Conference Topic: F1

Spatial and Federal Transport Planning in Germany: How to implement spatial planning goals into federal transport plans

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1. Introduction

The transport ministry in Germany is setting up a new federal transport plan (BVWP) using an improved planning methodology. Part of the planning procedure is the Spatial Planning Assessment (SPA), which analyses how transport investments contribute to spatial and regional planning targets. Since the old SPA has been largely criticised for it crudeness, the transport ministry decided to develop a new methodology. This was done during a research project by the Federal Office for Building and Regional Planning (BBR) in co-operation with the Ministry of Transport. It was the objective to develop a methodology

- which reflects the major spatial planning goals,
- which integrates into the federal transport planning procedures,
- which can be easily understood and
- which can be 'sold' to decision makers.

The paper focuses on the description on how these targets can be transformed into assessment procedures. The research project is still going on. The paper is based on a proposal on the new planning methodology presented to the ministry. It does not present the opinion of the ministry. It reflects the state of the research in the beginning of 2001. The procedure will be adjusted during the phase of testing the methodology. All statements are within the sole responsibility of the author.

2. Federal transport planning in Germany

In Germany transport planning is done on three levels: Communities (5000), states (16), and the federal government. Only the latter level, which comprises investments with country-wide relevance, shall be regarded in this paper. The Federal Transport Plan (BVWP) is developed and implemented by the Federal Ministry of Transport. Proposals on the investment projects are done by the states. The ministry has the task, to select amongst the many proposals the best projects and set up the Federal Transport Plan.

The last Federal Transport Plan has been set up in 1992 short after the reunification of West and East Germany. The BVWP ’92 included the following effects:

- Reduction of transport costs,
- maintenance of transport infrastructures,
- improvement of transport security,
- spatial impacts,
- environmental impacts
- and other effects.

All these effects were monetarised and included in the CBA. The B/C ratios were the decisive ‘data’ handed over to the politicians in order to decide about the plan, which decided that only projects with a C/B ration higher than 3 should be implemented. The planning methodology has been criticised for various reasons; amongst the most prominent were the crude assessments of spatial and regional planning impacts.

Now the federal government is planning to develop a new transport plan. It is the task of this plan to assess and rank over 1300 projects proposed by the states of Germany. For this purpose, the old planning methodology from 1992 was improved. An overview on the new planning methodology is given in Figure 1. Heart of the new procedure remains a cost-benefit analysis, which assesses the impacts of the proposed projects. For this purpose, two scenarios are developed: The Reference Scenario reflects the situation in 2015 without any of the proposed projects, while the Plan Scenario includes the proposed projects.

Figure 1: Overview on new planning methodology for the federal transport plan

Improvement of Transport Models

CBA

- Transport Costs
- Maintenance Costs
- Transport Security
- Spatial Effects (reduced)
- Environmental Effects

Additional Effects

- Environmental Risk Assessment
- Urban Planning Impacts
- Spatial Planning Assessment (SPA)

Seaport-Hinterland Connections, Airport Links

Induced Traffic, Interdependencies

Source: BMVBW 2000, own translation

Next to the traditional cost benefit appraisal, additional effects, which cannot be monetarised are taken into account. This paper focuses exclusively on the Spatial Planning Assessment (SPA) of transport investments.

Why a separate assessment of spatial planning impacts? Cost benefit analyses assess the optimal allocation of resources, they do not reflect spatial planning goals, such as reduction of spatial disparities. Since these targets are extremely difficult to monetarise and to integrate into the C/B analysis, a separate assessment of the spatial planning impacts is necessary.

3. Overview on the methodology of the new SPA

The objectives of the new spatial impact assessment (SPA) were to transform spatial planning goals into operational procedures, which are simple and can be easily understood by political decision makers. The new planning methodology target on two very different planning goals:

- Target I : Distribution and Development
- Target II: Disencumbrance and Modal Shift

Figure 2: Overview on SPA methodology

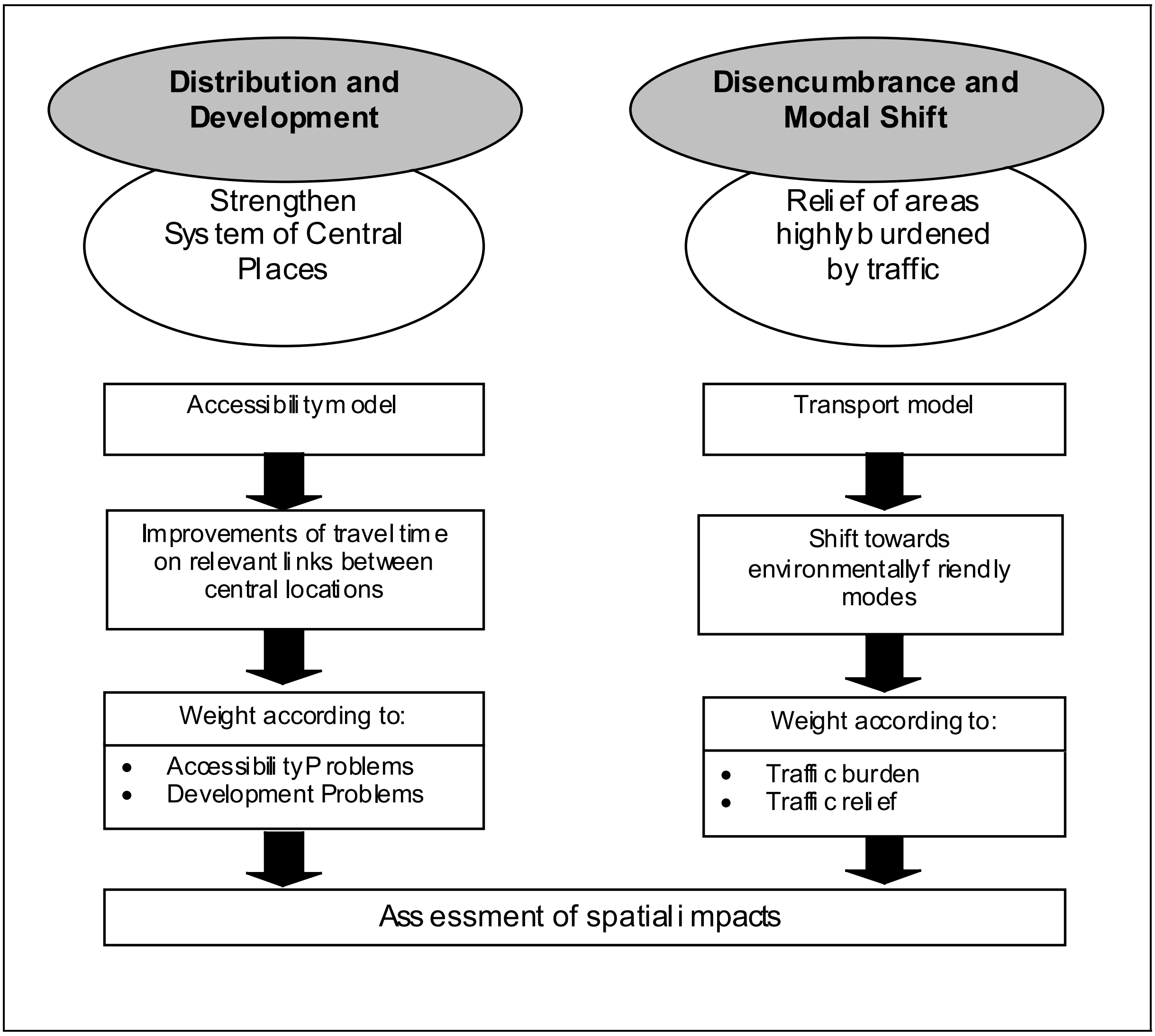


Figure 2 gives a rough overview on how these two targets are assessed. The first target reflect the 'classic' spatial planning goals in Germany: Reduction of spatial disparities and strengthening the system of Central Places. Transport investments can do this by improving the access to essential goods and services. For this purpose a set of relevant links between these Central Places is defined. An accessibility model is used to measure the effects of transport improvements on these links. The SPA takes into account deficits of accessibility as well as development problems of the areas affected.

While the first goal reflects more the positive impacts of transport, the second goal 'relief of areas highly burdened by traffic' focuses more on the negative aspects. Background is a decision of the Ministerial Standing Conference on Regional Policy (MKRO 3/7/1997) to reduce the impacts of transport in highly burdened areas. It is the task of the SPA to measure the effect of new transport infrastructures on the modal split in these areas. The assessment methodology measures the transport volume shifted from road to more environmentally friendly modes, i.e. rail and inland waterways. A four-stages-transport model is used in order to assess the effects of transport investments. Since the assessment methodology of target II is still on the way, only target I will be discussed more in detail.

4. Target I: Distribution and development

This part of the Spatial Impact Analysis (SPA) was based on a research by Sinz (1981). The Target I targets reflect the 'classic' spatial planning goals in Germany. Its main features regarding transport are:

- *Equal access to transport in all regions of Germany*
  It is one of the main objectives in spatial planning to secure that all citizens have equivalent access to transport wherever they live.
- *Safeguard of adequate access to goods and services.*
  This target reflects the spatial equality of access to essential goods and services. It is the political will to give all citizens equal access to a set of defined goods and services, which can be obtained in 'Central Places'. Transport infrastructures have to secure that all communities have equivalent access to these Central Places.
- *Development of disadvantaged or undeveloped regions*
  This goal is aiming at the reduction of spatial disparities with emphasis on economic development. This is of special relevance fort the regions of East Germany, which belonged to the former GDR and are still underdeveloped compared to the western part of the country. The improvement of transport infrastructures is regarded as a necessary but not sufficient precondition for a development process, which enables these regions to catch up with the rest of the country.

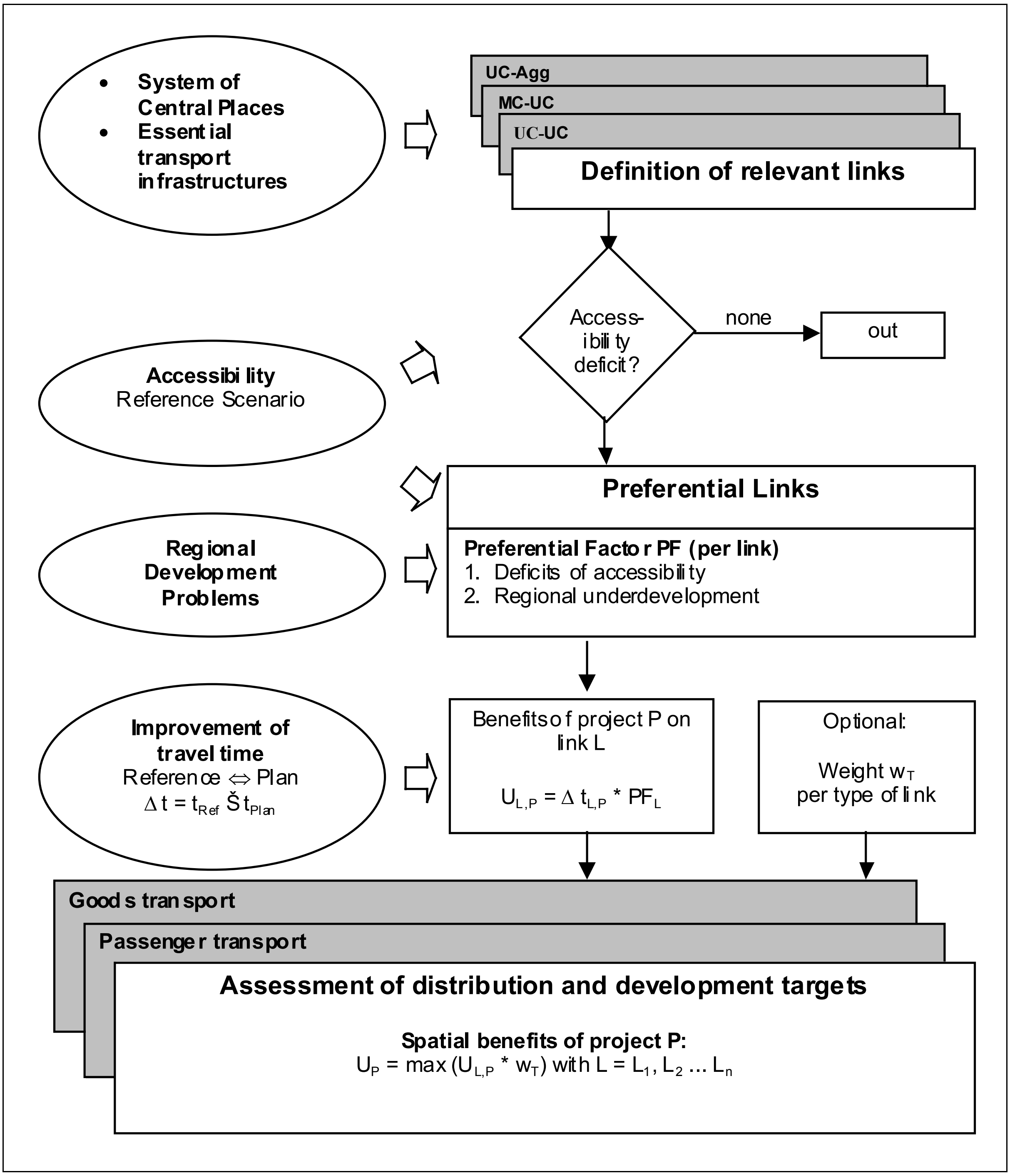
Figure 3 gives an overview on how these targets are transformed into a procedure for the assessment of transport projects:

1. Firstly, links are defined, which are essential in terms of spatial planning. Inputs are the system of Central Places and essential transport infrastructures, such as ports and airports. Amongst the multitude of possible links between these places, only the essential links in terms of spatial planning are selected. Travel time improvements on these links are regarded as beneficial, other improvements are neglected.
2. In a second step, the accessibility for every link in the reference scenario is analysed. Links, which have a relatively good accessibility, are excluded from the procedure. Only if accessibility is below the median of all links of the same type, the connection is regarded as worthwhile to be improved.
3. The remaining links (called Preference Links) are weighted according to
   - the deficits of accessibility (No. 2)
   - the degree of regional underdevelopment

   The result of this procedure is a Preference Factor for all Preference Links
4. The benefits of a project are assessed by measuring its travel time improvements on Preference Links. Improvements are calculated as the travel time difference in the planning scenario compared to the reference scenario. This Δt is weighted with the Preference Factor described above (No 3).
5. In the last step, the benefits for each proposed project are computed. Since one project might induce travel time improvements on several Preference Links, only the link with the largest impact is taken into account.

This procedure is described in further detail in the following sub-chapters.

Figure 3: Procedure for Target I: distribution and development



4.1 Definition of the relevant links

Basis for the definition of relevant links is the system of Central Places (Christaller 1933). The Central Places, defined by state authorities, are given in Table 1.

Table 1: Classification of Central Places in Germany

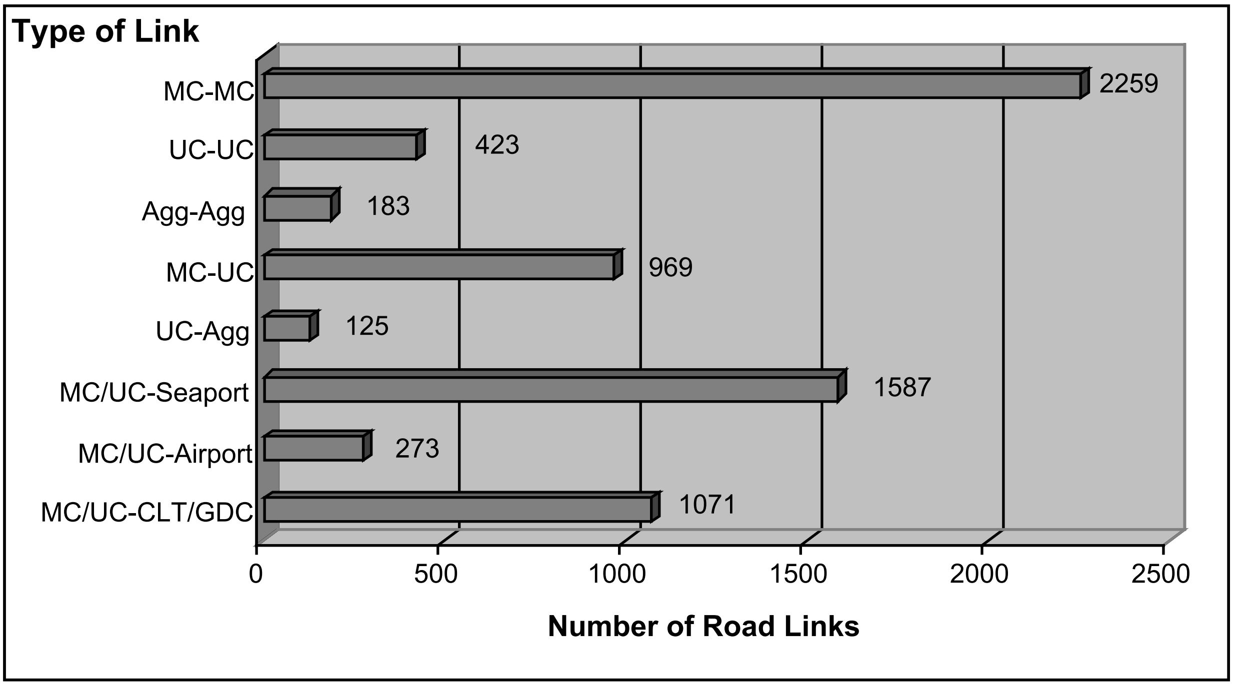
Community		**Number**	**Features, Remarks**
no central function		1468	-
Small Centres		1151	Provision with basic goods and services
Lower Centres		1481	Provision with daily and weekly goods and services
Mean Centres	MC	933	Provision with medium term goods and services
Upper Centres	UC	153	Provision with long term or periodical goods and services
(Agglomerations)	Agg	(12)	not part of the official Central Places hierarchy
Total		**5186**	(no double counting of agglomerations)

Since a national transport plan is to be developed, links with purely local character are disregarded. Therefore, Mean Centres are the lowest level of the locational hierarchy taken into account. However, interlinking all these locations would result in more than a million links and thus make no sense in terms of spatial planning. Therefore, a method is developed in order to define the relevant links. This is done according to three principles:

1. *Safeguard of adequate access to Central Places*
   This refers to the links from a centre to the next centre, which is higher in the locational hierarchy, i.e. Mean Centres to the next Upper Centre (MC-UC) or Upper Centres to the next Agglomeration (UC-Agg).
2. *Support of town networks*
   This refers to links between locations of equal rank in the locational hierarchy, i.e. Mean Centre to the neighbouring Mean Centre (MC-MC); likewise upper centres (UC-UC) and Agglomerations (Agg-Agg).
3. *Safeguard of adequate access to essential transport infrastructures*
   Access from Central Places to airports, to sea- and ferry ports and to rail terminals for combined load transport (CLT) and goods distribution terminals (GDT).

Table 3 lists the type of links that have been chosen for road transport. 6,900 links are included in the analysis, of which 1360 are regarded as links devoted exclusively to transport of goods.

Figure 4: Type of links for road transport



For rail transport, the definition of Preference Links is different, because the network is more wide mashed than the road net and railways develop their system specific advantages on long distance links. Therefore, all links connecting Mean Centres, the lowest level in the roads assessment, are disregarded. The rail passenger links comprise Upper Centres (UC-UC, UC-Agg, UC-Airports) and Agglomerations (Agg-Agg). On top of that, the 12 main economic centres are connected amongst each other in order to represent rail goods transport. Overall, rail links comprise 934 connections, of which 66 are goods transport links.

4.2 Deficits of Accessibility

The quality of access to Central Places is one of the main criteria for the SPA. It is assumed that links, which already have an adequate accessibility, do not need a further improvement. According to the spatial planning principles it is more important, to improve links, which provide low quality access. Therefore, only links, which are worse than the median value are taken into account. Table 2 shows the intervals based on the percentiles of all links of the same type.

Table 2: Quality of access

Deficits of accessibility	Percentiles
very high	worst 10%
high	10% - 25%
moderate	25% - 50%
no deficits	best 50%

The quality of accessibility is measured in terms of travel time or bee-line speed. Travel time can be used for links that give *access to Central Places or transport infrastructures* (principle 1 and 3, page 8). This measurement secures that citizens reach their destination within a given time limit and thereby takes care that the governmental goal to give adequate access to goods and services is secured.

However, this does not apply for the links between equal towns (principle 2, page 8: *town networks*). Since spatial distribution patterns of towns are not equal, a measurement using travel time would distort the analysis. Therefore, the accessibility is measured using the 'bee-line speed', which is defined as follows:

$$v_{bl} = s_{ec} / t_{ref}$$

with v_{bl} = bee-line speed, s_{ec} = euclidean distance, t_{ref} travel time reference scenario. Bee-line speed is low, if big detours have to made or low speeds are dominating. A low bee-line speed is an indicator for high potentials in case of improvements.

Figure 5 gives an example for the bee-line speed on links between Upper Centres in Germany. Very clearly, the quality of accessibility in Easter Germany is worse, than in the remaining parts of the country.

Figure 5: Bee-line speed for UC-UC links

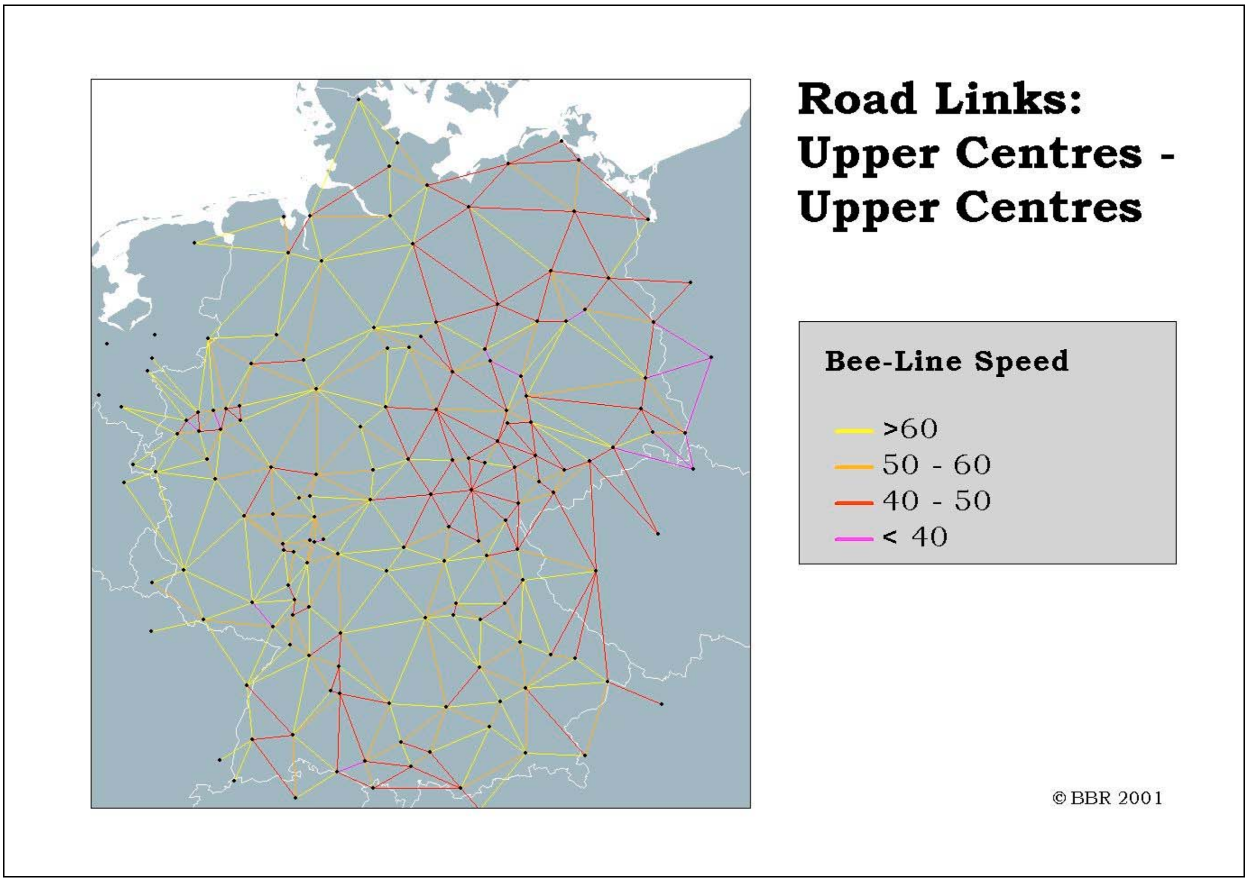


Table 3 shows the class intervals for the definition of accessibility deficits in road transport on all links. An accessibility model, based on the 1998 road network, was used to test the methodology. The boundaries were set according to the percentiles given in Table 2. The travel times and speed listed reflect the rounded values of these percentiles. Clearly visible, speed increases and travel times decreases with augmenting importance in the locational hierarchy.

Table 3: Class intervals for accessibility deficits in road transport 1998

Type of Link	**Deficits of accessibility**			**Unit**
	moderate best 50 - 25%	**high** 25 - 10%	**very high** worst 10%	
Passenger				
Town Networks				
Mean Centres	40-45	35-40	<35	km/h
Upper Centres	50-60	40-50	<40	km/h
Agglomerations	70-80	60-70	<60	km/h
Accessibility				
Mean Centre - Upper Centre	30-40	40-50	>50	min
Upper Centre - Agglomeration	60-90	90-120	>120	min
...				
Goods				
Mean Centre - Port	35-40	35-25	<25	km/h
Mean Centre - CLT/GDC	50-70	70-90	>90	min

4.3 Regional Underdevelopment

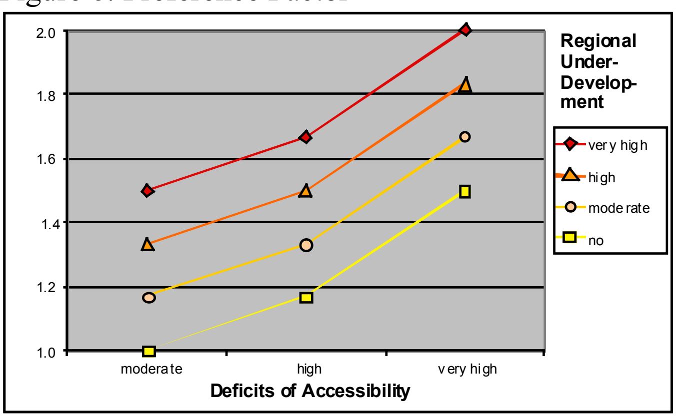
Spatial planning has the task to assess regional disparities and give hints to where further investments are needed. A set of indicators was developed in order to define development problems, which shall not be described but listed in Table 4.

Table 4: Area types for Germany

Underdevelopment	**Type of area**
very strong	Rural areas with very strong development problems
strong	Rural areas with strong development problems
	Densely populated areas with structural development problems
moderate	Rural areas with moderate development problems
no	Densely populated areas without structural development problems
	Mixed urban and rural structures

4.4 Assessment of Target I

Figure 6: Preference Factor

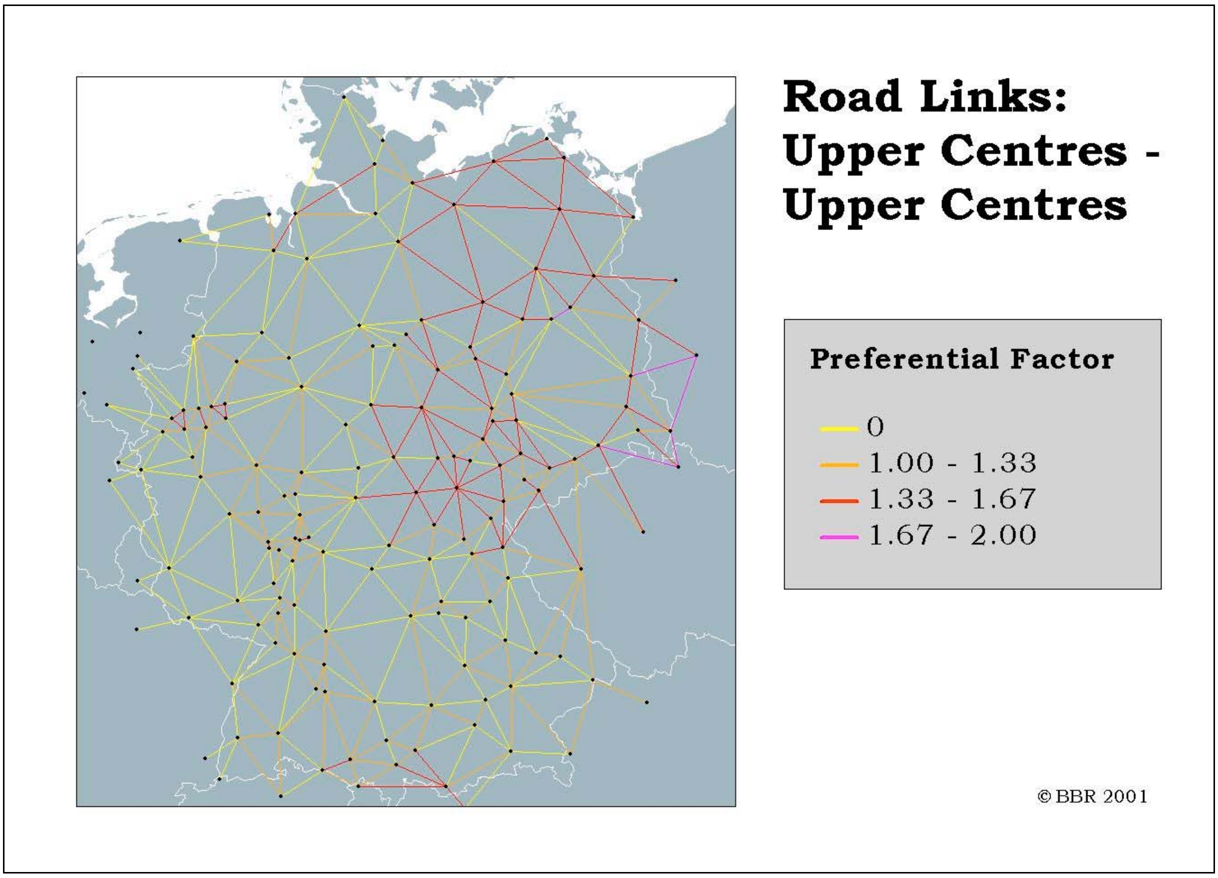


As already mentioned above, the Preference Factor comprises the judgements on the deficits of accessibility and the regional underdevelopment. These two components are combined as depicted in Figure 6. The resulting Preference Factor varies between 1 and 2.

The Preference Factor is attributed to each of the links defined above. Using this method spatial planning priorities can be visualised: The following maps show the Preference Factors for selected types of road links. The maps show, how a travel time improvement on the selected links will be weighted. They depict from the spatial planning perspective where it is worthwhile to plan road investments.

Figure 7 shows the Preference Factor for road links between Upper Centres. The map is similar to the one presented in Figure 5 depicting the quality of accessibility. The differences are due to the additional weight for regional underdevelopment. Regional prosperity is the reason why some links in Southwest Germany have a lower priority than they had, if only accessibility would have been taken into account.

Figure 7: Preference Factor for road UC-UC links



Further examples of the spatial distribution of the Preference Factors are given in
Figure **8** for road links from Mean Centres to the next Upper Centre and in Figure 9 for rail links between agglomerations. The latter maps shows that some East-West connections and many links crossing the Alps are worth improving. It has to be emphasised that the 1998 net-work used to test the methodology. Thus, none of the planned transalpine rail links have been included. Of course, the BVWP planning procedure will include the 2015 network.

Figure 8: Preference Factor for road links between Mean and Upper Centres

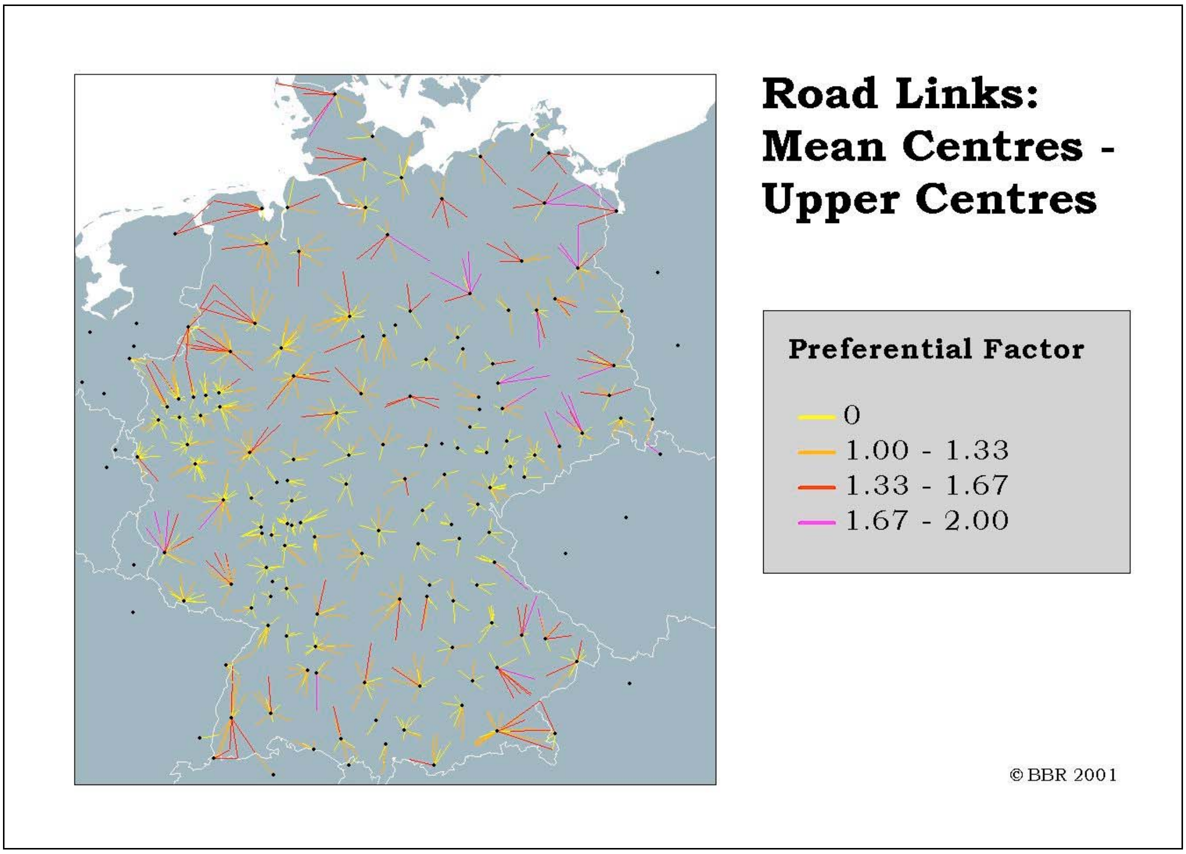
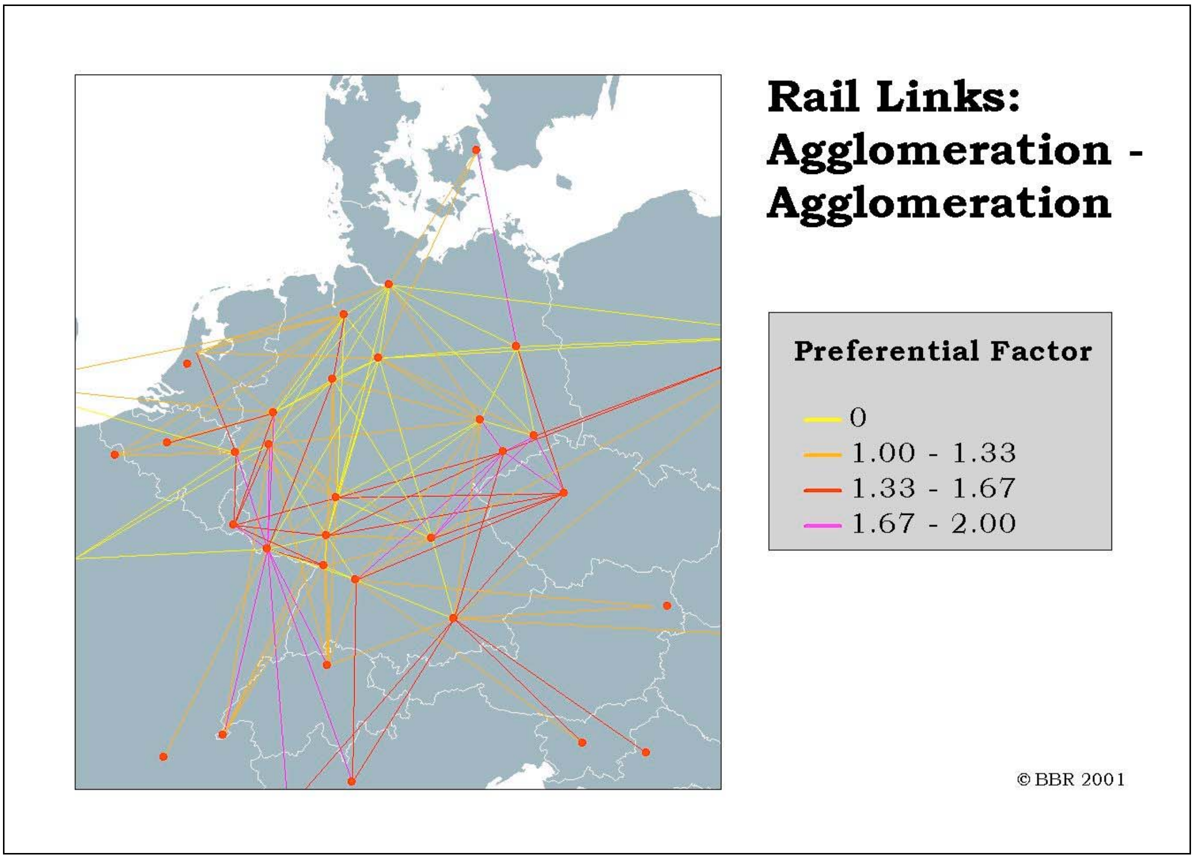


Figure 9: Preference Factor for rail links between Agglomerations



The final assessment of Target I is done in the manner as depicted in Figure 3. Only projects inducing travel time improvements on the defined links are taken into account. Decisive is the improvement of travel time Δt of the planning scenario compared to the reference scenario:

$$\Delta t = t_{Ref} - t_{Plan} \qquad (4.1)$$

The benefit $U_{L,P}$, which a project P induces on link L calculates as follows:

$$U_{L,P} = \Delta t_{L,P} * PF_L \qquad (4.2)$$

with $\Delta t_{L,P}$ = Improvement of travel time on link L induced by project P,
PF_L = Preference Factor for link L

The question raises whether an improvement e.g. on a Mean-Centres-link values as much as on an Upper-Centres-link. Therefore, a weight w_T per type of link is introduced, which reflects the preference of the decision-makers. Until today no political decision on this value has been taken.

Some projects might have effects on several links. The total benefit of project P taking into account all links is assessed as follows:

$$U_P = \max (U_{L,P} * w_T) \text{ ,with } L = L_1, L_2, \ldots L_n \qquad (4.3)$$

If a project induces impacts on several links, only the biggest impact is counted. This is done in order to avoid double countings and due to the methodological problems related to the addition of benefits. However, this pragmatic approach disregards the network effects produced by the improvements. Therefore, it is discussed to add all travel time effects instead.

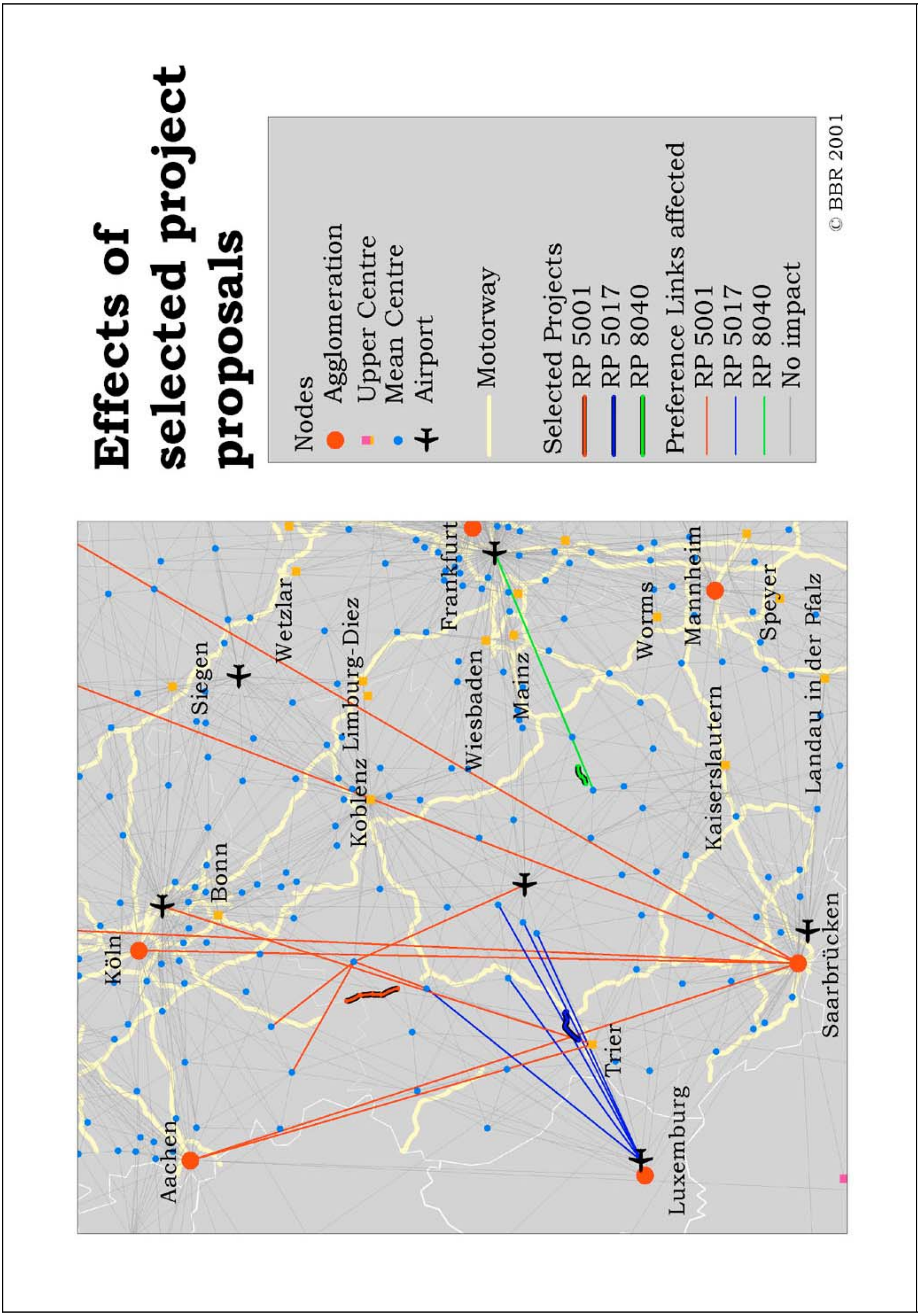


Figure 10: Effects of selected project proposals in

5. Example: Effects of selected project proposals

Three project proposals by the state of Rhineland-Palatinate are used in to assess the effects of road investments using the SPA. Figure 10 shows the projects and the preference links affected. Table 5 lists the effects of these projects on the preference links.

RP5001 fills a 26 km gap in the motorway network in the Eiffel hills. The project improves the travel time on 11 links, of which 5 belong to links between agglomerations. Here the strongest effects can be found. Travel time decreases by maximum 21 minutes. Taking into account the preference factor, the maximum benefits amount to 31 points. RP5017 is a new 10 km motorway by-passing on 4 lanes the town of Trier. This project has impacts on 5 links connecting the airport in Luxembourg with Mean Centres in the Eiffel. Maximum travel time improvements amount to 5 minutes but the spatial planning preferences push this value up to 9 points. RP8040 is a new 2-lane by-pass of a smaller town. Only one preference link to the airport of Frankfurt is affected inducing travel time improvements of one minute. This shows, that smaller by-passes do not have significant effects regarding spatial planning targets. Their benefits must be justified by environmental effects and the reduction of accidents.

Figure 11: Type of links affected

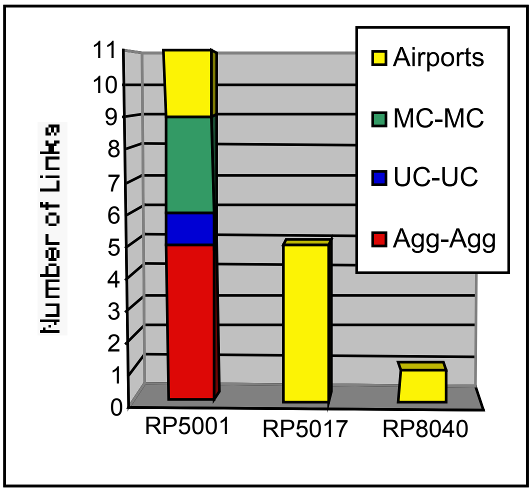


Table 5: SPA impacts in Rhineland-Palatinate

	RP5001	RP5017	RP8040
Road No	A 1	A 64	B41
Project length	26.1	10.0	5.4
Links affected	11	5	1
Travel Time improvements (minutes)			
Min	1	5	1
Max	21	5	1
Sum	143	26	2
Benefits on affected links			
Min	2	8	1
Max	31	9	1
Sum	178	44	1

Einfügen Resultate der 100 Projekte

6. Concluding remarks

More often than not this approach has been criticised for double counting the effects of improved accessibility, already included in the CBA, which is undertaken in parallel. In contrast to the CBA, the SPA only assessing accessibility of selected transport links and is not taking into account the number of vehicles using the improved link. In addition, the SPA only takes into account improvements of links with accessibility deficits and weights them according to spatial planning goals (reduction of spatial disparities). A comparison of SPA results and outcomes of the CBA will only be possible in September 2001.

The procedure is still on the way and a number of problems have not been solved yet. For example the following distortion might occur: Let's assume that the same improvement on a long link (e.g. Agg-Agg) and a short link (e.g. MC-UC) occur and the impacts on travel time

(Δt) are equal. However, the relative effects, measured in percent of the total travel time are much stronger on the short link. Therefore, it is researched if instead of absolute improvements (Δt), relative travel time gains can be used as main factor for the SPA. This would as well reduce the criticism regarding the double counting effects of accessibility.

The procedure has been designed in simple manner, in order to make it easy to understand, taking into account that scientific inaccuracies might occur. However, making the SPA easy to 'sell' to decision makers outweighs the scientific disadvantages. More often than not, political deliberations influenced the design of the SPA. For example, the procedure could as well include negative effects, which occur if induced traffic causes congestion of existing links. However, it is the political will to include mainly positive effects in this stage of the implementation of the new SPA methodology.

The result of this procedure is a selection of relevant projects and their ranking according to spatial planning goals. It has to be made clear that it does not replace a cost benefit analysis. E.g. transport on defined links might be hampered by natural barriers, such as mountains or rivers, that are very costly to overcome. The increased travel time, needed to circumvent these barriers, increases the Preference Factor for the relevant link. A C/B analysis reveals that benefits are far too small to justify the vast expenditures preferred by spatial planning. Therefore, the SPA has to be additional to the C/B analysis, i.e. a project with a B/C ratio below 1 has to be rejected, even if it is preferred by spatial planning. On the other hand, the SPA might change the ranks of projects with high B/C ratios and thereby have its impacts on the prioritisation procedure. The insecurities regarding the methodology have lead to the consequence the that the SPA results will be classified into three or four classes, which give additional information next to the CBA. It is not clear yet how both assessments will be combined.

The new Spatial Planning Assessment is a real step ahead, because up to now spatial planning targets were only included in a very crude manner as a part of the C/B analysis. The new methodology is able to transfer a set of complex spatial planning targets into computable procedures, which assess large numbers of project proposals.

Acknowledgements:

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