performed on CO₂ emissions in Parâng Resort, we found that the emissions result in significant quantities, so that in the described monitoring conditions, respectively in 52.5 hours of monitoring, the 585 vehicles emitted approximately 86325 g CO₂/km. The total value of the emissions depends on the number of kilometers traveled by each vehicle, and if all these vehicles had covered the analyzed section (4,825 km) the emissions would have exceeded the value of 400 kg of CO₂. On average, 100 vehicles emit about 15 kg of CO₂ per kilometer traveled.

Given the road conditions, level difference of over 500 m, high slope and serpentine, fuel consumption and implicitly emissions can increase considerably.

Table 5. SWOT analyzes.

STRENGTHS	WEAKNESSES
<ul style="list-style-type: none"> improving traffic conditions (including for emergency services); comfortable, fast and safe access in the sense that there is no need to depend on public transport; reduction of the amount of dust in the atmosphere considering that the road was circulated even before the modernization, being a dirt road; 	<ul style="list-style-type: none"> increasing traffic; land occupation due to the need to build parking lots; fragmentation of ecosystems; negative visual impact; major financial investment;
OPPORTUNITIES	THREATS
<ul style="list-style-type: none"> development and integration of the area in the national and international tourist circuit; increasing the number of tourists; attracting investors; economic growth of the region; 	<ul style="list-style-type: none"> noise pollution; disturbances caused by noise and light; air pollution as a result of gas emissions; affects human health; affects the quality of the environment and exerts negative pressures on ecosystems; affects the well-being and tranquility of people and wildlife and can affect their mental health and behavior; contributes to the accentuation of the greenhouse effect, which indirectly determines the modification of the atmosphere functions, the maintenance of a higher temperature in the region, the more frequent formation of clouds, and the increase of the precipitation amount; risk of road accidents;

The results obtained from the study indicate that in addition to advantages, the opening of public traffic on the county road DJ709F brings a number of disadvantages and negative effects on environmental and human health. These are highlighted by the method of SWOT analysis (strengths, weaknesses, opportunities, threats – Table 5), being useful in determining the need to develop roads towards objectives located in mountainous areas, such as Parang Resort.

Gas emissions from vehicles that reach the atmosphere in the form of aerosols, solid particles or very small liquids, invisible to the human eye (soot, lead salts, hydrocarbon vapors, etc.), and noise emissions affect human and environmental health by various means: affects the respiratory tract, discomfort, sleep disorders or insomnia, negative effects on the cardiovascular and metabolic system, high heart rate, mental disorders and high levels of stress, cognitive problems, reduced ability to concentrate, hearing problems, learning problems, cognitive impairment in children, many species can suffer from disorientation or considerable changes in behavior.

For a community and a developing economy, mobility is an essential condition, and it must not lead to a worsening of the quality of life but must harmonize with existing activities through appropriate methods and means.

Among the solutions to minimize the impact generated by transport on the environment are: the use of unleaded gasoline, introduction of catalysts to reduce CO₂, CO, NO_x and hydrocarbon emissions, increasing the combustion temperature of the fuel, but really the best measures that can be proposed are:

- Prohibition of car traffic in the analyzed sector and the installation of a card-based barrier in order to allow the access only for the residents;
- Introduction of public transport (minibus, bus) running according to a well-established schedule;
- Purchase of electric public transport vehicles, which are quiet and have no impact on air quality as they have no emissions on-site;
- Encouraging tourists to use cable transport (the existing chairlifts);
- The extension of the operating programs of the 2 chairlifts etc.

4 Conclusions

Following the study we found that the main types of pollution with significant negative effects on the environment are noise and air pollution. Considering that reducing CO₂ emissions is the EU's primary target, in this study we focused only on it, while the other emissions will be evaluated in future studies.

During the monitored period (52.5 hours/10 days) an equivalent noise level of 69.854 dB was determined - in the morning and 70.25 dB - in the evening.

According to the calculations made on CO₂ emissions, it was found that the 585 vehicles registered in circulation during the monitoring period emitted an amount of approximately 86 kg CO₂/km resulting, therefore, an average of 15 kg CO₂/km per 100 vehicles.

In conclusion, emissions from vehicles affect air quality through greenhouse gas emissions, gas emissions leading to formation of acid rain, toxic gas emissions, dust and powder emissions that cause adverse health effects from respiratory infections, damage to lung tissue, damage to the respiratory system, reduced immunity, damage to plant tissues to the death of plant tissue, the appearance of various forms of cancer, and death of humans and animals, while noise emissions at the recorded levels do not affect human physical health but rather the psychic one producing annoying effects, affecting the well-being, peace and relaxation of people and wildlife and can affect mental health and their behavior.

According to the results obtained and the effects on health, Parâng Resort, due to the noise produced by road traffic, falls into an area where the noise is annoying, affects, but does not cause hearing damage or other dangerous effects on physical health.

For the development of Parâng Resort, respectively for attracting tourists, the modernization of the county road is considered to be of a major utility, but we consider there are more disadvantages than advantages and the situation can be improved by applying the appropriate measures, of which we mention closing the public traffic and allowing access only to residents and utility vehicles, establishing a traffic program, using public transport based on electricity, extending the operation program of chairlifts, and encouraging their use by tourists.

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