Towards a more sustainable modal and spatial split of freight traffic for crossing areas: the case of the transalpine freight traffic

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Abstract

There has been a significant growth in freight traffic over the last few decades. The development of road transport, which contributes to air pollution, noise, congestion, and safety concerns, is particularly worrying the Alpine region, where freight traffic is concentrated on a limited number of routes and where topography results in the limited dispersion of pollutions. Concerns with planning for sustainable development have incited European countries to reach a consensus surrounding the necessity of balancing the use of different transportation modes, and in particular, increasing rail mode share. As such, the main objectives of this research is to evaluate the impact of transalpine road and railway freight traffic on the vulnerability of crossed regions and to observe if a change of the modal and spatial split of transalpine freight traffic can have a significant influence on this impact. The method, developed for the Alpine segment (Fréjus – Brenner), is tested to the whole of Switzerland.

Keywords

freight traffic – modal and spatial split – air pollution – noise – sustainable development – Geographic Information System – indicators – multicriteria analysis

1. Introduction

There has been a significant growth in freight traffic over the last few decades in Europe. Road transport, which is well adapted to the requirements of production and distribution system, is mainly concerned. But this mode deeply contributes to air pollution, noise, congestion, and safety concerns.

This evolution is particularly worrying the Alpine region, which represents a natural barrier between North and South Europe. Linked to its topographic and climatic characteristics, the Alps are considered as a sensitive area facing transport externalities in particular.

Nowadays the European Union, like Switzerland, aims at a more sustainable transport system. That means a system, which maintains the integrity of the environment, improves the social equity (including the well-being and quality of life) and improves the economical effectiveness.

The advent of these preoccupations leads to set new objectives and targets to help decision-makers to opt for a sustainable policy and actions. In this context, development of methods and tools are required to evaluate policies and actions.

The sustainability of the transport system strongly depends on traffic volumes and on the modal split. Thus, focusing on the spatial dimension of the sustainable development concept, this research aims to emphasize if a change in the modal and spatial split of transalpine freight traffic can make the transport system more sustainable for crossed regions.

This paper first presents the context and introduces the objectives of the research. The methodology is then described followed by the presentation of the first results. Finally, the perspectives of this approach are given.

2. Context and objectives

2.1 Environmental impact evaluation

During the sixties, at the same time as environmental preoccupations, the environmental impact evaluation appears. Environmental impact evaluation consists of assessing and predicting the consequences of a policy or an action. The objective is to obtain quantitative and qualitative results and to improve the quality of decision-making.

Since 1969, the year of implementation of the National Environmental Policy Act (NEPA) in the United States, a lot of research has been carried out on the methodology of environmental impact evaluations. The methodology has been constantly renewed and progressively a more mathematical and data-extensive approach has been introduced.

During the seventies, economical methods were principally used. These methods encountered some difficulties due to the nature of environmental impacts (Rambeaux 1996), the high number of environmental parameters (Cohen de Lara et al. 1997, Lamure 1991, Larrue 2000) and the differences observed between the different evaluations and the results obtained (Rambeaux 1996, Nicolas 2002).

Developed since the end of the sixties, the multicriteria decision analysis seems to be able to make up for shortcomings of the economical and operational research. This method is now often used because of the growing need of an interdisciplinary.

Concerning the assessment of sustainability, no standardized framework and method exist nowadays. However a set of indicators of sustainability are often developed for this purpose.

2.2 Application to the transport sector

Environmental impact evaluation methods were relatively recently adapted to the transport sector. Evaluations in this domain principally concern planning problems and route planning analysis. The studies also mainly focus on the economical impacts and rarely consider the location of the emissions (Van Wee, Janse, Van den Brink 2005).

Several European projects, for example ExternE[1] (Bickel P. et al. 1995-1998), COMMUTE[2] or Recordit[3] (Schmid et al. 2001), were or are still devoted to the assessment of different

[1] EXTERNalities of Energy

environmental impacts induced by different transport modes. Some national projects were also carried out in Switzerland, for instance PNR 41 "Transport and environment", MFMU[4] or studies lead by Ökoscience. A minor number of projects were carried out at the alpine level. A couple of them just commenced, for example Interreg program III B "Alpine space", Monitraf[5] or Alpnap[6].

A literature review on this subject shows also that there is only a small number of studies that consider the impact of the modal and spatial split of traffic volumes and also that the main focus is on the spatial dimension of the sustainable development concept. Nowadays, there is also still no tool developed for the alpine region stretching from Fréjus to the Brenner.

2.3 The spatial dimension of the sustainable development concept

Despite a lot of different approaches, researches including the sustainable development concept principally focus on the temporal dimension. This is the case in particular in the transport sector, where most of the studies look for a compromise between traffic growth and environmental protection (Feitelson 2002). In this case, the emphasis is put on the notion of equity between generations. To complete this approach, it is interesting to consider the equity inside one generation and thus take the spatial dimension into account: « *the spell concern or, at least, the consideration of the interests of future generations have a sense only if it takes the present generation into account with its variable situations. In this respect, levels of well-being according to the territories represent a main variable* » (Laganier et al. 2002). However, it still remains difficult to define what is called sustainable and this sustainability will probably never be reached on the whole territory.

Focusing on the spatial split of traffic volumes and on the localisation of emission (immissions), this research participates in assessing sustainable development through its spatial dimension. To put traffic and territory in relation, the notion of vulnerability is used. This notion represents a link between the disruptive element, the traffic, and the vulnerable element, the territory. The notion of vulnerability takes the importance and the frequency of disruptions (hazard) and the environmental, social and economic values of the affected elements into account.

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[2] Common Methodology for Multi-Modal Transport Environmental

[3] Real COst Reduction of Door-to-door Intermodal Transport

[4] Monitoring Flankierte Massnahmen Umwelt

[5] Monitoring of road traffic related effects in the Alpine Space and common measures

[6] Monitoring and Minimisation of Traffic-Induced Noise and Air Pollution Along Major Alpine Transport Routes

2.4 A generic methodology to assess traffic impacts

The objective of the developed methodology is to assess the impacts of traffic volumes and to observe if a change in the modal and spatial split of these traffic volumes should have a significant influence on the vulnerability of the crossing areas. The method can also be interesting in assessing the sustainability of crossing areas. Sustainability includes the environment, the social and the economical dimensions.

Focusing partly on the modal split, the method must be usable on a large scale but also on a more local scale to consider impacts on crossing areas. This is a great difficulty this research is faced with.

This generic method can be extended to different types of traffic, to different impacts or also to various indicators. So it can be used to compare different routes or regions considering different impacts and different modes of transport.

2.5 Application to transalpine freight traffic

The objective of this study is to apply the above-described methodology to the transalpine freight traffic.

In the European context, the Alps are considered as a sensitive area. The sensitivity of this region to traffic impacts is linked to its topographic and climatic characteristics: traffic is concentrated on a limited number of routes and the valleys concerned present limited emission dispersion conditions.

This research also mainly focuses on transalpine freight traffic because this traffic is potentially transferable from road transport to railway.

The method, developed for the Alpine segment (Fréjus-Brenner), is tested to the whole of Switzerland. For that purpose, data available for the different alpine countries is used provided availability.

3. Methodology

3.1 Traffic modelling

A Geographic Information System (GIS) is used to model traffic volumes. Data from 1999 are used because of their availability when this research began. Only working days are considered.

A distinction is made between nocturne and diurnal traffic volumes, passenger and freight traffic volumes, non transalpine and transalpine freight traffic volumes. To assess the vulnerability of crossed regions to transalpine freight traffic, this research compares a situation considering all the traffic to a situation considering only no transalpine traffic.

A geometric network is created to represent traffic volumes on the Swiss road and railway networks. Scenarios can be simulated. Transalpine freight traffic volumes can so be transferred form one mode to another or from one route to another. Different parameters, for instance the length of the route, can be chosen to select a route. The maximum traffic volume that is possible to transfer can also be identified.

3.2 Noise and air pollution

Noise emissions induced by railway and road traffics are calculated. For railway emissions, this calculation takes the number of train per hour, the length of the train, the speed of the train, the type of train and the type of trainbrake into account. For road emissions, the STL 86 model modified by the EMPA is used (Hertig 1999). The number of vehicles per hour, the proportion of heavy goods vehicle and the average speed are considered for this calculation.

Air pollution emitted by road traffic is also calculated. This calculation is based on the Handbook emission factors for road transport (Federal Office for the Environment 2004).

Based on the emission values of the different sections of the network and using dispersion models, noise and air pollution immissions are calculated. For noise dispersion, reduction due to the distance separating the source from the receptor, reduction due to the air and also the influence of the ground are taken into account. A Gaussian dispersion model, which resembles to the Sutton model, is used to calculate the dispersion of linear emissions. This dispersion model takes some meteorological parameters into account.

Railway and road emissions and immissions are calculated for a situation considering all the traffic and for a situation taking only non-transalpine traffic into account.

3.3 A road to rail transfer scenario

The objective of a transfer pattern scenario is to observe which effect can have a modal and spatial split of a transalpine freight traffic volume. To verify the validity of the method, only one extreme scenario is tested. The following scenario can be presented as an ideal situation that will present the maximal advantage of a road to rail freight traffic transfer.

The scenario tested consists of transferring the maximum of road transalpine freight traffic passing through the Gotthard on the train using the Lötschberg – Simplon tunnels. The hypothesis that there is enough capacity of the railway Lötschberg line is admitted.

4. Results

Following the network and mainly on the plateau, road freight traffic is much more dispersed as railway freight traffic in Switzerland.

While road and railway freight traffic is well dispersed on the Swiss network, transalpine freight traffic is concentrated on three main corridors: the Gotthard (railway and road), the San Bernardino (road) and the Lötschberg – Simplon (railway).

Considering the spatial location of these different freight traffic volumes, a high participation of freight traffic and in particular of transalpine freight traffic in induced emissions can be expected on some sections of the network.

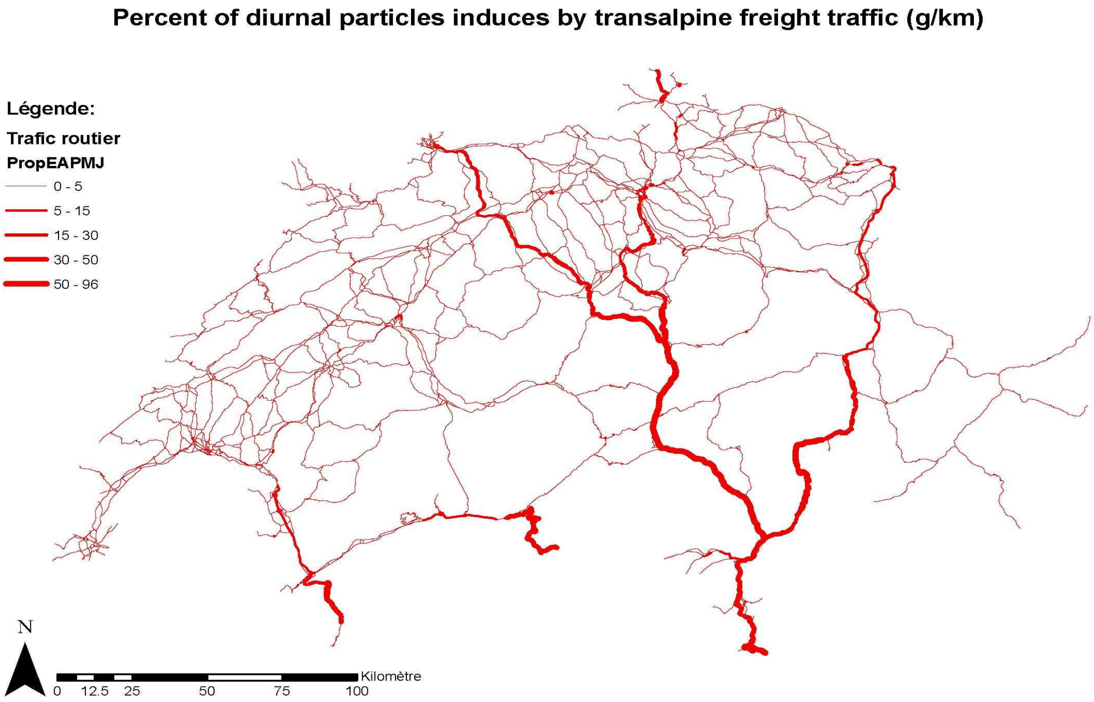
Concerning air pollution emissions the results show that, in Switzerland, up to 59% of the emissions can be induced by road freight traffic. Nevertheless this percentage deeply varies according to the different pollutants. The following table show the total emission induced by different categories of vehicle in Switzerland.

Table 1: Total pollution emissions of different categories of vehicles in Switzerland (ton/1999)

	SO_2	CO_2	PM	NO_x	CO	HC
Passenger cars	786	5588673	204	15564	58582	3677
Light-duty vehicles	88	425306	149	2357	11984	463
Heavy duty vehicles	450	1600239	580	20443	3262	1049
Motor cycles	7	54251	0	219	6757	1116
Cars	35	123300	48	1543	206	67
Total	1366	7791770	982	40126	80791	6372

About 12% of the road freight traffic emission is induced by transalpine freight traffic. In this domain, the following map shows that on some sections, the proportion of particulates induced by transalpine road freight traffic can attain about 50%.

Figure 1 Percent of diurnal particles induced by transalpine freight traffic (g/km - 1999)



The results obtained for road traffic emissions in Switzerland have been compared with the results obtained by the Swiss Federal Office for the Environment (Office fédéral de l'environnement 2004). This comparison shows that both results are not far apart. However a probable overestimation of freight traffic and underestimation of individual traffic can be expected.

Concerning noise emission, the results show that between a diurnal situation with or without transalpine freight traffic, the difference observed in dB(A) can reaches 3% for road and 5 to 8 % for railway.

Due to the type of data (some of them are estimations), the quality of the data and the method used, there is some imprecision in the results, which can be more or less disturbing. They can easily be identified because they disturb extreme values in particular.

The results of the scenario are still not completely available but are ready for publication on short notice.

5. Perspectives

5.1 Indicators

The next step is to develop indicators using immission-data, population data and regional data. The objective is to develop simple indicators with which it is possible to aggregate different impacts like noise and air pollution induced by railway and road traffic.

5.2 Comparison of corridors

The main objective of the development of indicators is to compare the situation between different regions and between different corridors. Thus the results will give an indication about the spatial distribution of impacts, about the change induced by a modification of the modal and/or spatial split of a freight traffic volume and so to pinpoint more critical regions.

5.3 Potential additional parameters

Additional parameters can easily be added in the methodology developed. For example, it will be interesting to introduce data relative to railway and road capacity or relative to noise barriers.

The consideration of other parameters mainly depends of the availability of these data. Sometimes a common database gathering the data for the whole country is not available or the data available are still not georeferenced.

6. Conclusion

The alpine region, which is considered as a sensitive area in Europe is worried by the growth of freight traffic which induces significant impacts on the crossing areas through air pollution and noise in particular.

Methods and tools have been developed to assess environmental impact or in some way the sustainability of the transport system. Some of them were devoted to the Alps.

The originality of the method presented in this paper and tested on a national scale lie in its possible use in the alpine scale. The main objective of this research is to give some indications for a possible further development of a tool for the alpine space. The final objective would be to see which consequences a modal or a spatial change in the transalpine freight traffic volumes can have on one or more alpine corridors.

Until now the main limitation of the method is that some imprecision appears relative to the attribution of traffic volumes on the network. This problem could easily be solved with a more precise work on the data.

To emphasize the interest of the method further results are impatiently expected.

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