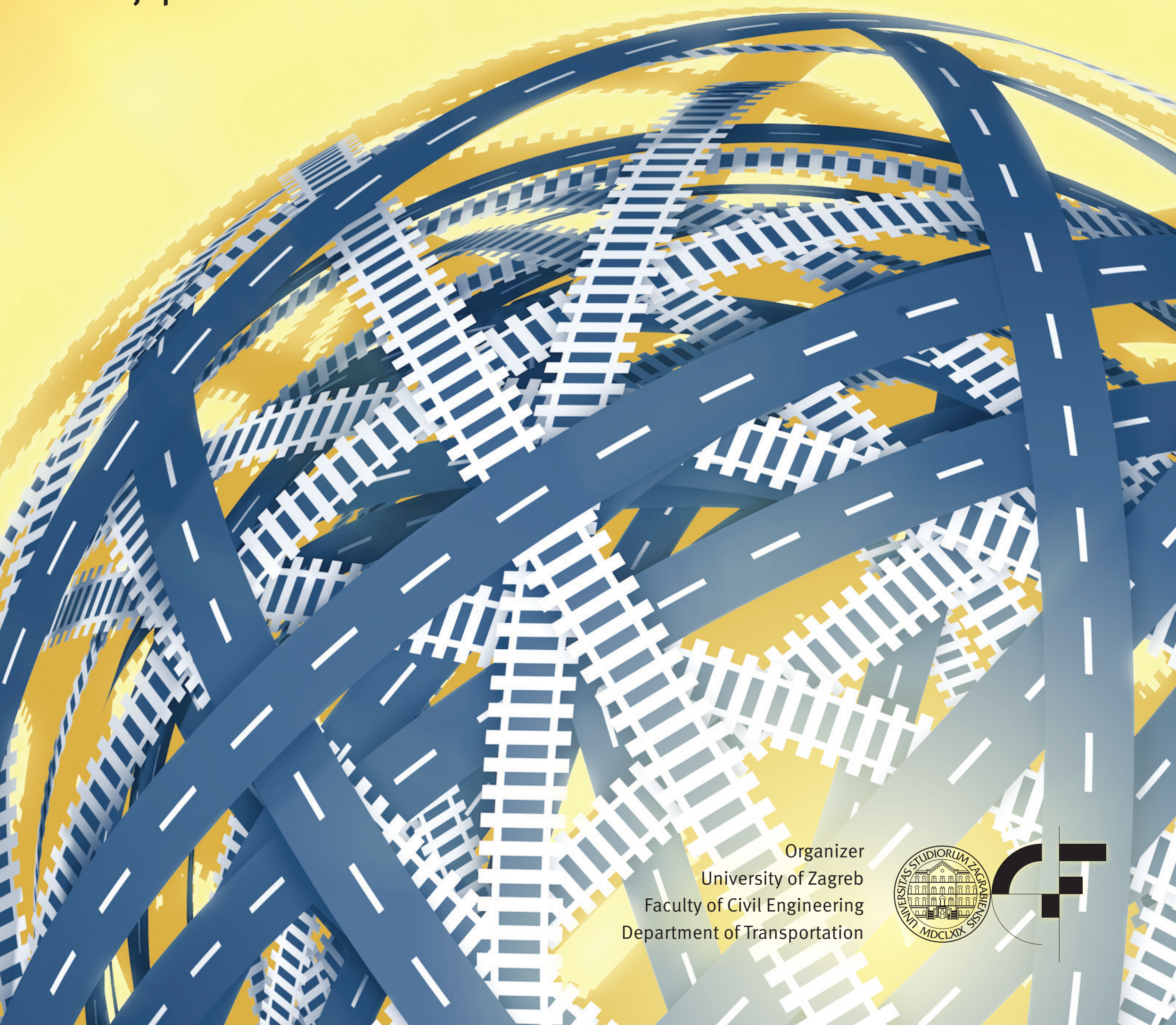
CETRA[2016]

4th International Conference on Road and Rail Infrastructure
23–25 May 2016, Šibenik, Croatia

Road and Rail Infrastructure IV

Stjepan Lakušić – EDITOR



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EDITOR
Stjepan Lakušić
Department of Transportation
Faculty of Civil Engineering
University of Zagreb
Zagreb, Croatia

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THE NATIONAL TRANSPORT MODEL FOR THE REPUBLIC OF CROATIA – APPLICATION AND USE

Uwe Reiter[1], Igor Majstorović[2], Ana Olmeda Clemares[3], Gregor Pretnar[4]
[1] PTV Transport Consult GmbH, Germany
[2] University of Zagreb, Faculty of Civil Engineering, Croatia
[3] INECO, Spain
[4] PNZ, Slovenia

Abstract

The Croatian Ministry of Maritime Affairs, Transport and Infrastructure commissioned the development of the National Transport Model to a Consortium combining local national knowledge with international expertise. The scope of the project is to develop the National Transport Model, collect all available data, carry out necessary surveys, develop networks models and demand models for freight and passenger demand for the base year, calibrate and validate the models, and develop forecast models for the time horizons of 2020, 2030 and 2040. The purpose of this National Model is to identify shortcomings, bottlenecks and issues in the current and the planned future transport systems of Croatia. Furthermore, this model is the basis to identify and develop strategies to alleviate the shortcomings of the current transport system and to develop the future transport system in a direction of meeting future demand and of promoting the economic and social development of the Country without compromising its sustainability. The model is used to identify specific measures and projects for the different transport modes and their integration supporting the selected strategies.
Both, the individual measures as well as the complete strategies will be tested with the National Model. The model will produce quantitative results allowing to determine impacts of the strategy alternatives and of the measures on traffic conditions, on social and environmental impacts. Consequently, the National Transport Model is a basic and important component for the development of the future National Transport Strategy, delivering the necessary quantitative basis for analyses and selection of alternatives. Furthermore, the National Transport Model forms the basis for the development of Regional and Urban Models, necessary for the respective Regional and Urban Master Plans. The availability of a high-quality National Model guarantees that similar approaches are used at the regional level, improving the general transport planning approaches all over the country.

Keywords: Transport Model, Analysis of transport conditions, transport forecast, development of transport strategy, evaluation of impacts

1 About the project

The National traffic model for the Republic of Croatia is co-financed by the EU from the European Regional Development Fund under Transport Operational Programme 2007–2013 within the project “Support for the preparation of the Republic of Croatia´s Transport Development Strategy and designing of the national Traffic Model for the Republic of Croatia – National Traffic Model for the Republic of Croatia”.

2 Introduction – purpose of a national transport model

The development of the National Transport Model for the Republic of Croatia was not an end in itself. The intention of the Croatian Ministry of Maritime Affairs, Transport and Infrastructure in commissioning the model development was to obtain a quantitative tool that could support the development of the National Transport Strategy, help to analyse current conditions and forecast future conditions, provide the basis to identify necessary strategies and measures and finally being able to calculate the impacts of strategies and measures on the future transport system and the influencing processes, like social, economic and environmental processes. A National Transport Model is the necessary tool to plan the sustainable development of the transport system.

3 Model development

The model was developed using the software suite PTV VISION (Visum and VisEVA). It follows the classical 4-step approach. However, it should be noted that the National Model of Croatia is a Synthetic Model using network data, socio-economic data and behavioural data as its foundation. Only a synthetic model, and of course a synthetic model calibrated and validated to actual empirical data, is capable of scientifically and correctly forecasting future developments and of calculating impacts of changes in influencing conditions (exogenous factors like economic and social development) and of changes within the transport system itself, e.g. implementation of strategies and measures (endogenous).
For passenger transport, a scientific trip generation model was developed for the resident population and for the visitors and guests of the country, information of the actual destinations of trips of residents and visitors was used for trip distribution. Similarly for freight transport, data on import/export, production, processing and consumption of numerous commodity types was used to develop the freight generation and distribution. For both models, mode choice and assignment were based on costs including actual travel times.
The socio-economic data was collected from different sources at the level of model zones mainly from National Statistics. The basis for the behavioural data was a household survey with more than 3,000 interviews and a survey of freight operators, both carried out within the project. Empirical data was complemented by traffic counts and public transport passenger counts. The empirical data from external sources and from the own surveys was used to calibrate and to validate the model. To represent differences between the summer season with high numbers of tourists visiting the country and the rest of the year, two different models were produced, an off-season model and a seasonal model.
Model development consisted in the development of a base year model and of forecast models for the horizon years 2020, 2030 and 2040. Forecast was based on the available and accepted official data of future socio-economic development of Croatia and the surrounding countries (EU Energy, Transport and GHG Emissions Trends to 2050 [3]). For all forecast horizon years, a so-called do-minimum scenario was developed that will be used as a reference scenario, including only those projects and measures that are already under development or that are planned and financed. The do-something or strategy scenarios will include additional projects and measures being part of the national transport strategy. Details of model development, calibration and validation are described in the other two papers of this conference, namely:

- The National Transport Model for the Republic of Croatia – Development of the Freight Demand Model [1]
- The National Transport Model for the Republic of Croatia – Development of the Passenger Demand Model [2]

4 Application and Use of the National Transport Model

After development, calibration and validation of the transport model, it can be used to assess current and future conditions, to identify potential strategies and measures to improve conditions and to assess the impacts of these strategies and measures on the transport system itself and on influenced processes, like environmental impacts, accessibility and social inclusion, social impacts and impacts on economic development.

4.1 Analysis of current conditions

The model was used to analyse current conditions on the Croatian road network and on the National public transport system. Examples are described below. For road transport, the total vehicle flows in terms of Annual Average Daily Traffic (AADT) for the off-seasonal conditions and the Average Seasonal Daily Traffic (ASDT) are given in figure 1 in form of number of vehicles.

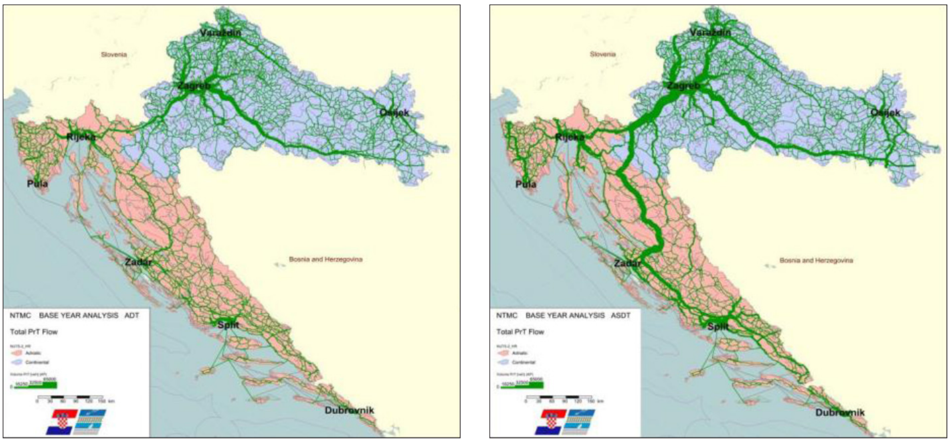

Figure 1 Road traffic – Annual Average Daily Flow for whole Year (ADT) and for seasonal traffic (ASDT)

Of course the highest traffic flows can be observed on the motorway and trunk road networks from Zagreb to all parts of the country and around the larger metropolitan areas in Croatia, mainly Zagreb, Zadar, Rijeka, Split, Varaždin, Osijek and Dubrovnik. The traffic flow analysis is the basis for identifying the major OD relations in the country and to determine external impacts like environmental impacts emission of pollutants and noise.
For understanding the internal impacts and to identify bottlenecks in the network and potential shortcomings, it is necessary to relate the actual flows to the provided capacities. The figure 2 shows the volume/capacity ratio, again for the off-season conditions and the conditions within the summer season.

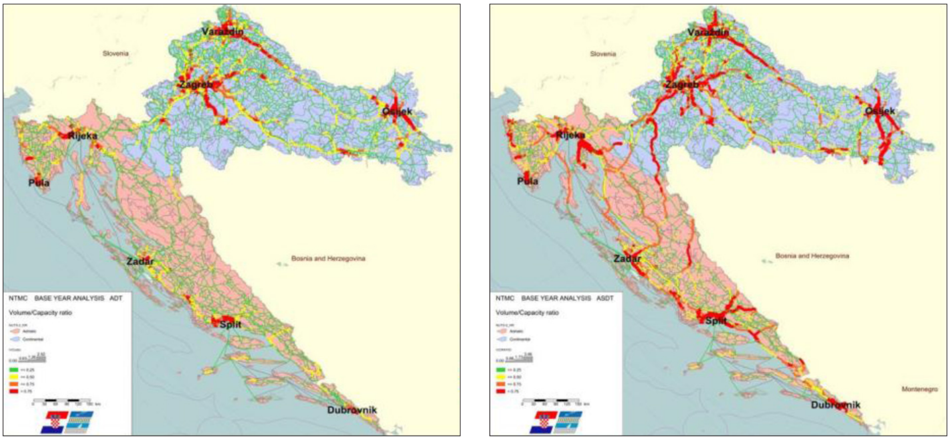

Figure 2 Road Traffic – Volume/Capacity Ratio for Annual Average (ADT) and for seasonal traffic (ASDT)

Differences are clear; while in the off-season situation, high volume/capacity ratios can be observed mainly around the major cities, and here more in the continental cities of Croatia, in the summer season high volume/capacity conditions occur also on the motorway network towards the Adriatic coast and in and around the Adriatic cities. Levels above 75% volume/capacity ratio are critical, potentially bearing the risk of congestion and traffic breakdowns at peak hours.

To better understand what internal impacts high traffic flows have on the road users, the Visum transport model allows to display the so-called lost time. This is defined as the ratio between travel times at free flow conditions and the actual travel times at the actually calculated flow conditions. The lost time in form of the ratio current travel time / free flow travel time is shown in the figure 3 for annual average off-season and for seasonal conditions.

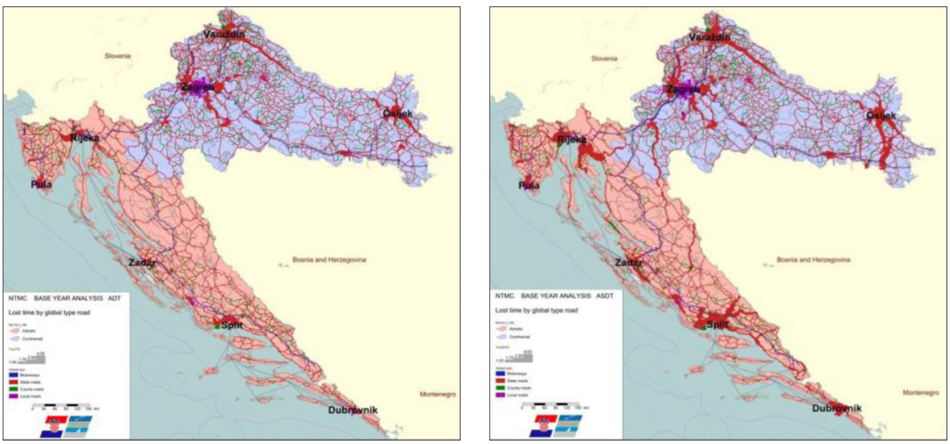

Figure 3 Road Traffic – Lost time for oss-season (ADT) and for season (ASDT)

Similar analyses can be carried out for public transport. The passenger flows are displayed in the left figure 4 for the 3 main modes of public transport rail, bus and ferry/boat. Capacity overexploitation and resulting lost times are usually not the problem in public transport. It is rather gaps in supply, service gaps or very long travel times particularly in comparison to other modes, mainly to the car. To display supply/ service quality, the figure 4 to the right shows the accessibility of the city centres of the major cities from the whole territory of the country in 30 minute steps. This could also be compared to similar accessibility plots for car traffic. The accessibility analysis shows that there are service gaps between the cities, mainly between Zagreb and Zadar and Zagreb and Osijek, with very long access times or even no public transport at all. However, these are remote areas with low population densities. More graphical and quantitative analyses are possible and have been carried out for the current conditions represented in the base year model.

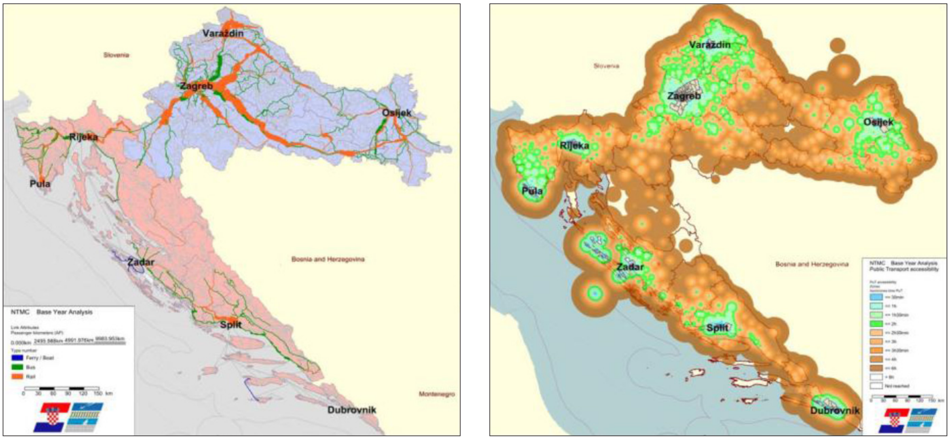

Figure 4 Public Transport – Flows (Assignment) and Accessibility of City Centres by Public Transport

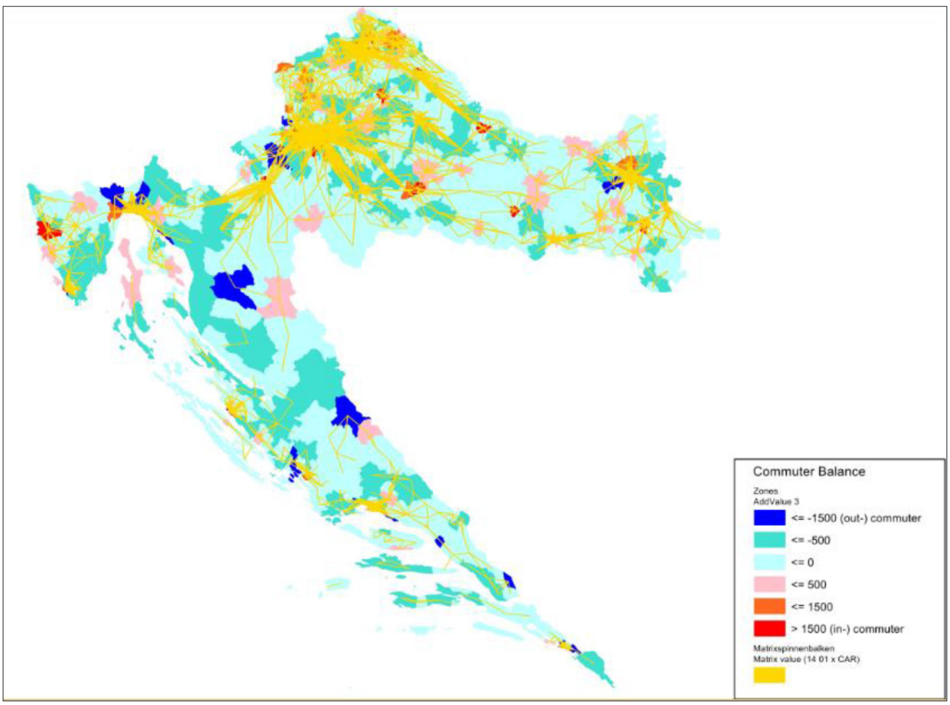

Figure 5 Display of Commuter Flows for the definition of Functional Regions

Model results can also be used for a more complex analysis, for example for defining so-called "Functional Regions". Functional regions are areas with a high frequency of internal regional interaction. The concept of functional regions is used worldwide to understand and define functionally connected areas that need to administer the transport system across administrative borders. The most commonly approach to define functional regions is using data on population commuting to work and school because the pattern of daily commuting rule is a good approximation for staging other types of interaction. The National Transport Model has been used to determine commuter trips into and out of the major cities as a basis to define functional regions for Croatia (see figure 5).

4.2 Analysis of future conditions

Since the National Transport Model of Croatia not only represents current conditions but was designed also for the forecast horizon years 2020, 2030 and 2040, the analyses can be carried out also for the future transport conditions. To identify future bottlenecks and shortcomings, a so-called do-minimum scenario is used. In the do-minimum scenario, future demand is calculated based in forecasts of socio-economic and behavioural development, whereas the transport networks represent current conditions only enhanced with those measures and projects that are already under construction now or are planned and fully financed. These do-minimum scenarios allow to evaluate how conditions will develop if no strategy is applied and are used as reference scenarios to the do-something scenarios, representing future strategy or strategy alternatives.
As an example the following 3 plots (figures 6, 7 and 8) show the development of road traffic volumes and the ratio of volumes/ capacity for the off-season conditions for 2020, 2030 and 2040. Obviously, all other graphical and quantitative analyses are also carried out for these 3 forecast horizon years.

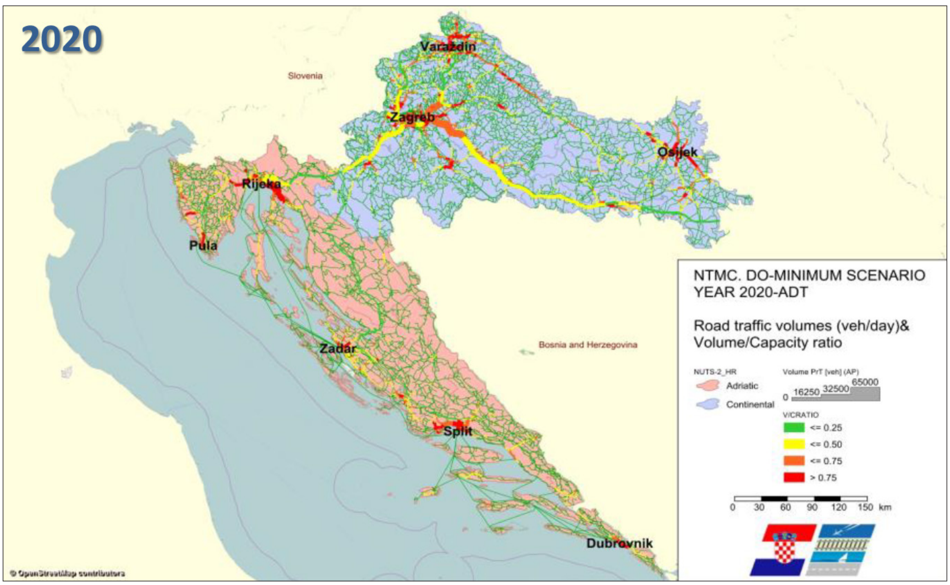

Figure 6 Forecast 2020; Do-Minimum Scenario; Off-Season; Road Network; Road traffic volumes and Volume / Capacity Ratio

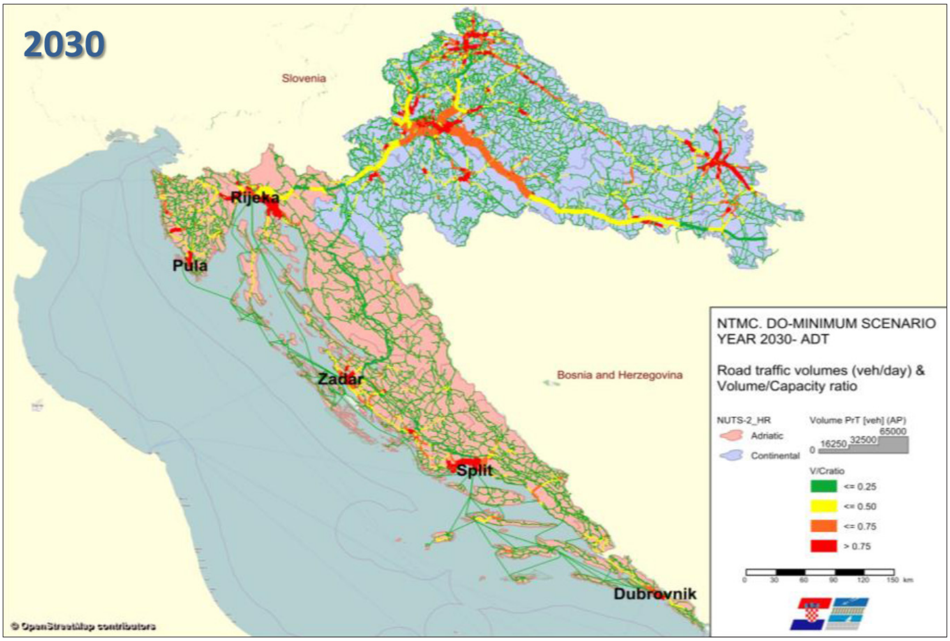

Figure 7 Forecast 2030; Do-Minimum Scenario; Off-Season; Road Network; Road traffic volumes and Volume / Capacity Ratio

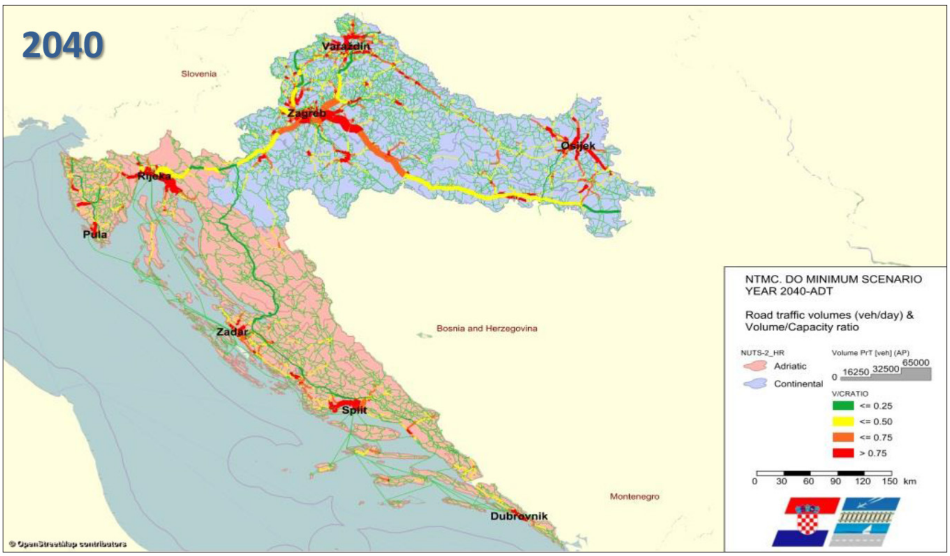

Figure 8 Forecast 2040; Do-Minimum Scenario; Off-Season; Road Network; Road traffic volumes and Volume / Capacity Ratio

The graphs clearly show that an increase in long-distance road traffic is calculated over the 3 time horizon years (width of the link bars), resulting in an increase of links with higher volume/capacity ratio (colour of the link bars), meaning deteriorating traffic flow conditions, if no strategies and measures are implemented, i.e. infrastructure capacity remaining unchanged and no demand policies applied.

4.3 Identification of strategies and measures

These analyses of current and forecasted future traffic conditions, accessibility and transport impacts are an important input to develop strategies and measures to alleviate the identified shortcomings and to transform the transport system in accordance with more general transport visions and objectives. The development of strategies and measures will normally be based on the overall Vision and the defined objectives of the National Transport System. Normally, these objectives will include:
- Ensure economic, social and environmental sustainability
- Provide accessibility and social inclusion
- Increase traffic safety
- Increase transport efficiency and quality of services
- Reduce negative impacts on the natural, man-made and social environment

Strategies will use a combination of the following
- Influence transport demand towards more sustainable modes, shorter travel distances etc.
- Optimise exploitation of provided transport capacities (increase vehicle occupancies, temporal optimisation like peak spreading, technical increase of capacities through transport telematics/ ITS)
- Expand and improve network capacities through new links and more services, enlarged links and improved junctions

Based on objectives and strategies and on the findings about current and future traffic conditions, measures will be developed that belong to the following types:
- Policy measures, like speed limits, vehicle access restrictions, information measures, parking policies and others
- Infrastructure measures: new links, new junctions
- Financial measures: pricing of car use (e.g. fuel prices, taxes), road use (tolls), parking (fees), pricing of public transport (fares)

As the National Transport Strategy for Croatia is currently under development by the Ministry and the Strategy Development team, no final results can be given at this stage. The preliminary list of measures includes improvements of capacities and travel speeds on the rail network (corridor Zagreb – Karlovac – Rijeka, Zagreb – Hungarian State border, Zagreb – Serbian State border), the road network (mainly motorway extensions to the border with neighbouring States) and capacity and accessibility developments for a number of ports and improvements to road traffic regulations.

4.4 Assessment of impacts of strategies and measures

At the time of writing this paper, the strategy and the measures developed by the Transport Strategy Team of the Ministry are still preliminary and the modelling team can only start representing these in the model in form of a do-something scenario. This process will most likely be finalised by the time of the conference and results of the impact analyses might potentially be presented at the conference.
In any case, the impact assessment will include the type of analyses described above for the base year and the do-minimum forecast year scenarios. Besides these evaluations, of course the differences between the strategy alternatives (do something) and the reference case (do minimum) will be calculated, displayed and processed.
This will form the basis for the impact assessment, for cost-benefit and multi-criteria analyses of the Strategy alternatives and the included measures.

4.5 Development of a National Transport Strategy

As a result of the assessments and analyses of the strategy alternatives and the impact assessment of the individual measures, a National Transport Strategy will then be developed, combining the most suitable strategy options and most effective measures.
The final assessment of this National Transport Strategy can then again be based on the results of the National Transport Model.

5 Development of regional and urban transport models

Numerous regional and urban transport and mobility master plans are now under development throughout Croatia. All regions and metropolitan areas are carrying out these master plans. One important component of these regional and urban master plans is the quantitative analysis of current and forecasted conditions and the impact assessment of proposed measures and changes. Regional and urban transports model are needed for these exercises. The National Transport Model forms the basis for the development of these models representing smaller areas.
Technically, the National Model can be used to extract so-called sub-network models, then forming the basis for the implementation of further details, like more detailed zoning structure in the respective area of interest, more detailed allocation of socio-economic data based on the refined transport zones, adding details to the road network and adding local public transport lines and services.
It is important that the general structure remains in line with the National Model for consistency and plausibility reasons, e.g. the assumptions of socio-economic developments over the forecast horizon years. After finalisation of regional and urban master plan studies, local and regional improvements to the models can be fed back to the National Transport Model.

6 Conclusion

The Ministry of Maritime Affairs, Transport and Infrastructure has commissioned the development of the National Transport Model in preparation of the development of the National Strategy. The consultant team have finalised the main work on developing this powerful tool in form of a synthetic 4-step model, by developing the base year model with network model, passenger and freight demand models, have calibrated this model with survey data and have validated it against empirical data. The result is a robust model capable of forecasting future transport conditions and calculating impacts of exogenous changes (like political and socio-economic conditions) and endogenous changes in form of transport strategies and measures. The model is now available to test and assess the strategy alternatives and to assist in developing the National Transport Strategy for the Republic of Croatia.

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