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SPATIAL DECISION SUPPORT FOR NEGOTIATION AND CONFLICT RESOLUTION ON ENVIRONMENTAL AND ECONOMIC EFFECTS OF TRANSPORT POLICIES (DTCS).

SUMMARY FINAL REPORT

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I. OBJECTIVES

The evaluation of a transport policy, plan, or infrastructure requires a systematic analysis of the multiple consequences of the development, and of their acceptability for policy makers and stakeholders. In most cases, this analysis has a spatial dimension. This is due to the geographical distribution of the policy effects, and the possibility of drawing different benefit-cost balances depending on the scale at which the policy is evaluated. The mix of multiple policy goals, multiple actors, spatial distribution of policy performances, and uncertainty on the policy effects makes this process problematic. Typical consequences include:

A poor articulation/harmonisation of policy objectives at different spatial levels. For instance, supranational objectives which are not fulfilled at the national level, or local objectives which are not accounted for at a higher policy level, disregarding regional identities and priorities.

An insufficient understanding and ability to predict conflicts between different policy levels (e.g. nations and local authorities, citizens), which complicates the decision process and may interrupt or stop policy development.

A lack in transparency and structure in the policy assessment process, with unclear specifications of the role of factual information, value judgements, and uncertainty in determining the suitability of the policy.
An insufficient understanding of the different perspectives of decision actors, with the result of over (under) estimating critical issues, sensitive aspects, and conflicts.

The goal of the project was to design a methodology which could be used to articulate policy objectives at different spatial levels, to assess and compare policy alternatives, and to support the analysis of spatial conflicts in a transparent way. The project had two operational objectives. The first was to identify a methodological framework and a systematic way of thinking about spatial conflicts. The second was to develop a series of tools, which could support the various stages of policy analysis. In particular, these tools are meant to support:

the exploration, identification, and structuring of the concerns of actors involved in the evaluation of a transport policy at different spatial levels (e.g., national, regional, and local levels). This serves to produce an organised overview of the issues which determine the suitability of a policy at a given scale and location.

The assessment of the consequences of a transport policy and of their attractiveness. This serves to identify the most probable policy impacts and to establish the degree to which they may be an attractive or unattractive outcome at various spatial levels.

The sensitivity of this analysis to various types of uncertainties and information gaps. This serves to understand if the results obtained are robust and reliable.

The identification of conflicts and the analysis of their cause. This is meant to identify between which spatial levels conflicts occur, which policy measures trigger conflicts, and which components of a policy measure cause the strongest conflicts. This also serves to improve the search for solutions which may improve the attractiveness of a policy.

The project has demonstrated the applicability and relevance of the methodology and of the tools in four real situations. Based on these applications, the project produced recommendations and practical advise, the dissemination of which will continue in the future.

II. METHODOLOGY

BOX 1: The four case studies

- The ***Channel Tunnel*** rail link in the UK: assessment of alternative station locations and route options for the London-Channel Tunnel high-speed railway.
- The ***Betuweroute*** in the Netherlands: assessment of the pros-and-cons of the freight railway at the national, regional and local levels.
- The road network in the ***Lisbon*** metropolitan area: analysis of the attractiveness of road investment packages for the region and its municipalities.
- The public bus network in ***Lombardy*** (Italy): suitability of spatial zoning for increasing public-transport efficiency for the region and the provinces.

The methodology was the result of empirical analysis, fundamental research and tests in real cases. The empirical analysis included the critical assessment of transport policies in Europe and the four states involved in DTCS (Italy, Netherlands, Portugal and United Kingdom). It focused on the relationship between transport, environment and spatial planning. The issues which emerged from this review were investigated in more detail in four case studies (Box 1), representative of situations in which spatial conflicts were critical policy issues.

This analysis focused on the decision process and on the role of the spatial actors involved in the policy assessment. In all cases, multiple points of view were considered (e.g., policy effects on the transport sector, economic and environmental impacts), together with the interests of multiple actors (e.g., administrations and NGOs) at different spatial levels (e.g., national, regional and local levels).
The case studies served for three distinct purposes. They were first used to identify the needs of policy analysis and to streamline a way of thinking about spatial conflicts. During the project, they served to test the applicability of the tools developed to support policy and conflict analyses. At the end of the project, the cases were used to systematically test the methodology and demonstrate its usefulness.

III. METHODOLOGY

The term policy was used in a broad sense to include general indications for action (e.g., to shift transport from road to rail, or to decongest urban areas); plans and programmes (e.g., upgrade schemes for road and rail networks, managemenet of the level of service); and individual policy measures (e.g., a railway project). The framework applies to all these levels, but the case studies were limited to programmes, plans and projects. The *methodological framework* is built around three fundamental policy issues:

- The analysis of the attractiveness of a policy with respect to the policy goals and concerns;
- The assessment of the policy consequences at multiple spatial levels;
- The identification of spatial conflicts, and the analysis of their causes and intensity.

MultiCriteria Analysis (MCA) constituted the basis to address these issues. MCA has evolved from a mechanism to rank alternatives, to a structured approach to organise factual information, value judgement, and to argue logically about the pros-and-cons of policy solutions (Box 2).

The link between space and MCA is made through the concept of policy unit. A unit is an area, administrative or other, associated to a distinctive evaluation perspective. Units are found at various spatial scales, for instance: national government, regional authorities, municipalities, local communities. They can also be defined in terms of functional borders (e.g., a river basin, a transport corridor) or special area features (e.g., a protected area).

BOX 2: Multicriteria analysis

Multicriteria analysis (MCA) is a branch of management science. The essence of MCA lies in structuring management and planning decisions in terms of a number of relatively precise but generally conflicting criteria. Multicriteria methods are used in two basic contexts. In the first, a decision maker seeks to make a decision which does not seriously impact, or require justification to, other actors. In this case methods can be relatively informal, and the rationale for the decision does not need substantial justification. This contrast with contexts in which an individual or group has to make a decision on behalf of a larger group or community. In this case, the rationale for the choice must be documented and consideration of each interest or point of view must be demonstrated. This requirement necessitates the use of more formal methods of analysis, even when they may be less efficient and/or may impose structures (of preference, for example) which may not be strictly justifiable empirically. There are various multicriteria techniques available, which usually evolve around the following common activities: ***structure*** **(**establish goals and concerns for the problem, select criteria for the evaluation, and predict the performances of policy alternatives); ***value analysis*** (study the attractiveness of individual impacts and the relative importance of the criteria for the actors involved), ***recomendation for the decision*** (depending on the way the problem is structured, this requires some type of aggregation, leading to a ranking of the alternatives, or the isolation of one or more promising solutions).

Due to scale and location factors, units usually employ different evaluation perspectives, making the same policy attractive for some units and unattractive for others. There is a variety of reasons for these differences, which can be brought down to four main factors: value system factors (actors disagree on goals and concerns; they employ different criteria and/or have different priorities); impact distribution factors (the spatial distribution of policy effects is, or is perceived to be, unjust); uncertainty factors (uncertainty on the policy effects, disagreement on the likely outcomes, insufficient understanding of synergies with other policies, hesitation about preferences and values) and process factors (actors have difficulties in communicating with each others, or are unsatisfied with their role and influence in the decision process).
Because of these factors, different units may prefer different courses of action, which indicates the existence of a conflict. By applying MCA at the level of policy units it is possible to analyse the causes of (spatial) conflicts and how they relate to value system, impact distribution and uncertainty factors. The origin, causes and

intensity of conflicts can be investigated, and information can be supplied to the negotiation and conflict management process. The interpretation of this information, and the implications for negotiation, depend on the type of setting used for policy assessment. Most practical applications correspond to one, or a combination of, the three settings described in Box 3.

BOX 3: General settings for conflict analysis

Individual Structuring - Individual Evaluation (IS-IE)	***Group Structuring - Individual Evaluation (GS-IE)***	***Group Structuring - Group Evaluation (GS-GE)***
Applies when units employ totally different perspectives to evaluate the same policy. Differences may regard any aspect, and even fundamental issues such as the policy goals. Conflicts may emerge due to a variety of reasons such as different policy priorities or unfair impact distribution.	Applies when units agree on how to assess the policy. This implies a basic agreement on what a policy should be meant for and what goals it should pursue. However, the units may disagree on the relative importance of different aspects and may be affected by different impacts, leading to conflicts.	Applies when units share the same evaluation perspective. This implies an agreement on the policy goals and on the relative importance of different factors. Conflicts may emerge only due to the impact distribution, which determines a different balance of benefits and costs for the various units causing conflicts.

Information on type and intensity of conflicts is provided by a set of conflict indices (see Box 4). They identify the units between which conflicts are stronger, and the differences between units which are at the basis of conflicts. The indices can be used to detect the critical conflict factors, which can be the spatial distribution of costs and benefits, differences in the fundamental objectives and concerns of the units, difference in the relative importance of these concerns etc. This evidence can be used either to inform and support the negotiation process, or to drive the search for alternative policy measures, which decrease conflicts and are better suitable to respond to the interests of actors involved.

BOX 4: Some examples of conflict indices. Each index identifies and measures the intensity of a specific type of conflict

Index of rank reversal: measures the number of rank reversals between the rankings of two units. There is no conflict only when units share the same ranking of the policy options.	***Index of unattractiveness***: for each unit, it measures how unattractive is the preferred option of another unit. There is no conflict only when the best option for a unit is at least attractive for the others (though not best).	***Index of maximum loss***: for each unit, measures the sacrifices which would be necessary to accept the best option for another unit.

Inside the methodology: the *toolbox*

The tools composing the DTCS toolbox can be organised into three main classes of instruments: tools for structuring, for analysis of attractiveness, and for conflict analysis (Table 1).

Structuring means: to explore and identify the objectives/concerns of a policy unit, and to organise them into a value tree which specifies areas of concern for a unit (e.g., social effects of the policy, environmental impacts), individual concerns (e.g., accessibility and noise) and the criteria selected by the unit to measure the impacts of interest (e.g. number of houses exposed to high noise levels). The value tree and the criteria may be the same for all units, or be partly or completely different for different units. The tools for structuring include various forms of interview techniques, which lead to qualitative problem representation, such as mind-maps, cognitive maps, or rich-picture diagrams.

Impact analysis serves to predict, as accurately as possible, the consequences of a policy for a unit. The results are summarised in an impact table, where impacts can be expressed in cardinal, ordinal, verbal, descriptive or even pictorial terms. In the DTCS approach, the impacts of a policy cannot be defined in isolation from the interests and expectations of the units involved. Since the value tree of the units may be different, there may be several impact tables, each one associated to one or more units. Geographical Information Systems (GIS) are often used for impact assessment due to the large information demands which are necessary to perform impact calculations for multiple units at multiple spatial scales and locations.

Impact analysis results into an impact profile associated with each policy option for each policy unit. However, this information does not state if the policy consequences are attractive or unattractive. Questions such as "*Does an increase in accessibility of 10% justify the costs of the policy?*", or "*Is a land take of 500 ha acceptable?*", require additional inputs from the policy actors. These inputs are embedded in value functions. They apply to single criteria and translate impacts into attractiveness scores. Value functions are usually the result of interviews with policy actors or sector experts. Specific interview schemes have been designed to simplify the task of the respondents and allow for qualitative and imprecise estimates.

The overall attractiveness of a policy depends on these values and on the weight associated with individual objectives/concerns. The assessment of weights is one of the characteristic activities of MCA: it is also one of the most critical stages. Weights are intrinsically subjective and are meant to represent the decision strategy of a policy unit. The assessment of weights requires interviews with policy actors, for which specific interview protocols have been developed. Through a weighted scheme, an overall value score can be associated to a policy option, reflecting its overall attractiveness (for a policy unit).

Policy estimates may be affected by substantial prediction and measurement errors. In addition, people may hesitate about their preferences and priorities. These uncertainties imply that the conclusions of the analysis may be weak and require careful use. Sensitivity and robustness analysis serve to test the credibility and stability of the results when uncertainty and information gaps are present. Several tools can be used for this purpose: simulation, statistical analytical or tailor-made methods optimised for specific types of uncertainty.

Conflicts between units correspond to disagreements on the preferred course of action. They may depend on the distribution of costs and benefits of the plan, but they may also depend on different objectives, specific evaluation criteria and individual weights employed by the units. Conflict analysis is based on conflict indices. Each index applies to a different situation and highlights a particular dimension of conflicts. For instance, ordinal conflict analysis applies to ordinal rankings, and measures the disagreement between units as concerns their rankings of policy options. Cardinal conflict analysis may be used to measure the intensity of conflicts between units. Also, indices have been developed to assess conflicts between pairs of units, or between one unit against all others.

Table 1. Policy question, methodology and tools

Policy question	***Methodological phases***	***Support tools***
STRUCTURING and IMPACT ASSESSMENT		
Who are the policy actors and what are the spatial levels for evaluation?	Identification of policy units and their spatial relation.	Institutional analysis, stakeholder analysis and territorial analysis.
What are the goals and concerns of the actors and what criteria do they use to assess policy options?	Problem structuring and construction of a value tree.	Structuring tools, such as cognitive maps, mind maps, rich-picture diagrams.
What impacts are relevant for the units to substantiate their position?	Impact analysis; isolation of impacts for each policy unit.	Impact prediction models. Impact scales for ordinal, cardinal, verbal, descriptive, pictorial impacts.
ANALYSIS of ATTRACTIVENESS		
Are the individual impacts attractive or unattractive?	Analysis of attractiveness based on value functions.	Interview technique to assess value functions
What is the relative importance of different concerns?	Analysis of trade-offs and of weights of different concerns.	Interview technique to assess weights.
What option is more attractive in global terms?	Aggregation of impacts based on attractiveness and importance.	Additive aggregation rule.
Are the results credible?	Sensitivity analysis to test robustness of results.	Methods for sensitivity of impacts, value judgements and policy priorities
ANALYSIS of CONFLICTS		
Are there conflicts between the different units?	Identification of differences between the results of different units.	Conflict indices to identify causes and intensity of conflicts, and the policy options which generate conflicts
What are the causes of conflicts and which measures could be investigated to reduce conflicts?	Feedback analysis.	Methods to identify critical conflict factors (impacts, priorities, etc.) and changes in the policy measures to reduce conflicts.

GENERAL CONSIDERATIONS

The methodology requires a close interaction with the actors in the units. This interaction can take on different forms, such as meetings, workshops, interviews, questionnaires. It is an implicit assumption that actors can participate in the decision process, that their interests are considered, and that there is a positive engagement of actors in the search for an acceptable solution.

There is a wide set of instruments which can be used to support policy assessment and conflict analysis, from simple qualitative guidelines to sophisticated quantitative models. The complexity and diversity of real situations is such that there would be no point in specifying a single best instrument for decision aid. Flexibility and adaptability to the specific contexts are required to be able to provide the type of support which is most appropriate in each situation. The tools developed for structuring, impact analysis, policy assessment, and

conflict analysis are components of a toolbox of instruments, which need to be combined in ways which strongly depend on the necessity of individual applications.

RESULTS

Policy framework

Four themes can be used to organise the transport debate in Europe: mobility, competitiveness, cohesion, and sustainability. The analysis of the transport policies in Europe and in the four countries involved in DTCS (Italy, Netherlands, Portugal, United Kingdom) has shown that achieving objective levels in all themes simultaneously may prove more difficult than traditionally assumed. The key concerns relate to the degree of synergy between mobility and economic growth as primary objectives of policy, and to the distribution of policy effects between different groups, different regions and the environment. The analysis of the case studies in DTCS shows that the assumption of a policy making role by one level of policy making may impose serious costs leading to conflict on both higher and lower level. In addition, the articulation of policy at higher levels needs to be clear and precise to avoid misinterpretation at lower levels. The articulation of policy at the EU level, for instance, is frequently too imprecise to be correctly interpreted by lower levels. This arises, for example, where a Trans-European Network (TEN) is planned. This produces a clear expectation of an EU level of interest, but the EU is not capable of expressing it clearly, in a way which can be interpreted and evaluated by other policy units or stakeholders. A better articulation of policy objectives and a better integration of concerns at different policy levels is thus necessary to achieve a suitable balance between mobility, competitiveness, cohesion, and sustainability.

Structuring

An insufficient articulation of policy objectives and concerns, and an unclear link between policy consequences and policy objectives, emerged in the two case studies for which an ex-post evaluation was made. The exchange of information and views with policy makers and transport experts, in all four case studies, confirmed that there is substantial confusion on the interpretation and use of even fundamental concepts, such as *policy objective* or *evaluation criteria*. Establishing a clear language for the assessment was therefore a basic requirement for the methodology. After long discussions, it was decided to recommend the use of the terms *concern* and *impact descriptors*. The main reason for preferring less common terms than those proposed in the literature (objectives and criteria, in particular) is that they are rather neutral, and can be precisely defined without introducing semantic distortions and confusion with the normal use of the terms in daily language.

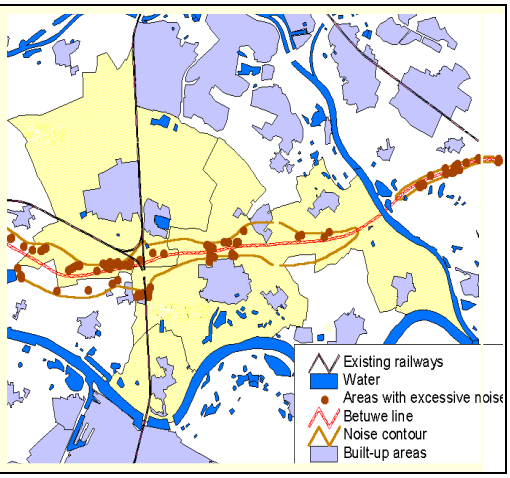
The concerns of a policy unit include the objectives of the policy (the reasons why there is interest in a policy action, such as "*to remove constraints to economic growth"*) and the preoccupation for the adverse effects that the policy actions may have (such as "*to minimise the noise disturbance*"). Concerns cannot be strictly justified empirically, as they stem from the actors' value system. However, they should respect some fundamental properties to be useful for the analysis, such as independence and absence of double counting. Concerns are made operational by introducing the *impact descriptors*. For instance, the concern "*to minimise the disturbance to residents"* could be associated with the impact descriptor *"number of houses exposed to high noise levels"*, which is the quantity that is measured to assess the policy performances. A policy measure is thus described by a list of impacts on the descriptors. Descriptors can be quantitative, verbal, continuous, discrete, and even pictorial. Also, there may be several suitable descriptors for an individual concern. The choice depends on the degree to which a descriptor is able to clarify and communicate as unanbiguously as possible the implications of policy actions, with respect to a given concern.

The identification of concerns and the selection of descriptors is an interactive process which can be supported by various techniques (such as cognitive maps, mind maps, rich-picture diagrams, etc.). Instead of focusing on the technicalities of these methods, the DTCS project has focused on the logic behind this process, providing recommendations on how to correctly select and interpret concerns and descriptors. Also the broad set of modelling and measurement techniques used to predict the policy consequences, the *impact assessment* techniques, have not be addressed in the project. It was clear that impact estimates, albeit affected by substantial errors, were not a bottleneck in the case studies. Carefully structuring the decision problem appeared to be more a crucial factor, and a substantial input to policy evaluation could be provided even based on approximate impacts. An example of impact assessment for a case study is shown in Box 5.

BOX 5: Impact analysis for the Betuweroute.

☞ The impacts of the Betuweroute have been computed with a GIS. Noise contours, for instance, have been estimated taking into account the noise produced by the trains and the effects of mitigation measures, such as noise screens. The number of houses exposed to levels higher than 57 dB(A) was used as a descriptor for the concern "noise disturbance to residential areas".

	Unit a	Unit b
Demolition	17	15
Noise	34	28
Accidents	5.4	8
Visual impacts	0	8
Landscape struct.	2	3
Nature	0	0
Agriculture	80	69
Economic impact	0	0

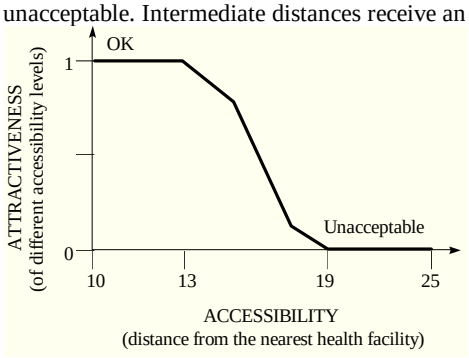


Assessing the attractiveness of a policy: value functions and weights

The attractiveness of a policy measure, for a policy actor, depends on the policy impacts and on subjective judgements. Subjective judgements affect the attractiveness of individual impacts, and the relative importance of the concerns. Value functions are used for the former.

BOX 6: Value function for accessibility in the Lombardy case.

Accessibility of social facilities (such as hospitals) needs to be guaranteed by the public bus service of Lombardy. The province of Mantova considers 13 km as an acceptable distance to the nearest facility, while more than 19 km become unacceptable. Intermediate distances receive an intermediate rating.



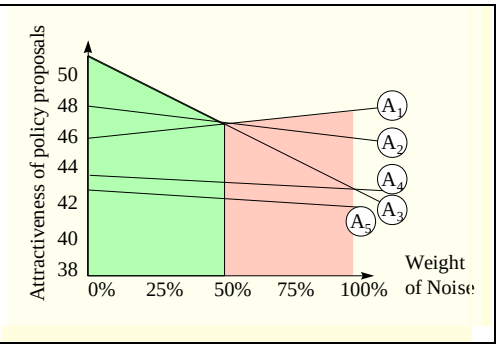
A value function translates an impact level into an attractiveness values, which states the degree to which the policy meets a concern (c.f. Box 6). This may be a demanding and complex task. DTCS uses a technique (called MACBETH) which extracts value functions from qualitative, verbal judgements. The technique is based on a interview protocol: with the support of software, the user is shown a series of impact levels and is asked to judge their attractiveness in plain language. By requiring more judgements than strictly necessary, and by judging the same impacts from different angles, it is possible to assess value functions based on qualitative, imprecise responses, which are tested for internal coherency. This approach proved useful and relatively easy to apply.

Further insight can be gained by weighting the concerns and providing a more aggregated picture of the policy performances. Weights are assessed and used, implicitly or explicitly, every time the assessment of a transport policy depends on the combination of several impacts. However, it clearly appeared that the practice of weight assessment is very poor. The concept of weights is frequently misused and misunderstood. The most critical mistake is the use of weights in isolation of the range of impacts of a policy and of the method used to aggregate impacts. This may result in weights which do not represent policy priorities and which cannot be used to aggregate impacts. This often increases confusion, instead of increasing insights. For this reason, the DTCS project has made a substantial effort to provide clear definitions of weights and clear guidelines for their interpretation. A variation of the MACBETH technique is proposed for the weight assessment. Similar to the procedure for value functions, the weight assessment is based on qualitative verbal responses. These are checked for internal coherency and used to extract a set of weights representing the decision strategy of the respondents. In DTCS, the overall attractiveness of a policy is the result of a weighted combination of individual attractiveness scores.

The results of an analytical model to assess the attractiveness of a policy are sensitive to various types of uncertainty, such as errors on impact predictions, uncertain value functions and uncertain weights. To test the robustness of the outcomes, the DTCS project has developed a series of sensitivity tests, which check the credibility of the results against imprecise impact estimates; uncertainty on the attractiveness of a given impact (value functions); and uncertainty and hesitation about the relative importance of different concerns (weights). An example of sensitivity analysis is shown in Box 7.

BOX 7: Weight sensitivity for the Lisbon case.

In the Lisbon case, the quality of the road network would be substantially improved by implementing the road links in the policy proposal called A3. However, this proposal would generate a high noise pollution in some areas. If the weight of noise is less that the total weight of all other concerns, then A3 is the best balance between transport improvements and environmental concerns. If the concern for noise increases above that level, then the proposal called A1 should be preferred. This option is less effective than A3 in transport terms, but the area affected by noise is much smaller.



Conflict analysis and feedback.

The term conflict, as used in daily language, may be associated to a wide range of types of disagreements between two or more decision actors. The term conflict in the project has been associated to a disagreement on the desired outcome of the decision. Two actors (or two units) may prefer different policy solutions for a variety of reasons (e.g., they have different concerns, they are affected by different impacts, they employ different weights, and so forth). However, differences on each of these factors individually do not necessarily lead to conflicts, should the preferred course of action be the same in spite of the differences. This approach to conflict analysis highlights disagreements on the policy solution, and not on, for instance, the policy objectives or priorities.

The various conflicts which emerged in the case studies could be classified in terms of conflict type (relative and absolute) and decision scope, which is the desired outcome of the decision (e.g., the choice of the best alternative, the choice of an attractive alternative although not the best, the ranking of the alternatives).

A conflict can be analysed by means of one or more conflicts indices. Conflict indices are developed for pair of units (to check if there is a conflict, and the intensity of the conflict); for the whole group of units (which units conflict more with the others) and for policy alternatives (which policy alternative causes which type of conflict). Several conflict indices can be used. The project focused on eight examples, which cover relative and absolute conflicts for the three decision scopes considered.

Conflict indices serve to identify which impacts of the policy, which differences in concerns, descriptors, value functions and weights cause conflicts. At present, there is no automatic procedure to perform this analysis. The DTCS project has focused on general guidelines for using the information provided by different indices. A typical result of this analysis is the identification of mitigation or compensations measures, or the indication of where to focus the design of new policies which could diminish a particular type of conflict. An example is given in Box 8.

BOX 8: Use of conflict indices to support conflict resolution in the Lisbon case.

Four packages of roads were considered for improving the road system of the Lisbon region. After a first analysis, one package seemed very promising. It combined good accessibility improvements in the region with limited environmental effects and few planning constraints. However, this package was very unattractive for two municipalities (out of eighteen). Five other municipalities considered the plan positive, but little better than the status-quo. This implied a conflict between a minority of the municipalities, the region and the remaining municipalities. Conflict indices pointed out the weak points of the proposal and measured the extent of the changes needed to improve the plan and reduce conflicts. This led to the identification of a new road package, in which some road links were replaced while respecting engineering and transportation constraints. The new package retained most benefits of the previous one, but significantly decreased the local costs. It represented a suitable solution to the conflict.

Example and software prototype

An example has been developed to illustrate all components of the DTCS methodology in a simplified setting. The example is self-contained and serves to explain in simple terms the usefulness and implications of the

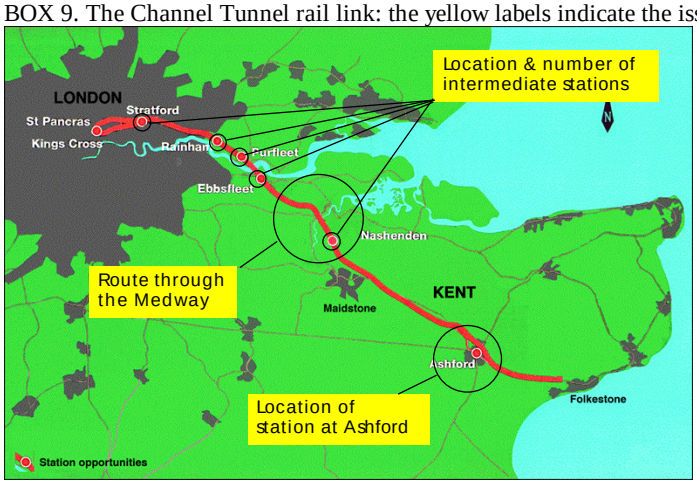
DTCS methodology. The DTCS methodology has also been implemented in a (prototype) software developed on a spreadsheet platform. The software supports all parts of DTCS and, for each component of the methodology, offers at least one option to carry out the analysis. The software can be linked to a GIS, so that spatial analysis and decision analysis can be integrated.

Case studies

The four cases include two TEN projects (the Channel Tunnel rail link in England, and the Betuweroute in the Netherlands); the reorganisation of the public bus network in Lombardy (Italy) and the re-organisation of the road system in the Lisbon metropolitan area (Portugal). The cases cover ex-ante and ex-post assessments; railway and road schemes; provision of infrastructure and management of service.

British case study. The Channel Tunnel rail link case focuses on the location of the Station in Ashford, the route through the Medway section (a natural area) and the number and location of intermediate stations (Box 9). The balance between business and economic concerns (e.g., economic generation capacity, penalty to international travellers), quality of life (e.g., traffic, noise) and ecological impacts proved difficult to achieve resulting into conflicts in the vertical sense (e.g., the national vs. the local level for the location of the Ashford station) and horizontal sense (e.g., between regions for the location of intermediate stations).

BOX 9. The Channel Tunnel rail link: the yellow labels indicate the issues studied in the case.

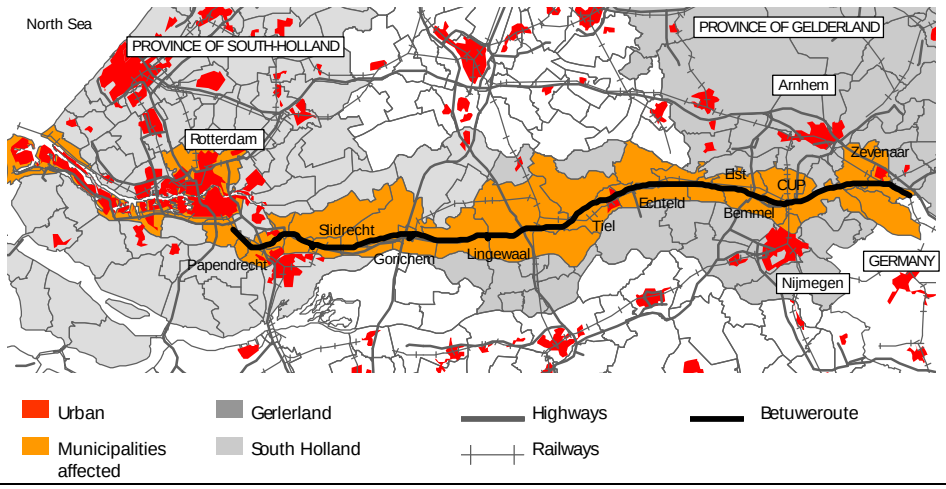


For the crossing of the Medway section, the DTCS methodology justifies the choice of the short-tunnel option, which represents a compromise between the national and regional authorities on economic and environmental concerns. For the Ashford route, the conflicts between the national unit and the regional/local units could be distilled down to a trade-off between economic regeneration capacity and costs. The application of the DTCS methodology justifies the choice of the least conflicting solution. For the location and number of intermediate stations, the methodology was applied ex-ante. It highlighted the difficulty to find a solution suitable for the national level (concerned with the quality of domestic and international connections) and the regional levels (interested in the economic regeneration effect of a station). The only way to find a station option, which is agreeable to the national and regional units, is by increasing environmental mitigation or economic compensation.

Dutch case study. The Betuweroute case focuses on the position of national, regional and local actors as concerns the final route of the railway (Box 10). The spatial distribution of benefits (which peak in Rotterdam) and costs (distributed across the whole corridor) was a main cause of conflicts. The case study first analysed the reactions of provinces, municipalities, citizens and stakeholders presented to the national authorities when the project was completed (more than 5000 documents).

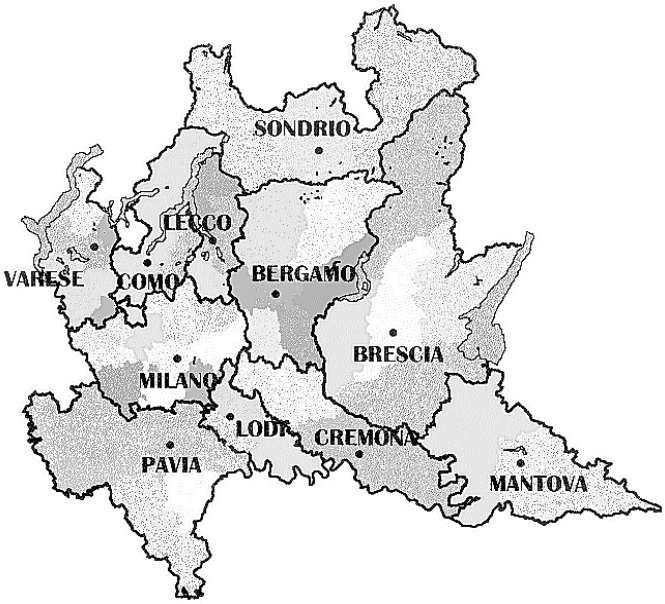
Box 10.

The Betuweroute corridor and the regional and local policy units involved in the case study.



Aside from the predictable correlation between complaints and impacts, the large share of procedural remarks (25%) indicates that local levels are clearly concerned about their participation in the strategic decisions. The analysis was also able to demonstrate that top-down decisions complemented by public participation may be inefficient, ineffective, and trigger strategic behaviours which undermine the usefulness of participation. The DTCS methodology was then applied ex-post, to analyse the perspective of the regional and local units from a different angle, and requiring their direct involvement in the assessment of the plan. For the units analysed (Province of Gelderland and its municipalities), the plan was unattractive, underlying a conflict with the national authorities. However, systematic differences in the positions of units could be identified. They were the consequence of impact distribution, but also of different concerns and weights employed by the units. Mitigation of noise and landscape effects emerged as the most effective strategy to reduce conflicts. However, only radical re-designs, such as the tunnelling of the whole railway, could change the position of regional and local units from opposition to neutrality. An alternative approach, based on the combination of the Betuweroute and other regional plans which produce regional benefits, emerged as a possible strategy to remove the deadlock produced by the conflict between national, regional and local authorities.

Box 11. The Lombardy case study. The map shows the final zoning solution adopted by regional and provincial authorities (51 areas).

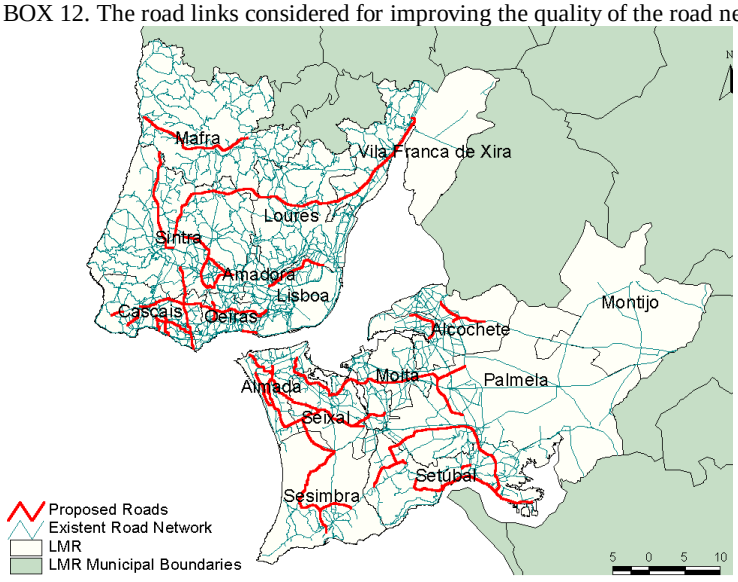


Italian case study. The zoning of Lombardy (Italy) requires the division of Lombardy into areas which are homogenous in terms of transport demand (Box 11). This process was part of the whole reorganisation of the bus service in the region. Within each area of a zoning solution, licences to operate the public bus network will be allocated through public tenders. This system is meant to increase the competition between bus operators, to increase the efficiency of the Lombardy bus network, and to decrease the amount of regional subsidies to bus

companies. The most suitable zoning solution was negotiated between regions and provinces, taking into account the national guidelines, and the interests of large urban areas, bus companies and trade unions. Conflicts emerged between the region (which prefers small areas to maximise competition and minimise subsidies), the provinces (which prefer large areas to minimise changes in the service level), and bus companies (large companies prefer large areas to keep their leadership; small companies prefer small areas to prevent being excluded from the tenders). The DTCS methodology was applied ex-ante, to support all stages of assessment, evaluation and negotiation. A large number of alternative zoning options was generated based on spatial transport demands. Each option was evaluated taking into account multiple concerns (such as accessibility levels in each area; and suitability of the zoning to generate competition between bus companies). The methodology was also applied to compare different zonings and to generate new solutions which could decrease conflicts. The approach guaranteed transparency, and the possibility of handling large amounts of information in a clear and rational way. It also provided information to support all stages of the negotiation between provinces and the region, which eventually agreed upon a final zoning (51 areas).

Portuguese case study. The reorganisation of the road network in the Lisbon Metropolitan Region involves the allocation of investments to packages of road links, which are meant to increase the quality of the regional road network and to decrease congestion (Box 12). The whole set of road links proposed would require a budget twice as high as the one currently available. The choice of which sub-set to implement requires the balancing of budget constraints, improvements in the regional transport system, economic benefits and environmental impacts. Since the costs and benefits of each package are not uniformly distributed across the 18 municipalities which compose the region, the spatial distribution of impacts has also to be taken into account. The DTCS methodology was applied ex-ante, to structure the perspective of the regional and municipal administrations. Impacts were estimated on a GIS platform. One of the four packages which was first evaluated emerged as a promising solution, attractive for the region and for ten municipalities. However, this package raised conflicts with the other municipalities, for instance due to high environmental impacts and limited economic effects. Conflict indices suggested the generation of two additional options which could potentially diminish conflicts. One of the new packages was then selected. This package was able to satisfy regional and local actors to a large extent, and to diminish the conflicts between regional and local authorities.

BOX 12. The road links considered for improving the quality of the road network in the Lisbon Metropolitan area.



Recommendations

Based on the results of the case studies and of the feedback received from the policy makers, the following general recommendations can be made.

A careful articulation of goals and concerns at various policy levels is a condition for the assessment of a policy measure which affects various spatial scales and locations. The project team found that in practice the articulation of policy goals and concerns is either implicit, poorly documented or simply neglected. Although it may be unrealistic to expect policy actors to be candid about their preferences, it is nevertheless necessary to articulate at least the fundamental goals and concerns of a policy. Without this basis, it becomes extremely difficult to investigate the pros-and-cons of a policy, and to facilitate any constructive debate between actors.

However, thinking in terms of fundamental goals and concerns did not seem to be the normal way of thinking of the majority of policy makers. Some experimented with this approach during the project, and most appreciated the advantages of this proposal.

The experience in the case studies suggests that participation, to be effective, should not be limited to certain stages of the decision process, or to specific decision issues. These limitations may undermine the value of participation, cancel its potential benefits, and even favour conflict escalation. The case studies explored the role of multiple actors involved in each case on the basis of different participation schemes. A wide spectrum of types of organised participation emerged from the analysis of the cases. The two extremes are the Portuguese and the Dutch case studies. In the Portuguese case a collective body including representatives of all policy units was involved in all stages of the assessment. This is an example of open participation based on a permanent negotiation forum, which affects the whole decision process. This arrangement was suitable for structuring, assessment and evaluation of policy effects at various scales and locations. In the Dutch case, local administration and citizens were only involved after the strategic decisions were made. The Dutch case is an example of strictly organised participation, in which the main actors (the national level) allocate participation rights to other actors (provinces, municipalities, citizens), who have a given scope of influence, which can be used at specific stages of the decision process. Although the pool of participants was very broad (every citizen could express its view), the procedural restrictions made this process ineffective and limited its usefulness to the choice of mitigations and compensations. This procedural arrangement was inadequate to include the views and opinions of a wide spectrum of actors, and increased conflicts and opposition instead of favouring cooperation. Together with the experiences in the other case studies, this seems to suggest that co-decision processes can deploy their benefits only when systematically adopted, while only a partial implementation may even be counterproductive.

The methodology for policy assessment and conflict analysis is a way of introducing clarity, and a structured way of thinking for complex decision situations. The tools which are used for supporting the analysis should be selected and adapted to the needs of a single case, and they should never be meant to interfere, automate or replace the debate between actors. The methodology developed in the project introduces structure and organises subjective judgements. The tools which support this analysis offer techniques to gain insight in this domain and to increase clarity. However, they are necessarily a simplified representation of people's values and tastes. Therefore, it is of fundamental importance to interpret these instruments as a means to organise discussion, debate and argument, rather than a means of engineering efficient policy solutions.

IV. SCIENTIFIC INTEREST AND NOVELTY

The main scientific result is the specification of a consistent and theoretically coherent approach, that goes from the identification of policy units, to the assessment of policy options from the unit's perspective, to the assessment of conflicts. Specific issues of scientific interest are: the conflict indices; the distinction between absolute and relative conflicts; and the analysis of similarities between policy units. The DTCS methodology is also particularly suitable for implementation in GIS packages, which offers a development opportunity for the project results.

Conflict indices. These indices are used to compare the results of different units, and to identify type and intensity of conflicts. Different indices apply to different type of results of the evaluation, such as indices for ordinal and cardinal rankings of policy options. Each index is also linked to a type of conflict, such as a relative or an absolute conflict. The project developed a small number of indices, able to describe the most frequent conflict situations. However, there is ample space for generalising the approach and for developing a comprehensive mathematical framework for conflict analysis. Indices also have interesting mathematical properties, which can be related to the broader field of social choice theory.

Absolute and relative conflicts. The results of multicriteria analysis performed for different units are not comparable in the cardinal sense without introducing reference profiles, which have the same absolute meaning for different units. Reference profiles correspond to real or hypothetical lists of impacts which, on the whole, can be associated with absolute evaluations, such as a *neutral* impact profile, or a *good* impact profile. These profiles are normally different for different evaluators: what's a *good* outcome for somebody is normally different from a *good* outcome for somebody else. Absolute references make it also possible to measure absolute conflicts, as opposed to the type of conflict analysis which is possible by comparing only the rankings for different units. The conceptualisation of absolute references is a critical activity for which there is limited theoretical and empirical evidence. Additional research is needed in this field, also on the basis of the results of the case studies. In some instances, it emerged that the selection of a neutral reference profile was biased by a "memory effect". In a case study, for instance, some negative impacts in a unit were considered as neutral,

since they were significantly inferior to those expected by the unit due to a previous policy proposal. Similar impacts in other units, on the contrary, were rated as very negative. This perception phenomenon may affect the evaluation, and raises the issue of the timing and stage at which the assessment is made.

Similarities between units. The influence of the scale and location dimension on the attractiveness of a policy can be assessed by comparing the value trees of units. An attempt has been made to provide a theory which identifies the inside decision-making contexts of a unit (e.g., a concern for those consequences which are directly experienced by a unit), and the outside decision making contexts (e.g., a concern for those consequences which are experienced by other units). The occurrence of conflicts can thus be related to the competitive or co-operative behaviour of a unit, and to the internalisation of positive and negative externalities. In practice, almost all actors share some, or all, concerns, and they are also concerned with issues which do not affect them directly (for instance, the concern for the loss of habitats or ecosystems which are locate in distant areas and which have no direct consequences for an actor; cf. also the concepts of existence value or option value). The communality of interests and the emergence of altruistic behaviour can be studied based on the results of structuring. This makes it possible to investigate common interests and perceptions starting from the most basic information provided by the actors as concerns their values. The project attempted to conceptualise these relationships between concerns of units at various scale and locations, but additional research is needed. Issues which need more investigation are: the degree to which concerns which are expressed at a low level (e.g., expressed by local community) become concerns at the higher level (e.g., a national issue), the way they are expressed at this higher level, and *vice versa*; and the degree to which concerns expressed by a minority of low-level actors are accounted for at a higher level, and *vice versa*.

Integration MCA with GIS. The integration of multicriteria analysis (MCA) and spatial analysis (SA) is often performed through map overlay to characterise an aggregated impact. All commercial GIS packages allow this type of basic operation. The same spatial operations can be used to implement the DTCS methodology in a commercial software. This implies that the methodology can be transferred to, and integrated with, most commercial Geographical Information Systems. It is relatively easy to produce either an add-on or a specialised package which uses GIS facilities to perform impact assessment at different spatial scales and levels. The prototype software developed for DTCS has already been tested for this, and links with commercial packages have been verified .

V. POLICY RELEVANCE

The case studies, the responses of the scientific community and of the policy makers involved in DTCS have highlighted a number of aspects of relevance for policy making.

Participation and co-decision. Policy makers involved in the project have expressed a clear concern for promoting cooperation between private and public organisations in policy assessment. Many experienced difficulties in making this effective and useful in practice. The bottleneck was not the political will, but the lack of a systematic approach to assess the perspectives of the many actors involved, and the implications of different perspectives. This was recognised as one of the main added values of DTCS.

A way of thinking and a toolbox. The approach is, first of all, a systematic way of thinking about conflicts. This is complemented by tools which support the analysis of conflicts. The DTCS methodology is not a recipe, but a toolbox of instruments applicable to a wide range of situations. It can be applied in full, only in parts, or even only as a guideline for thinking logically about conflicts and negotiation. A wide applicability of the approach emerged, as a technical tool to provide technical answers, and as a management tool to aid conflict management and negotiation. In addition, the approach can be applied to domains other than transport, whenever spatial assessments and spatial conflicts are a critical policy issue.

Conflicts. Conflicts in policy evaluations are almost unavoidable. Conflicts contain a creative force, which may drive policy improvements and better decisions, but beyond a certain threshold they can crystallise and jeopardise the interaction between actors. The DTCS methodology allows for an early identification of conflicts, and offers the opportunity to exploit them as a creative force, before they negatively affect the whole decision process and split the actors between winners and losers.

Communication. As recognised by many involved in the project, difficulties in communication between actors, and the lack of recognition of the position of other actors, may hamper policy design and evaluation. The DTCS approach promotes communication and the creation of a common language for the evaluation, so that actors can undertand their position, also in relation to that of others.

Support for policy improvements. By focusing on the weak points of the plan, as perceived by the players, it is possible to investigate mitigation, compensations or even completely new designs which could decrease conflicts and improve the outcomes of the plan. The case studies demonstrated that this can be done even on the basis of relatively poor information and qualitative evidence.

However:
It is clear that no analytical approach can substitute political negotiations and debate. Special attention was necessary to dispel any such doubt during the applications. Also, the degree to which the use of DTCS can trigger strategic behaviours is still to be verified (for instance, the exploitation of the approach to achieve over-compensation of damage). Such behaviour is present in any situation which mixes cooperative and competitive motives, but the effect of using a structured and transparent approach to conflict analysis on the negotiation behaviour of policy actors is still to be fully understood.

VI. PUBLICATIONS LIST

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