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TOWARDS SUSTAINABLE MOBILITY – CONFLICTS, IMPACTS, PRINCIPLES, CONDITIONS, ASPECTS OF CEECs

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Abstract

There is a growing realisation that the present economic and technological tendencies are unsustainable, in this respect the transport sector came to crossroads, due to its increasing conflicts with the living and built environment, the degradation, loading, pollution impacts.

This study surveys the impact and conflict elements between transport and environment, referring to the main three geographical levels – global, regional and local – including air pollution, land use and intrusion, noise, congestion, accidents and related social impacts. Regarding the basic environmental principles, the study submits proposals for their adaptation in the transport issues, first of all: sustainable development, the precautionary approach, the prevention, the responsibility, the polluter pays principle and other elements, like the integration approach, the environmental limits, the demand management, the environmental efficiency or the equity, as principles.

Concerning the environmental conditions of sustainable mobility, the study surveys the measurable transport impacts including the environmental objectives and selects criteria for sustainability. These criteria are: nitrogen oxides, volatile organic compounds, ozone, particulate matters, carbon dioxide, land use and noise. Regarding air quality, the study proposes vehicle emission and ambient air pollution levels, referring to WHO-EURO levels and OECD proposals and this is the case for land use and noise impacts as well.

Finally the study selects tasks and preferences for the main fields of transport, including international and domestic freight transport, domestic and urban passenger transport and soft modes like cycling and pedestrian mobility.

Keywords: sustainable mobility, environmental impacts of transport.

1. Introduction, Background

Transportation and different forms of mobility are considered in today's societies as essential services, including freight transport with access of goods from production to the markets and passenger transport on the professional mobility and in other social functions. Transport is a significant driving force of the economy, from manufacturing to services, including effects on regional development, employment and competitiveness.

At the same time, there is a world-wide growing perception, with different sectoral emphasis and on global level, that the present tendencies, approaches, technologies are *not sustainable* on a long term run, they will have strong environmental, public health, finally economic consequences.

In this respect transportation, the transport sector has been on cross-roads these days, first of all due to its *increasing conflicts with ecosystems* and built environment, and degradation, polluting, contaminating impacts. The so called transport problem has increasing importance compared to other sectors and their environmental impacts. While in the traditional sectors strong improvements of efficiency, changes of structures have been taking place during the last two decades, in the transport sector in spite of the technical development there is a characteristic expansion, quantitative growth with increasing environmental impacts.

During the last two decades, there has been a 30% increase of transport related CO_2 emission, compared to a 2% decrease of other sectors. In our region a specific problem is the growth of local and regional impact factors, pollutants, so the transport related NO_x and VOCs emissions have grown over 50% and this is over 60% at CO.

Besides air pollution, further impact factors have a growing role in the industrialised countries and in our region, these are: congestion, accidents, noise and vibration effects and the increasing land use, urban sprawl, with loss of biodiversity.

These problems, impact factors have different weight in our regions. The Central-Eastern European countries (CEECs), including those concerned in the EU integration process have a comparatively underdeveloped infrastructure and transport background. In this respect it should be emphasised that the *transport system development* of these countries should be completed on a sustainable approach, avoiding the exhaustion of the natural resources and the repetition of those mistakes committed by the Western-European region's countries during the last decades.

2. Impact Factors, Conflicts between Transport and Environment

Today's transport systems require strong natural resource input, first of all, non-renewable fossils. Beyond the direct adverse effects, the background industries, such as vehicle manufacturing, fuel production, construction of transport infrastructure etc, have additional impacts. The transport emissions appear on three geographical levels, on *global, regional and local scales*. Main global impact contributors of transport are the gases with direct and indirect greenhouse effects, including methane (CH_4), nitrous oxides (N_2O), carbon dioxide (CO_2) and nitrogen oxides (NO_x), volatile organic compounds (VOCs) and carbon monoxide (CO), through the contribution to tropospheric ozone (O_3), as greenhouse gas. NO_x, N_2O and CFCs (chlorofluorocarbons) have stratospheric ozone depletion impacts. CFCs which are still present in the transport sector have even strong greenhouse effects as well.

On regional level the main factors are the acidification pollutants as NO_x „ SO_2,

and O_3, being strong risk factors in our climate conditions, through the reactions of NO_x and VOCs with public health and ecosystem impacts. Further photochemical oxidant impacts have CO, NO_x, VOCs and SPMs (suspended particulate matters).

Among local effects we should emphasise the toxic impacts of CO and the SPMs through respiratory diseases. VOCs and SPMs especially in associated forms are strongly toxic, even more carcinogen. These elements are characteristic in urban, suburban regions, with cumulation of different pollution factors. Many investigations have proved that in today's urban regions the main air polluting risk factors are the emissions of combustion engines.

As a further effect we should emphasise the *transport related noise*, which is the main contributor to noise impacts. In the industrialised countries 20% of population is exposed to high noise levels, in our case the trunk roads' regions are exposed to 70 dB day-time and 65 dB night impacts, over the WHO limits.

The *land use* of transport is a significant impact factor, in our case in the CEECs being a strong challenge and danger. 5% of the Western part of Germany is covered by transport routes, plus the additional service, infrastructure and background functions. This could be in urban regions more than 25–35%. Additional elements of these tendencies are the sub-urbanisation, the urban sprawl, with use and distruction of active green, agricultural fields endangering the ecosystems and biodiversity. These structures have increasing transport energy use, growing mileage and individual car use.

Congestion belongs to the most adverse effects of transport, reducing the effectiveness of the original functions of vehicles and networks, with time delay, growing fuel consumption and pollution. A further consequence of congestion is the extension of capacities by infrastructure building, itself as an impact factor, inducing additional mobility, attracting traffic flows, reproducing the congestion, inefficiency and environmental impacts.

Accidents are not always considered as environmental impacts, but have a strong contribution to the unsustainable tendencies. Although specific data show certain improvement based on technical and safety measures, but as an indirect effect, there are segregation tendencies discouraging people from walking, cycling. A further element is a social impact in connection with the car dependency marginalizing some social groups, like children, elderly people, disabled and poor population, having limited access to mobility.

3. Environmental Principles, Transport Concerns

Main strategic elements of sustainable development, with reference to transport issues:

- Economic development, structural change *within natural and environmental limits* – in these frames the development programs, plans should be submitted to environmental impact assessment processes.

- During structural change we should prefer *land-saving solutions*, avoiding green field developments. This refers in the field of transport to the neglected, undeveloped existing networks, promoting their rehabilitation, upgrading, revitalisation.
- We should save our *advantages* in the field of environmental conditions, natural resources, even if we have opposite experience from the developed countries. Here we should refer to the safeguarding of our *traditional positions* in the field of public, communal forms of transport, the modal share of rail, the comparatively low level of motorization and motorway network.
- The *environmentally oriented influence* of products within market frames, preferences for environmentally sound products correcting the market value judgement. This refers to the support of vehicles, fuels, technologies with good environmental patterns, by tax, charge preferences promoting public transport, combined freight transport, demand side management solutions.

Basic *environmental principles* to be integrated, to get accepted in the field of transport, including the development process:

- *Precautionary approach*, the minimisation of environmental risks. This is important in those fields where the consequences, impacts are growing with the technical development. This is the case with the transport of dangerous goods but we can refer even to long term effects, like impacts resulting climate change.
- *The prevention* should be a basic economic requirement due to the fact that prevention is much less expensive than subsequent measures. In this respect those products, technologies should be supported, promoted, which have less environmental impact, resource need. We refer here to methods of transport telematics, application of mobility management methods or even development of bicycle route networks.
- In the frame of *partnership* , the local actors, municipalities, citizens' groups, local business community representatives should have an increasing role in the realization of environmental objectives. This could appear in local decision making on local developments, even businesses. In the field of transport this could cover several initiatives, from traffic damping to logistic center projects.
- The *host-approach* refers to that fact that environmental tasks, issues are not purely economic or market oriented activities, but they could be 'only' safeguarding or creating values, certain exemplary and responsible behaviour. This is necessary at local municipalities, authorities, having positive impacts on local population, entrepreneurs, contributing to the social participation. This could be manifested on local level in initiatives to bicycle routes, local public transport, or other positive developments.
- The *responsibility* or the polluter pays principle is an objective fundamentally debated in documents all over the world. Nevertheless the payment for the use of resources should be a particular objective. In the field of transport, all

internal and external costs of the use of environment should be paid by the user, including the damages caused in natural resources, human health, built environment. Enforcement of these costs is not a pure financial, economic issue, but it should be accompanied by additional push and pull measures, restrictions, regulations.

- The *planning principle* requires long term strategies in the field of environment. The two sides of this issue could be the National Environmental Programs with direct, indirect transport relations, outlooks, continuous regional and local, municipal environmental programs. The other side should be the Transport Policy, or Transport Master Plan, with regional, local levels, connections with regional development plans, integrating the environmental approaches.
- The *integrated pollution control* is a certain extension, continuation of the above issues, requiring the integration of environmental approach into other social, economic processes, so in the field of transport and mobility. On the other hand it requires the integrated approach in the field of safeguarding of ecosystem elements, in terms of tools and legal systems. Here we should refer to the institutions of EIA, SEA and Environmental Audit, having strong potentials in the field of sustainable transport development.

Further principles of sustainability, referring to the complexity of this issue, having social, economic, moral, political elements:

- principle of environmental limits,
- demand side management, with mobility management
- environmental effectiveness, with improved resource use
- the welfare efficiency
- the equity

4. Sustainable Mobility – Environmental Conditions

After basic approaches, definitions of sustainable development, including the Brundtland report, the UNCED declaration or Herman Daly's considerations, having common elements on the carrying capacity of the ecosystem and input-output models of energy and resource use, we have witnessed some attempts to define environmentally sustainable transport or mobility during the recent years. Kageson's approach is connected to the basic definitions of sustainability: Sustainable transport's objective is to offer a *basic mobility* to all citizens, without endangering, contaminating the nature and environment. It needs certain clarification of basic mobility needs, expected natural, environmental conditions, current public health risks and pollution limits, with additional timetable, action plans with medium and long term objectives.

The Centre for Sustainable Transport's approach is: Basic access needs of individuals and societies to be met safely and in a manner consistent with human

ecosystem's health and with equity within and between generations, is affordable, operates efficiently, offers choice of transport modes and supports a vibrant economy, limits emissions and waste within the planet's ability to absorb them, minimises consumption of non-renewable resources, reuses and recycles its components and minimises the use of land and production of noise. Beside direct environmental respects sustainability should have *social and economic elements*, reflecting fairness, equity and practical feasibility. It means that sustainable mobility could be combined with qualitative and quantitative criteria, arranging mobility objectives and environmental limits, criteria.

These quantitative factors could express emissions and other impact effects of transport, defining the cumulative character of transport loads. We should refer to the whole verticum of transport, with the background industries, manufacture and maintenance processes, including infrastructure development and waste disposal.

To the survey of impacts and selection of criteria we can use the matrix format arranging the *objectives and domains*, geographical levels.

	Types of objective		
Domains	**Public Health**	**Ecosystem Quality**	**Resource Management**
Global	Stratospheric O_3 Persistent compounds	Greenhouse gases Statospheric O_3 Biodiversity	Energy use Material use Recyclability
Regional	Troposphere O_3 Persistent compounds	Troposphere O_3 Acidification (NO_x, SO_2) Persistent compounds Nitrogen deposition	Land use Energy use Waste
Local	O_3, VOCs, PM Carcinogens Individual health and quality of life Noise, Safety	Impacts on the urban ecosystem, incl. landscape and separation of functions by transport and its infrastructure	Damage to the buildings Energy use Land use Waste

Beside these elements we can raise the level of mobility, but in this stage the main issue is the consideration of environmental conditions. In analysis of impact factors, we would give priority to the *public health* in strong correlation to the *protection of natural resources*. Based on these considerations, the following *criteria* could be proposed for construction of environmental conditions of transport:

- Nitrogen oxides (NO_x)
- Volatile organic compounds (VOCs)
- Suspended particulate matters (SPM)
- Fossil Carbon dioxide (CO_2)
- Land use in urban, sub-urban regions
- Noise impacts

These criteria mostly cover the collected and surveyed impact and risk factors of the table. Nitrogen oxides are good marking elements of combustion engine processes, having at the same time various impacts on all levels. VOC emissions are characterising the fuel verticum, while SPMs are the strongest risk factors of urban air pollution in connection, first of all, with diesel engines. The fossil CO_2 is another basic indicator of energy use and greenhouse effects. The transport related land use is an important factor expressing numerous impacts, like the paving of lands, urban sprawl, suburbanisation, adverse effects on biodiversity. Noise is in direct connection with motorised transport and its role, its contribution is over the air pollution in Europe.

Beside those elements we could mention the accidents and waste disposal as transport externalities, negative impacts, emphasising the lifecycle approach, but the above listed criteria have a good coverage of transport related impacts.

5. Analysis and Quantitative Proposals for the Criteria

- *NO_x*. Transport's share in NO_x emission is 60% in Europe, over 50% in Hungary. The ambient air pollution in several regions of Europe is over the critical limit, contaminating the ecosystem by acidification and eutrofisation. In spite of the increasing role of catalytic converters there is an expected growth of emission in non OECD countries by 40% and an estimated fall in OECD regions by 20% until 2030. Many experts claim a 90% decrease of emission in correlation with a 30 $\mu g/m^3$ ambient level (annual mean) as a sustainable impact in urban and suburban regions. The 90% fall of emissions could be realistic even within today's technologies, with additional improving fuel efficiency. Regarding emissions, current data of Otto engines of 0.6–0.7 g/km could be reduced to *0.12 g/km* which is technically feasible, being as sustainable criterion in this respect. For heavy, diesel engines the current EU level of 0.7–0.9 g/t.km could be reduced by 70% to *0.2–0.25 g/t.km*, which is a feasible level for sustainability. Due to the strong potential on fuel efficiency, the general 90% emission reduction should be realistic, targeting a *40 $\mu g/m^3$ limit* for urban conditions.
- *VOCs*. Many of them have direct toxic effect on humans and ecosystems, first of all, benzene and butadiene have carcinogen effects, while most of them have greenhouse and photochemical impacts. Main sources of emission are gasoline engines, through evaporation and unburned fuels. These elements raise technical tasks, improvements on engine design, fuel and exhaust systems. From technical point of view both for engines and fuel systems there are strong potentials, which could lead to a complete elimination of emissions. Levels of sustainability could be proposed as WHO/EURO impact levels: *benzene: 2.0 $\mu g/m^3$, butadiene 0.1 $\mu g/m^3$, PAH 0.5 $\mu g/m^3$*.
- *Ozone*. Needs special attention, being a direct public health factor. Based on international figures, critical concentration is above four times the harmful level. There is a certain relation between ozone formation and NO_x and VOC

level, but at catalytic converters, removing NO_x, there could be increasing ozone levels. On a long term level, the reduction of ozone concentration is the main public health and ecosystem challenge in strong correlation with NO_x and VOC control. Level of sustainability could be on residential areas *120* $\mu g/m^3$ (8 hours ambient level).

- *Particulate matter.* In certain opinions, SPMs represent the most serious urban risk factor these days, although in concrete atmosphere only a certain amount could be attributed to motor vehicles, first of all, to diesel engines. From this category the diameters of less than *2.5* μm have a paricular risk to respiratory systems, associated with hydrocarbons or benzapyren as strong carcinogen substances. Reduction of this impact could be achieved by low sulphur level fuels and better combustion processes. The related sustainable ambient impact level, based on WHO/EURO orientations could be *15–20* $\mu g/m^3$ (annual mean) referring back to the high risk of particles less than 2.5 μm.
- *Fossil* CO_2. One basic criterion of environmentally sustainable transport should be the control of CO_2 emissions. The IPCC panel proposed a general reduction of 50–70% on a short term basis, contributing to the stabilisation of atmospheric concentration. Certain experts argued for a 80% reduction of emission in the industrialised countries, while we can witness a permanent growth of transport related CO_2 emission all over the world. We should note that there are crucial differences between specific emissions of different regions and countries: USA 5.8, Germany 2.3, Hungary 0.7 tonnes CO_2/capita/year and between modes of transport. Regarding reduction opportunities, there are short term potentials of 60–80% in energy intensity of vehicles, targeting vehicle construction and performance, which could be extended by the introduction of renewable fuels, positive corrections of modal split. In this respect there are certain regulations in the USA for ZEV (zero emission vehicles), and introduction of non fossil vehicles would be necessary. Criterion for sustainability in this issue should be *70–80% reduction* of transport related CO_2, first of all, in the OECD countries. In spite of our region's relatively favourable position we should make steps in this respect, in connection with the economic growth and its consequences of increasing CO_2 emissions.
- *Land use*. Transport related land use is a particular adverse effect of urban, suburban regions, degrading ecosystems. Here we should refer to urban sprawl, suburbanisation processes, having increasing mobility, first of all, car use demands beside loss of active green fields. Transport related land use in developed regions is over 20–25%. As quantitative criterion for transport purposes, including maintenance and other background infrastructure a *10% limit* could be determined, accompanied by further measures, for safeguarding, rehabilitation and limited disturbance of living ecosystems.
- *Noise.* Transport related noise became a significant public health risk, with different direct and indirect adverse impacts – stress related psychiatric illnesses, reduced immunity, blood pressure. In our region there is a charac-

teristic noise impact of 70–75 dB by day and 60–70 dB at night, along main roads. WHO proposals refer to *55 dB day-time and 45 dB night* levels in residential and 50 dB/40 dB in recreation areas, being acceptable from the point of view of sustainability.

6. Related Tasks, Preferences

Besides technical measures regarding emission control of gases mentioned among the criteria and other emissions, there is a need for a strong *policy change* both in the field of transport development, management of transport systems and additional regulative policies. Main elements of these measures in some transport sub-sectors:

- *International/transit freight transport*. A structural shift of freight flows towards combined transport. Additional development of transit charges and regulative systems, in connection with vehicles' environmental performances. Promotion of development of vehicle pools of combined transport targeting rail and waterway technologies, including the necessary logistics chains. Formulation of transit corridors, avoiding sensitive areas.
- *Domestic freight transport*. Structural development towards logistics principles, considered development of logistic centers. Application of differentiated vehicle charges, relating to environmental performances, with green card system for lorries. Extension of time, regional and weight limitations.
- *Domestic interurban passenger transport*. Improvement of rail transport's conformity, access time – competitiveness, increase of speed with upgrading of rail network, special vehicle pool for small rail passenger flows. Integration of transport modes.
- *Individual car use*. Car users should be charged by environmental impact related, proportional fees, costs. A network of development, categories of environmental impact assessment should be introduced, including service and management facilities. Improved control system for vehicles' technical, environmental registration and control.
- *Local passenger transport*. In urban road networks, the tolerable load, environmental impacts should be the determining factors instead of mobility demands. Preservation and improvement of relative price positions of public transport. Introduction of road price, cordon systems in urban areas, traffic priorities for public transport vehicles. Integration of rail networks in local and suburban public transport. Further mobility demand management in sensitive urban regions with growing car free areas.
- *Bicycle mobility*. Extension of networks, with additional serving infrastructure – parking, lending, repair etc. Integration with public transport, regulation of safety measures and related traffic.
- *Pedestrian mobility*. Strong potential in urban regions by car traffic control, improvement of ratio of pedestrian areas. Measures, programs towards access, safeguarding of pathways from other functions.

7. Central-Eastern European Aspects, Priorities

During the recent year, a multi-country Phare Project has been launched in the field of transport and environment, covering the 13 Phare countries of the Central-Eastern European region. Main objectives were, targeting a multi-country approach, the reduction of environmental impacts from the expected growth of transport, and integration of environmental issues into transport policies. After the review of current situation of the field of transport and environment in the concerned countries, there has been a strategy formulation and in this period an action planning has been taking place. Main elements, experience of the *review* raising the most crucial problems of the region include:

- Outdated and old vehicle fleet both in road and rail transport, with high emissions, low fuel efficiency and noise impact.
- Increasing motorization with insufficient infrastructure, particular in urban, suburban areas.
- Low fuel quality with environmental consequences.
- Expected increase, pressure of road infrastructure development.
- Loads, contaminations of recent and former activities, including waste disposal, fuel storage and vehicle management.

The formulation of *key objectives* was based on the current problems, existing and planned policies, regulations of the concerned countries and international regulations, policies relating to transport and environment. The objectives can be classified in three main categories:

- reduction of emissions
- transport demand management, modal split influence
- improvement of environmental performance of transport infrastructure

Key objectives:

7. To enhance the use of cleaner, more economical and quiet vehicles.
8. To enhance the use of cleaner fuels.
9. To reduce the car mobility and to encourage road transport efficiency.
10. To reduce the noise nuisance along main roads.
11. To promote transport by rail.
12. To enhance the use of maritime and inland waterway transport.
13. To strive for sustainable development of air transport.
14. To improve urban traffic management.
15. To improve the environmental performance of existing and new transport infrastructure.
16. To optimise combined transport.
17. To enhance the safety of transport of dangerous goods.

Some of the *proposed measures and instruments* contributing to the above key objectives:

1. Financial and taxation instruments.
2. Promotion of the use of cleaner and alternative fuels.
3. Variabilisation of external costs.
4. Setting noise emission standards and implementation of economic instruments.
5. Improvement of the railway infrastructure management.
6. Improving adaptability to intermodal transport systems.
7. Implementation of fair and transparent pricing.
8. Discouraging and control of motor vehicle traffic in densely populated areas.
9. Strengthening transport-environmental policies.
10. National plans and programs for implementation of combined transport.
11. Implementation of national control and reporting systems.

In the final and current stage, action planning is taking place, targeting the implementation of the key objectives on multi-country and national level.

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