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SUSTAINABLE TRAFFIC CONCEPTS IN CITIES AND REGIONS OF GERMANY

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Both the progressive division of labour in the spatial organisation of production and the liberalisation of international exchange of goods and services give rise to an enormous areal extension of procurement and market interweavings that affect high growth rates of freight transport. In passenger traffic car availability, that is almost ubiquitous, has enlarged the individual action spaces to an extent hitherto unknown. Despite all the efforts of environmental and climatic protection (especially efforts to reduce air and noise pollution as well as carbon dioxide emissions) the road traffic for people and goods continues to increase.

Sustainability of transport means, however, to uncouple mobility and traffic development from economic growth and rising standards of living. One example may be the successful uncoupling of energy consumption and social economic development in highly industrialised countries. In order to realise the objective of sustainable mobility for people and goods three main tasks have to be implemented.

(1) Firstly it is necessary to both support technical measures which improve vehicle efficiency (i. e. reduction of fuel consumption and pollutant emissions) and to optimise the traffic flow and transport logistics by means of telecommunication techniques.

(2) The second main task concerns traffic avoidance. The realisation of this chore requires a change of the individual traffic behaviour as part of a new way of life which is based on a balanced an polycentric spatial development ("from sprawl to compact city") and is supported by principles of multi-functional urban zoning.

(3) Thirdly it is vital to transfer mobility from motorised traffic towards more environmentally friendly transportation modes by strengthening the competitive attraction of the latter. This measure requires changing of conditions of transport as well as new policies to achieve a better balance in the use of various transport modes.

These three principles - ""smoothing" the flow of traffic, "savings" on time and energy involved, and "shifting" the traffic flows towards environmentally friendly transport systems (the so-called "three s"; Topp 1994) - constitute the three central components of a progressive approach which may be fully integrated in sustainable spatial development strategies. From the viewpoint of economic geography the third component is the most interesting field of action to bring transport in line with the environment.

1. Traffic Growth and the Change of Modal Split

But at first I will look at both the current problem of traffic growth and its consequences. From 1960 to 1990 the total volume of freight traffic in Germany doubled, but the long distance road traffic increased 4.5 times compared to 1960 figures. The road haulage related to tons per kilometre (tkm) raised its modal split in this period of time from 19.6 to 48.1 per cent (excluding short-haul transportation) while the freight traffic by rail fell from 43.9 to 24.7 per cent. In these thirty years the volume of passenger traffic in Germany doubled, too. However, passenger traffic in terms of persons per kilometre (pkm) even tripled while the traffic by car rose from 63.8 per cent (1960) to 82.1 per cent (1990); in the same period of time public transport lost half of its market share, i.e. the modal split dropped from 35.9 to 17.6 per cent (Deiters 1995b).

1.1 Development after the Fall of the Wall (1989)

Since German reunification a dramatic structural change in the field of transport took place in the newly formed German states. The share of the railway, which under socialism had been the main carrier of long haul freight traffic, of the whole transportation service dropped by more than 40 per cent while the truck share jumped from just under 10 to over 50 per cent. The private motorisation rose from just 240 cars per 1,000 inhabitants in 1989 to over 460 at present. In a few years time the motorisation index in east Germany will have caught up with the level of the old Federal Republic before the Fall of the Wall (namely 475 cars per 1,000 persons).

This adjustment of traffic conditions in the newly-formed states also becomes obvious if we look at the recent change of the modal split in urban passenger traffic (see *table 1*): in accordance with the developments outlined above nearly half of either walks or trips by West and East German citizens are now undertaken by car. However development of the urban travel behaviour in the last 25 years differs significantly.

transport mode	1972	1977	1982	1987	1992	1997 (trend)
FRG/old West German states						
by foot	41	34	30	26	23	21
Bicycle*	11	9	11	13	13	13
Car	31	40	43	46	47	49
public transport	17	16	15	17	17	17
GDR/newly-formed German states						
by foot	51	48	45	40	32	28
bicycle*	15	12	12	11	9	9
Car	11	15	19	25	44	49
public transport	23	25	24	24	15	14

*incl. Motorcycle

***Table 1**: Modal split in urban passenger traffic in Germany 1972–1997 (percent of either walks or trips). Source: Monheim 1997.*

In the former Federal Republic (FRG) the change of modal split is a gradual process in the course of which the non-motorised individual transport modes (on foot or by bike) were substituted continuously by the car (as a faster mode of transport). Public transport in the former German Democratic Republic (GDR) plunged into a crisis after the opening of the Wall due to its poor efficiency and lack of attractiveness. At the same time the expansion of western cars took place rapidly. I shall return to these problems below.

1.2 Forecasting Traffic Growth

The Federal Ministry of Transport expects in its traffic forecasts until the year 2010, which form the basis for planning road and rail networks in Germany, an increase of freight transport by rail of 55 per cent and for road traffic of 95 per cent (on the basis of 1988 figures). The expected growth rates of railway and car passenger traffic are 42 and 30 per cent respectively (Deiters 1995b). However it is impossible to increase the capacity of transport networks to an extend that will enable them to cope with such traffic amounts. This is especially true because the real growth of east-west freight traffic will presumably exceed considerably the forecasts due to an increase opening of the Eastern and Central European countries. Note that the results of this forecast scenario already take into account state interventions that aim at regulating the traffic growth and transfer mobility to ecologically more sound transport modes.

2. Environmental Pollution and the External Costs of Transport

2.1 The Impact of Carbon Dioxide Emissions on the Climate

The environmental pollution caused by traffic continues to increase as, for instance, the increase of carbon dioxide emissions as one of a multitude of negative concomitants of the traffic expansion shows (see BUND/MISEREOR 1996, p. 305). In 1987 traffic produced 169.2 million tons of carbon dioxide and was responsible for 16 per cent of all carbon dioxide emissions in Germany. Until 1993 these emissions rose by 20 per cent to 204.6 million tons which represented 23 per cent of the whole carbon dioxide emissions in Germany. Several forecasts confirm that this trend will continue so that the carbon emissions caused by traffic

will increase to about 35 to 40 per cent until 2005 and to about 42 to 50 per cent until 2010. Technical improvements in the efficiency of motor vehicles cannot by far compensate the expected increase of road traffic.

The former resolution of the German Federal Republic to reduce the carbon dioxide emissions until 2005 by 25 to 30 per cent (on the basis of 1987 figures) will therefore fail glaringly with respect to traffic effects. Also the commitment made by the European Union on the 1997 World Climate Conference in Kyoto to diminish the most important greenhouse gases until 2005 by at least 7.5 per cent and until 2010 by 15 per cent (on the basis of 1990 figures) is in view of the European traffic developments rather unrealistic.

Despite the efforts to create an integrated European high-speed rail network for passenger and long distance freight transport (the latter is to ease the great traffic load of transit areas) the priority of the EU common transport policy lies in fact on the extension of road networks. Its tasks is to secure and further a pattern of decentralised settlement throughout the Union and to assist peripheral regions in their attempts to overcome their disadvantages by improving their accessibility.

2.2 The Problem of External Effects of Road Transport

Growth stimulating investments in transport infrastructures together with the European Commission's deregulation policy foster intense competition that favours road and air traffic (the most polluting modes of transport) but is to the detriment of rail and waterways transports (as environmentally more acceptable systems). The problem of the external costs of transport and the unsolved problem of their covering (the polluter pays principle is difficult to apply) result in a considerable distortion of the market mechanism. The external effects of different modes of transport have recently been calculated for the European Union Member States plus Norway and Switzerland (Rothengatter 1995).

Externalities in this study are restricted to only those effects that cause market failures - "because of wrong cost signalling between agents" (ibid. p. 3). The following effects have been investigated: (1) the uncovered costs of accidents (that are costs which are not covered by traffic users or their insurance companies); (2) costs of traffic noise (base on the OECD statistics on population exposed to traffic noise evaluated by means of a willingness-to-pay approach); (3) costs of air pollution (the calculation for SO_2, NO_X and VOC emissions based on a damage cost approach); and (4) costs of climate change (estimated as prevention costs on the basis of national reduction targets of carbon dioxide emissions).

The total external costs of transport in the 17 European countries add up to about 270 billion ECU for the year 1991. This corresponds to 4.6 per cent of their average 1991 GDP. The share of road transport of the total external costs was 90 per cent (250 billion ECU/a). The share of rail transport, which was less than 2 per cent (5 billion ECU/a), can, however, be neglected. Two thirds of the externalities of road traffic are uncovered costs of accidents (social costs in the narrow sense) while the main problem of rail traffic is the noise stress (44 per cent).

A comparison of the external costs with the transportation service (in pkm or tkm) reveals the whole scope of the current unfair competition which puts the railway at a disadvantage. In the passenger traffic the relative external costs for cars amount to the fivefold, and in freight traffic even to the eightfold, of the respective rail externalities (see *table 2*). Note further that the relative external costs of freight transport are lowest for inland waterway shipping and highest for aviation. But the actual transport pricing of

different competing modes of transportation do not reflect these relations - it rather turns the true costs of transport upside down.

effect	road		rail	aviation	shipping
	(a) passenger traffic *(ECU per 1000 pkm)*				
	cars	buses			
accidents	32.3	9.4	1.9	-	
noise	4.5	4.2	3.1	3.0	
air pollution	6.6	4.1	2.0	5.0	
climate	6.6	2.7	3.0	9.8	
total	**50.1**	**20.4**	**10.0**	**17.8**	
	(b) freight traffic *(ECU per 1000 tkm)*				
accidents	22.2		0.9	-	-
noise	12.7		4.7	16.5	-
air pollution	13.0		0.7	26.3	4.2
climate	10.6		1.1	50.5	1.9
total	**58.4**		**7.3**	**93.2**	**6.1**

Table 2: *Specific external costs of transport in Europe 1991* ***(in relation to transportation service).*** *Source: Rothengather 1995.*

3. Regional and Urban Concepts to Reduce Motorised Traffic

The internalisation of the external costs of transport and the creation of "fair and efficient pricing in the transport sector" (as suggested by the European Commission in its 1995 Green Paper of the same name) should be implemented either on the EU level or at least on national level, for example with the introduction of a carbon tax on vehicle fuels. On regional and local level other measures and instruments are used to reduce motorised passenger traffic. As I will show below with the help of some case studies some authorities are exceptionally successful regarding efforts to achieve an environmentally friendly modal split.

3.1 Support of Public Transport

One of the most important concepts in this respect is the improvement of the attractiveness and efficiency of public transport. In addition to investments which aim at developing a modern public transport system (for example by replacing the tram with urban railway and the use of low-floor vehicles) the main instruments of this policy are extension of networks, raising of trip supplies, improvement of ride comfort and safety, accelerating measures and the creation of tariff incentives.

The modal split for selected cities (see *table 3*) certainly reflects different starting positions of urban development. Above all, however, it reveals planning principles which have been decisive for a long period of urban and city traffic planning. The old industrialised Ruhr cities (especially Bochum) are examples of car-friendly traffic structures: bicycle and public transport have long been neglected and represent only a small part of urban passenger traffic. It is noteworthy that the five cities in North-Rhine-Westphalia, that are summarised in table 3,

belong to the biggest Germans cities (with more than 500,000 inhabitants) in which - as in Hannover and Munich - about one quarter of the passenger traffic falls to public transport

	by foot	bicycle	car	public transport
Bochum	27	6	57	10
5 NRW-cities*	28	7	47	18
Kassel	28	8	45	19
Freiburg	21	19	42	18
Hannover	23	16	39	22
Munich	23	14	38	25
Münster	21	32	37	10
Wismar	45	11	33	11
Bologna/I	32	3	35	30
Groningen/NL	17	48	30	5
Zürich/CH	28	8	27	37

*average of the cities Cologne, Düsseldorf, Duisburg, Dortmund, Essen

***Table 3**: Modal split of urban population in selected cities (%).*

The whole range of city traffic organisation becomes obvious if we compare the modal split of the city of Bochum with the one of Zürich/Switzerland (*table 3*). Both cities have about 400,000 inhabitants but their traffic conditions differ fundamentally. The public traffic network in Zürich is twice as dense as in Bochum; regarding the service frequency of the tram and bus stops per square kilometre the traffic supply in Zürich is even five times higher than in Bochum (Apel 1992, p. 221). In addition 410 cars per thousand inhabitants compare with only 320 in Zürich. In the city canton of Basel the motorisation rate even amounts to less than 300 per 1,000 inhabitants. Nearly 350 out of 1,000 citizens, however, have a so-called "environment subscription" -a transferable runaround ticket for public transport (Monheim 1997).

This innovation of public tariff structure jumped from Basel to Freiburg (southern Upper Rhine, 194,000 inhabitants) were the so-called "conservation ticket" was introduced in 1984. In the meantime this customer-friendly tariff mode has been adopted by most German city transport services. In Freiburg the conservation ticket was extended in 1991 to cover the whole region of the Freiburg transportation association (area: 2,221 square kilometres) with a total of 553,000 inhabitants. For the first time in Germany a low price standard ticket was introduced that covered such a large area. Nearly 30,000 daily car trips were shifted to public transport which increased its modal split from 16 per cent to 18 per cent (Deiters 1995a).

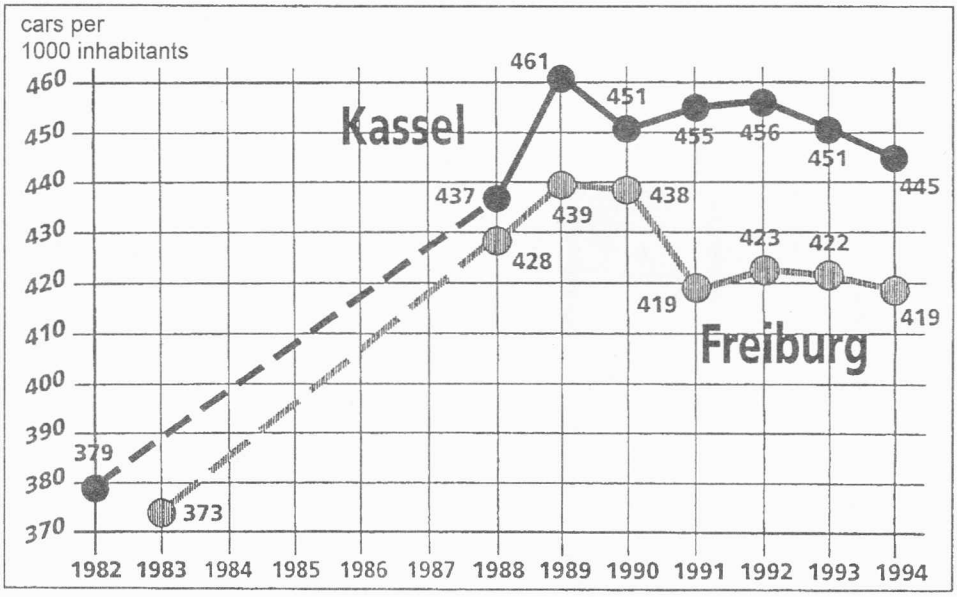

Figure 1: *Car ownership in Kassel and Freiburg 1982 – 1994. Source: Monheim 1997.*

The trend towards continuously higher rats of car ownership was disrupted (see *figure 1*): from 1990 onwards the number of private cars per thousand inhabitants decreased from nearly 440 to 420. The completion of a new tram line also contributed to this trend. A similar turning point of the private motorisation process can be observed in the city of Kassel (197,000 inhabitants): on the basis of the 1988 general traffic plan the improvement and modernisation of the tram system together with a public awareness campaign decreased the modal split of cars and increased that of public transit by 2 per cent (to 19 per cent in 1994, see *table 3*). Due to the implementation of the new traffic policy car ownership decreased to a similar extend as the one in Freiburg (see *figure 1*). The change in attitude is also expressed by the fact that only 9 per cent of the population prefer car-oriented city traffic planning while previously this share amounted to 27 per cent.

3.2 Development of Bicycle Traffic

Another point of action for the realisation of sustainable traffic development in cities and towns is to improve bicycle traffic in order to attract most of the short-distance trips which otherwise are made by car. The potential contribution of this measure to a greater environmental compatibility of local traffic is often underrated. Estimations for the former Federal Republic show that given trips are always made with the quickest mode of transport possible 10 per cent of trips made by car would be transferred to other transport modes, above all the bicycle (60 per cent; Deiters 1992). Cities and towns in the Netherlands are classical examples of great orientation towards bicycle traffic (see *table 3*: in Groningen the bicycle makes up half of the mobility). In Germany the city of Münster (about 270,000 inhabitants) is exemplary in this respect. The bicycle traffic rate, already high, increased further in the 1980's due to a growth of bicycle path investments of 34 per cent (see *figure 2*; in no other German city of similar size the bicycle development funds per inhabitant were higher than in Münster). The "price" of this bicycle-oriented traffic planning, however, is the

insignificance of the public transport system: 7 per cent in Münster, 5 per cent in Groningen (see *table 3*).

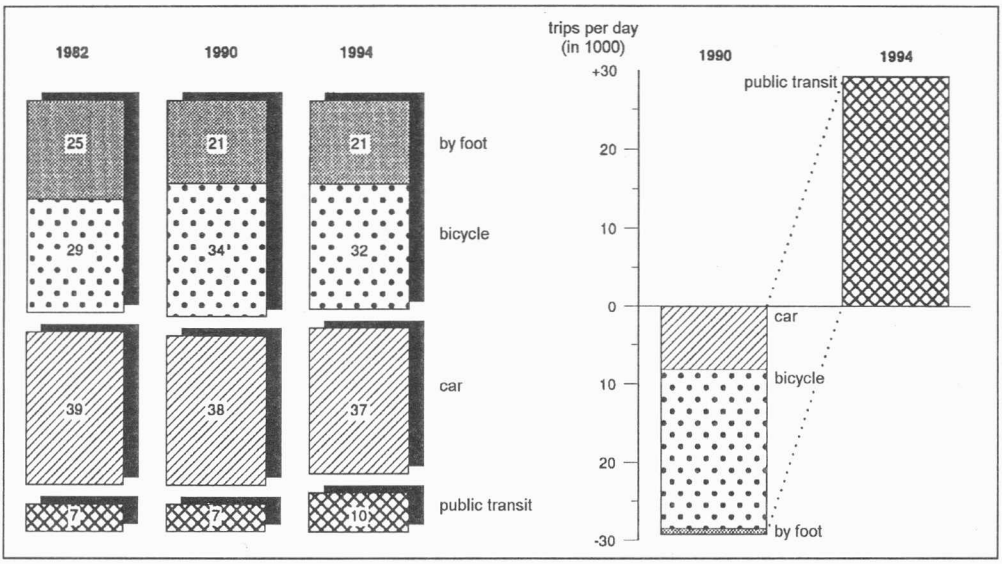

Figure 2: *The development of the modal split in Münster (%). Source: Deiters 1995b.*

In 1991 an extensive programme to improve the bus transport system was started in order to increase the volume of passengers until the year 2000 by at least 25 per cent. The programme was such a great success that within only five years the passenger volume increase by more than 40 per cent. The modal split of public transport rose from 7 to 10 per cent (see *figure 2*). The analysis of this shift reveals, however, that the number of passengers grew mainly at the expense of bicycle traffic. More than two thirds of the additional bus passengers (mainly students with the new "semester ticket") had used the bicycle before. Accordingly the modal split of the bicycle fell by 2 per cent.

Regarding the greater sustainability of urban passenger traffic this development is of course undesirable. It is mainly due to a lack of restrictive measures against car traffic.

3.3 Traffic Abatement and Parking Management

It is necessary to also include concepts of exhaustive reduced-traffic areas (mainly in residential areas) and measures of rebuilding main roads. The arrangement of car-free city centres (more exactly: car-reduced city centres) is an important, but not uncontroversial, measure to reduce motorise traffic. Measures of parking management, such as rationing of the public inner-city parking opportunities and residents-only parking in the adjacent residential areas (to ban the parked cars of commuters) are closely connected with these traffic calming concepts.

The Italian city of Bologna is a prominent example for the arrangement of a "car-free city centre" in which only the "necessary" traffic is admitted, such as delivery transports and

journeys made by inner-city businessmen and residents. In spite of the general enthusiasm for cars of the Italian people the modal split of car traffic in Bologna is on a sustainable level (30 per cent; see *table 3*). In Germany, the retail trade in the city centre is afraid that banning cars will reduce turnover.

For the Adivsory Board for Climate and Energy of the City of Münster, of which I was a member, I have calculated scenarios for future traffic developments under the condition that the reduction of carbon dioxide emissions until the year 2005 will be as great as possible. As expected the greatest reduction effects would result from a traffic policy that combines improved attractiveness of the environmentally friendly transport modes with restrictive measures against car traffic as described above. As a result the modal split of cars changes from 37 to 30 per cent and the carbon emissions caused by traffic might reduce by 17 per cent (climatic protection scenario).

An analysis of the city of Freiburg revealed very similar results. Strict adherence to environmentally friendly traffic modes will change the modal split of cars to 32 per cent and that of both public transport and bicycle to 22 per cent.

3.4 Further Approaches to Sustainability in Traffic Development

In the last year "soft policies" of traffic management based on education, information and motivation became more important. For example, public awareness strategies or installation of mobility consulting centres and transfer points in cities and regions are to further an environmental-conscious use of transportation modes.

Finally promising efforts exist to relieve the city centres partially from commercial transportation by concentrating the flows of merchandise (delivery and pick-up function). The task of "city logistics" is to optimise these flows economically and ecologically. Its success depends on the cooperation of the local haulage companies. The relief effects, however, are relatively small.

4. Sustaining the Environment: "Cost Truth in Traffic"

"Cost truth in traffic" or - economically speaking - the internalising of external effect of transport, is the central claim of a market-oriented traffic policy that aims at sustaining the environment. But to what an extend do several measures affect traffic avoidance or the shift towards ecologically sound transport modes?

Switzerland is the first country for which, on a regional level the external costs of transport were estimated. A package of adjustment measures was created and evaluated with regard to its effects - not only on traffic demand but also on the national economy, location decisions and the settlement structure. The Swiss National Research Programme "City and Traffic" paid special attention to the greater urban regions.

4.1 The Case Study of the Zürich Agglomeration

Since the initial conditions and traffic problems in the Zürich agglomeration are similar to that in German metropolitan areas it seems to be important in our context to present the main results of this study (see Maibach/Iten/Mauch 1993, Isenmann 1994) as a conclusion of this paper. The modal split of the city area and its hinterland showed a familiar picture for 1990 (see *table 4*): in the field of passenger transport the private road traffic had a share of 61 per cent in the city of Zürich but 85 per cent in its hinterland (the remaining agglomeration

area); in the field of freight traffic the share of road transport was 67 and 77 per cent respectively.

The external environment and accident costs are highest for the road traffic that is responsible for 92 per cent of the total traffic externalities in the whole agglomeration area. Unlike on the national or European level most of the road externalities (65 per cent) are air and noise pollution. In relation to transportation service the external costs are highest for the truck (30 centimes per kilometre-tonnage) followed by the private care (with 18 centimes per passenger kilometre).

	modal split 1990 *(% pkm/tkm)*		**specific external costs** *(Swiss centimes per 1000 pkm/tkm)*	
	Zürich	hinterland	Zürich	hinterland
passenger traffic				
car	61	85	18	10
bus	4	5	6	3
tram	26	-	2	-
rail*	9	10	4	6
freight traffic				
truck	67	77	30	12
rail	33	23	3	3

*incl. suburban train

Table 4: *Modal split and the specific external costs of transportation modes in the agglomeration area of Zürich. Source: Maibach/Iten/Mauch 1993.*

Because of the higher population density in the city centre the specific externalities of transport are generally higher in the city area than in the surrounding suburban region. Tram and rail (including suburban trains) are the most environmentally friendly transportation modes (see *table 4*, right column). These results reveal a hidden subsidising of urban vehicle traffic by the human society. This puts into perspective the occasional argument of the neglected road and parking-place construction due to uncovered costs of public transport that have to be compensated by the authorities. One of the main demands of the advocates of "cost truth" in traffic is to use the additional revenues from individual car drivers partly to subsidise a better public transport.

In their examination of ten measures to internalise external costs of traffic the authors of the Zürich study conclude that the cost-benefit-relation is by far greatest for fuel price increase (assumed: 70 per cent), followed by the reduction of speed limits (as supporting, non-market measure), parking management and a city toll. It is interesting that single measures to support public transport show no positive cost-benefit-relation in this context (Maibach/Iten/Mauch 1993). A fuel price increase by 70 per cent would reduce the journeys made for leisure purposes by 30 to 45 per cent of vehicle kilometres. The "winner" would be the public transport system with an increase in traffic demand of between 7 and 14 per cent (Isenmann 1994, p. 161).

The question of the extent to which fuel consumption is dependent on the fuel price is discussed controversially in the literature. On the aggregate level of the OECD countries it has recently been proved that besides the prosperity indicator of the countries the fuel price is the

most important determinant of fuel consumption - and with it on the volume of car traffic (Franzen 1997). In order to sustain the environment the establishment of policies to internalise external effects of traffic is a task of high priority.

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Resumé

PODPŮRNÉ NÁVRHY DOPRAVY V NĚMECKÝCH MĚSTECH A REGIONECH.

Juergen DEITERS

Jsou uvedeny tři hlavní zásady strategie rozvoje dopravy a to „uhlazení" (optimalizace dopravních toků a zlepšení účinnosti vozidel), „úspory" (času a energie např. v důsledku vytváření funkčních zón ve městech) a „přesun" (k druhům dopravy příznivějším z hlediska vlivů na životní prostředí). Důraz je kladen na využití třetí zásady. Obecné tendence vývoje dopravy v Německu

i v dalších evropských zemích jsou ilustrovány četnými statistickými údaji o měnící se skladbě dopravy ve městech, o nárůstu dopravy po silnici a o výši externích nákladů pro různé druhy doprav. Jsou diskutována opatření vedoucí ke snížení individuální automobilové dopravy a na podporu hromadné dopravy v regionech i ve městech, podložená internalizací externích nákladů.

Summary

SUSTAINABLE TRAFFIC CONCEPTS IN CITIES AND REGIONS OF GERMANY

Juergen DEITERS

Tree main principles of development strategies in traffic are introduced, namely „smoothing" (optimization of traffic flows and improvement of vehicle efficiency), „savings" (towards more environmentally friendly transportation modes). The possibilities of applying namely the third principle are investigated. The general trends of development of transport Germany and also in other European countries are there documented by different statistic data, concerning the changing structure of urban traffic, the growth of rood traffic and the values of external costs of different means of transport. Regional and urban concepts reducing the motorized individual traffic and supporting public transport are mentioned, based on internalization of external costs.

Zusammenfassung

UNTERSTÜTZENDE VERKEHRSKONZEPTE IN DEUTSCHEN STÄDTEN UND REGIONEN

Juergen DEITERS

Drei Hauptprinzipe der Entwicklungsstrategien in Transport werden eingeführt, nämlich das der „Glätten" (Optimierung von Verkehrsströme und Verbesserung der Wirkungsgrad der Fahrzeuge) , der „Ersparnisse" (der Zeit und der Energie beispielsweise aufgrund der viefunktional Stadtzonen) und der „Verschiebung"(zu den minder umweltschädlichen Verkehrsmitteln). Nämlich die Möglichkeiten der Anwendung von dritten Prinzip werden untersucht. Die algemeine Tendenzen der Entwicklung des Transports in der Bundesrepublik Deutschland und in der anderen europäischen Ländern werden mit verschiedenen statistischen Angaben dokumentiert, welche die wechselnde Struktur des Stadtverkehrs, das Wachstum des Straßenverkehrs und die Werte der externen kosten der verschiedenen Transportmittelnbetreffen. Die Konzeptionen für die Regionen und für die Städte, die den individuellen Motorverkehr reduzieren und den öffentlichen Transport fördern, werden auf der Idee der Internalisation der externen Kosten entwickelt.