Low-Volume Rural Roads and the Environment: Some Ideas and Experiences from Hungary

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After a brief description of the Hungarian road network, aspects of accessibility, land use, fuel consumption, and emission of pollutants are discussed concerning low-volume paved and unpaved (dirt) roads. The old truth, "we have to pay for the road whether we build it or not," is also valid for low-volume rural roads. Hence, if the paving of such a road is economically viable, subject to proceeding with the required care for the environment, the environmental aspects will also support the decision to pave it.

Hungary is in the central part of the Carpathian basin. Most of its territory (93 000 km^2) is plain and hilly. The highest peak is approximately 1000 m above sea level.

The climate is temperate, with warm summers and sometimes cold and snowy, sometimes milder and rainy winters. (Average yearly temperature is 10°C, and precipitation is 550 to 700 mm/year.) The greatest part of the land is cultivated (70 percent), there are forests on about 18 percent, and the rest is uncultivated or used for urban, industrial, and other purposes.

GENERAL ENVIRONMENTAL ASPECTS IN THE DESIGN, CONSTRUCTION, AND OPERATION OF ROADS IN HUNGARY

The Hungarian road network consists of national and local public roads and private roads. The network's main characteristics are given in Table 1.

The domestic vehicle fleet of Hungary in 1990 consisted of about 2,000,000 passenger cars, 240,000 trucks, 126,000 buses, and 400,000 motorcycles. In 1990 approximately 88 percent of passenger and 25 percent of goods transportation was by road, which includes local public transit, buses, and private vehicles. Thus the importance of roads in the Hungarian transportation system can be assessed. They are not as important as in the United States or Western Europe, but from an environmental standpoint the greater share of the railways and of public transport is clearly an advantage. Yet, the roads and road transportation have their environmental and social problems in Hungary, and there is a growing and sometimes fashionably exaggerated social sensitivity toward them.

These problems are essentially similar to those of all European countries and are aggravated by regional peculiarities:

- Excessive fuel consumption and pollutant emission of the socialist-made part of the vehicle fleet;
- Lack of funds for investment, modernization, maintenance, and operation of the transportation system; and
- An overall decline of morals, causing a tragic safety situation, waste of human and natural resources, lack of care for the environment, and so forth.

In recognition of the significance of environmental issues, in the last decades a great amount of normative legislative activity got under way. The first major item was the Parliamentary Act II of 1976 "on the protection of the human environment." A separate ministry was created to officially address environmental and land use issues.

With regard to road transportation, several governmental and ministerial decrees, standards, and regulations have been passed. The recent technical regulations on motorway and highway design and operation will be supplemented by a set of "principles for the environment of roads." The first draft came out in 1992 (*1*).

Environmental impact analysis is performed for all motorway and major highway construction and modernization projects. The tendency is to follow and duly implement the regulations of the European Community—as in all aspects of economic life.

Environmental issues have always been taken into consideration in the design and construction of transportation infrastructure in Hungary. With growing public concern for the environment, directives were elaborated for all transport branches (*2*).

The overall environmental problems related to motorized road traffic are similar everywhere. They must not be treated as an isolated issue but should be integrated into the construction, maintenance, and operation technologies of transportation systems (*2*).

Road transportation influences the environment in several ways. According to recent Hungarian guidelines and practice, the principal efforts to mitigate these effects are as follows:

- Air pollution: the influencing of modal split (preference of other modes, combined transport, and public transport); reduction of passenger car trips; improvements in motor vehicle fleets, vehicle operation, maintenance, traffic conditions, and vehicle fuels; and reduction of pollution caused by road construction (e.g., asphalt mixing plants);
- Noise: improvements in motor vehicle fleets; use of silent pavements and noise barriers on road construction and re-

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TABLE 1 Hungarian Road Network, 1990

Road Category	Paved (1000 km)	Unpaved (dirt) (1000 km)	Total (1000 km)	Veh/day (1000)
National				
Main roads	6.7	--	6.7	7394
Secondary roads	22.5	0.4	22.9	1710
Total	29.2	0.4	29.6	3000
Local				
In built-up areas	22.5	24.1	46.6	2410*
In rural areas	1.6	27.5	29.1	n.a
Total	24.1	51.6	75.7	n.a
Private				
Agricultural	13.5	33.7	47.2	n.a
Forestry	2.5	2.3	4.8	n.a
Total	16.0	36.0	52.0	n.a
Grand total	69.3	88.0	157.3	n.a

* In 1985, on a sample of 1700 km of paved roads.

Source: Kőzutak főbb adatai 1990 január 1 OKF, Budapest, 1990 (Principal Data of Public Roads of Hungary)

habilitation; systematic control and maintenance of vehicles; traffic engineering measures (ensuring smooth traffic flow); and reduction of noise emission of transportation establishments (e.g., commercial vehicle plants and repair shops);

- Waste materials (hazardous wastes produced in road transportation amount to 0.7 to 1 percent of the national total): treatment and depositing of slurries from vehicles washing installations; clean burning of used oils and oily wastes; collection and recycling of batteries and acidic wastes; and treatment of paint material wastes (a national network of temporary and final storage sites for hazardous wastes is under construction);
- Pollution of soil along the roads: reduction of quantity of deicing salts; substitution of NaCl by other materials; and elimination of lead from vehicle fuels; and
- Pollution of water: reduction of water use in vehicle maintenance plants; treatment and cleaning of wastewater in maintenance plants; and catching and sedimentation of water flowing off the roads.

LOW-VOLUME RURAL ROADS IN HUNGARY

Table 1 shows that some 100 000 km (i.e., two-thirds of all roads) are low-volume roads, and most are unpaved (dirt roads). These roads do not have a great national or regional importance but are significant for their vicinity. They often serve as the last access elements to areas with less than 200 inhabitants. Moreover, in several cases they represent the missing links in the local and even secondary national network. Approximately 39 percent of Hungarians live in villages with population under 10,000. With 10.4 million inhabitants, Hungary has a population density of 108 persons/km^2, much less than that of Western Europe but much higher than that of North America. Therefore, low-volume roads are important for most inhabitants of villages with a population under 2,000 and for many inhabitants of villages where 2,000 to 10,000 people live (16.6 and 22.2 percent of the population of Hungary, respectively). Most such roads are essential accesses to the surrounding agricultural lands and forests and allow crops, timber, and other material to be hauled efficiently and in good condition.

If low-volume rural roads are paved and maintained adequately, they do not create a hazard to their environment. Vehicles traveling along them present their effects individually. The design hourly volume is about 40 vehicles per hour (i.e., less than 1 vehicle per minute) in the peak hour. Environmental problems can easily be caused by improperly operated individual (e.g., overweight) vehicles.

Environmental issues are, even in spite of the low traffic volumes, important in the case of unpaved (dirt) roads. In Hungarian soil and climatic conditions, such roads are usually (*a*) dry and dusty (summer, early autumn); (*b*) wet, muddy, slippery, and even impassable for a long time after rainfall (spring, late autumn, winter); (*c*) hard-frozen (some weeks in winter); or (*d*) covered by snow after storms and impassable for days because of drifts.

Generally, their surface is very uneven, causing excess fuel consumption, increased emission of pollutants and noise, deterioration of the vehicle and its load, and extra costs and time losses for the road users. Often, such dirt roads occupy a very wide strip of terrain, because the drivers try to find more even surfaces to travel on.

Of course we must never forget that all-weather accessibility of living and working places, hospitals, schools, and so forth is a basic human right, independent of a domicile in Budapest or in a hamlet.

FUEL CONSUMPTION ON DIRT ROADS

To assess the detrimental effects, in June and July 1992 several fuel consumption measurements were performed on dirt roads in a sandy valley in Pest County (Domonyvölgy-Erdôkertes). It is graded every month, so major unevenness cannot develop on it.

The surface of this road varies according to the composition of the soil and variations of the microclimate (on sunscorched and shadowy, moist sections, etc.). Thus, in dry weather, it has some sections that are almost as hard as a paved road, whereas others make the vehicle sink 1 to 2 cm into the sand, and some other sections with loose sand cause vehicles to "plow" through the sand to a depth of 4 to 5 cm. Consequently, the rolling resistance varies considerably.

The first case corresponds to driving on a level road, the second to a gradient of 8 to 10 percent, and the third to a gradient of 55 to 65 percent. The attainable speed decreases on the worse surfaces because only lower gears can be used and the dynamic effects must be kept at a reasonable level. A "critical speed" can be defined as the optimum safe speed under the given road and vehicle conditions.

The effect on fuel consumption is shown in Figure 1 and Table 2 for a Rumanian-made five-speed Dacia 1310 TLX passenger car (license of Renault). The figure shows absolute values of the fuel consumption and the critical speed. The measurements were made with an Ono-Sokki type fuel consumption meter. For each curve in the diagram, three to five points were measured with 10-km/hr speed intervals, and for each point at least eight measuring runs were made with flying start. The pressure in the tires corresponded to the value prescribed by the factory for solid pavements.

Table 2 presents the fuel consumption ratio.

These results are for moist sand. Loose, dry sand has less resistance, and the vehicle whirls up much dust.

The very wet sands and soils (nearly flowing mud) behave like melting snow. The wheels push it before themselves, making a slush of 1 to 2 cm to a continuous hindrance of 4 to 5 cm. Under such conditions, the fuel consumption ratio can reach 3.5 to 4.0 compared with the asphalt road.

Measurements on other roads with other passenger cars and trucks gave similar results. For trucks, the load on the vehicle is also an important factor. Often, trucks cannot travel along a deteriorated, wet, or muddy dirt road with full loads.

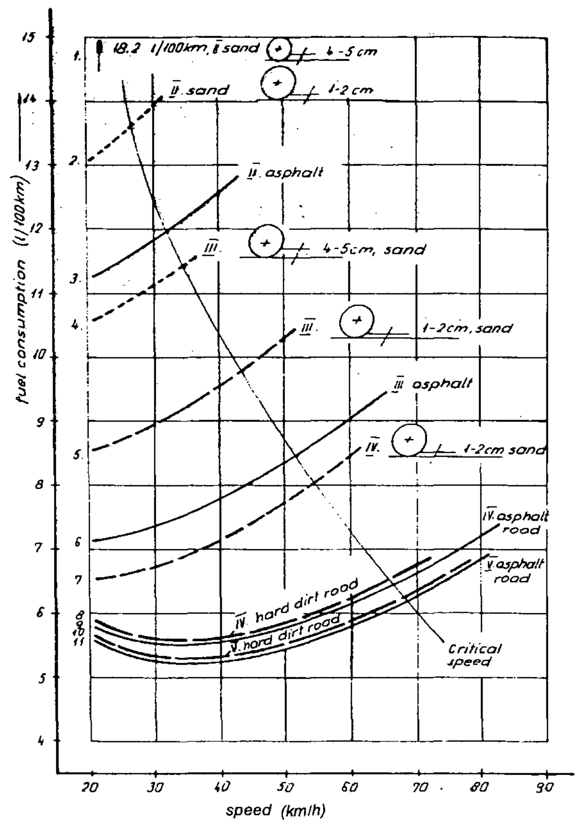

FIGURE 1 Fuel consumption of a passenger car on asphalt and sand roads (parameter: gear position).

Excess vehicle travel means increased fuel consumption and, consequently, increased emission of pollutants.

SOME PRACTICAL CONCLUSIONS AND A CASE STUDY

The paving of several such roads would be necessary. This means essentially construction of a new road but using the existing right-of-way. In Hungary during the preparation of the plans, designs, and the legal procedure for obtaining permission to construct the roads by the local urban authorities, environmental issues are being taken into consideration.

TABLE 2 Fuel Consumption Ratios of a Passenger Car Traveling at the Critical Speed (Reference Value = 1.00 on a Good Asphalt Road)

Sinking into the Road (cm)	Gear			
	V	IV	III	II
0 (asphalt)	1.00	1.03	1.22	1.94
0 (dirt)	1.02	1.05	1.24	1.96
1-2 (dirt)	*	1.32	1.58	2.19
4-5 (dirt)	*	*	1.85	2.94

* It was impossible to travel in this gear.

Source: Measurements of Kôzlekedéstudományi Intézet, summer 1992.

Usually, the low traffic and the existing dirt roads do not pose a grave problem. Care is taken to avoid environmentally sensitive areas, such as well-defined and legally protected natural reserves, and to provide appropriate protective measures.

Systematic nationwide plans for closing the gaps in the secondary national road network are now being elaborated. For each of the 19 counties, these plans contain a map showing protected areas and the planned roads. The construction of the Lébeny-Tárnokréti connection in northwest Hungary (County Gyôr-Sopron), a major link of 7.8 km (3.3 km strengthening and 4.5 km paving of a dirt road) on the secondary network provides a case study.

During the design phase, after the construction permit was obtained, the newly paved section bordered the Hanság National Park, an important wetland. However, on December 1, 1990, the area of the Hanság National Park was extended to include the section to be built. A strong campaign was launched by some pressure groups against the road and against the interests of the local population. The issue went before the Commission for Environment of the Parliament, too.

Since the Hanság area was extended after the issue of a construction permit and route relocation would have been impracticable, in August 1991 a formal agreement between the Highway Directorate in Gyôr and the Directorate of the National Park was signed. Its principal points were as follows:

- The road will be built (it is now in operation).
- Along the stretch across the national park's area, covering bushes will be planted on both sides to protect animals (bustards, etc.).
- For reptiles (vipers, etc.) and amphibians, 10 subterranean passages will be built.
- The new road will have a speed limit of 60 km/hr, stopping will be prohibited, animal warning signs will be posted, and no transiting heavy traffic will be allowed.
- The disturbance of the environment will be minimal during the construction and operation of the road.
- There will be an agreement between the signatory parties on the use of financial resources.

The cost of the special measures for environmental issues was about 5 million HUF from a total of 75 million HUF (about $1 million U.S.) in construction costs.

CONCLUSION

It appears evident that paving of low-volume rural dirt roads is equally beneficial for the road users and the environment.

"We have to pay for the road, whether we build it or not" is also valid for low-volume rural roads. This means that if the paving of such a road is economically viable (*3*, Chapter 2)—subject to proceeding with the required care for the environment—the environmental aspects will also support the decision to pave it.

The inadequate capacity of the main road network has been the primary cause of concern for a long time. However, recently the problems of secondary and low-volume roads were also recognized, and a comprehensive research program is being launched to deal with their operation and management.

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