

THE DUBROVNIK REGION ROAD NETWORK IN THE FUTURE

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Abstract

The Study presents the planned construction of high service level roads, which in the future would bring such traffic volumes to Dubrovnik for which the existing network does not have the capacity. What is special in the approach to planning on how to solve the problem of connecting Dubrovnik to the future road network is the fact that the Old City of Dubrovnik is a “masterpiece of human creative genius” on the UNESCO World Heritage list. This Study presents the way based on modern traffic modeling to find the solution for connecting Dubrovnik to the future network. New road solutions are discussed herein, as well as the past efforts made in solution finding, and the efficiency of these solutions in the future is being proved.

Keywords: traffic modeling, traffic planning, effects of traffic, designing of highways, designing of roads, appraisal and selection of solutions

1 Introduction

The future highway network planned in the Dubrovačko-neretvanska County shall bring to Dubrovnik the volume of traffic for which the existing road network lacks capacity. All the efforts made so far to connect Dubrovnik to the planned road network did not result in acceptable solutions. The “standard” procedure of solution finding, which usually ends in adoption of the environmental impact study has been suspended. The non-governmental organizations and the public have in this case overpowered the proposed technical solutions.

The road corridors, according to which the technical solutions were made, were evidently not well conceived. The technical solutions elaborated for these corridors did not consider the value of the space the corridors covered, and as they did not dare step out them, the solutions have proved to be lacking. Such a turn of events is not a usual practice in Croatian democratic procedure of defining infrastructural projects. In this case, the fact which prevailed was that the City of Dubrovnik is an acknowledged part of the world heritage. The corridors entered into the physical plans should be revised and new ones elaborated. The proposals of corridors should be filtered in respect of technical accuracy and traffic efficiency. The study presents the possibilities of solution finding through the modern traffic planning and road designing. The procedure presupposes the elaboration of a traffic model for the problem area, technical design of certain network segments, calculation and valorization of traffic effects of the modifications arising by the introduction of new road segments into the existing road system.

2 The traffic model

The area under examination has been limited to the Dubrovačko-neretvanska County. The County has the territorial organization of 5 towns and 17 municipalities (see Figure 1).

The model consisting of 235 zones in total was made which corresponds to the territorial division into towns within the Dubrovačko-neretvanska County, into 4 external zones and a separate zone of the Čilipi Airport.

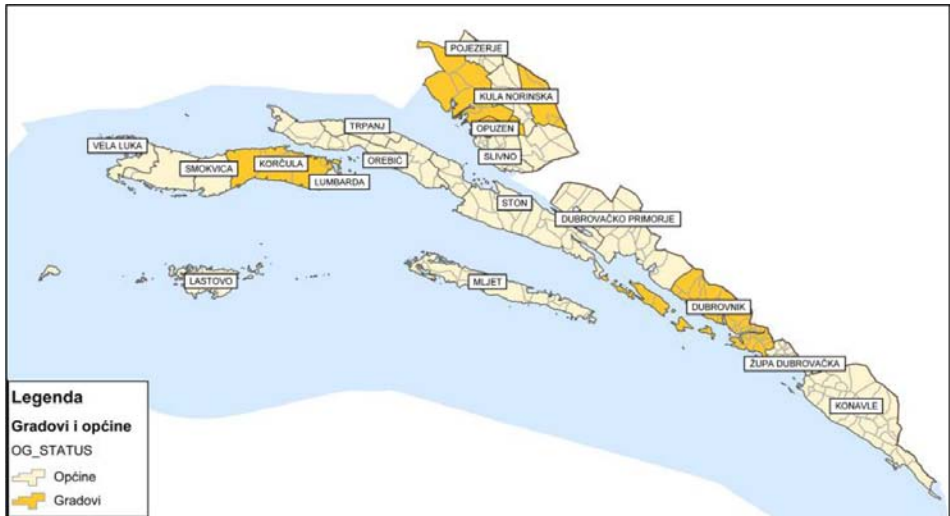


Figure 1 Area under investigation – cities and municipalities of the Dubrovačko-neretvanska County

The zone model attributes were as follows:

- number
- code
- name
- population
- employees
- work places
- tourist visits
- construction surface area
- airport passengers

The population distribution per the DNC zones, distribution of work places per zone, as well as the average daily tourist visits per zone are the zone characteristics which were used in elaboration of the transport demand.

2.1 Demand model

The traffic model was elaborated as a three-layer traffic design model for individual transport with the following levels:

- Travel generation
- Travel distribution
- Assigning traffic to the network

Travel generation was elaborated for the following activities:

- House - work journey
- Tourist travels
- External-internal
- Transit travels

And as per groups of persons for:

- Employed
- Tourists

Travel attractions are presented by work places, tourist programs and construction area surfaces. The activities and groups of persons have been connected to the attractions and the travels into and from the zone were calculated.

The travel distribution was conducted through the gravity model and the distribution matrices were calculated to define the journeys from and into the zone. The travel matrices were calibrated on the basis of historical and current data on vehicle volumes in certain sections as per the traffic count on the roads of the Republic of Croatia and the Federation of Bosnia and Herzegovina.

The traffic volumes in the model reflect the summer average daily traffic (SADT) on certain road segments for the entire area of the DNC. The summer traffic is relevant for the analysis of traffic flows as the economy of Dubrovnik is almost entirely focused on the tourist traffic in the summer period, and dominantly depends thereon.

The traffic has been generated for two time sections:

- The base year is 2008
- The planned year is 2018

The individual transport growth for the Dubrovačko-neretvanska County is planned in the 2008-2018 period in the amount of 2% per year. The traffic growth factor in 2008-2018 amounts to 1.22.

2.2 Search model

The search model is described as the traffic network to which certain transport systems are being joined. The traffic network which is being described here has been divided per the road categories to motorways, highways, national roads, county roads and local roads in the existing and the planned network. The total length of the existing and the planned network with the respective variants amounts to 1,689km. The existing network length (Figure 2) is 1,266km.

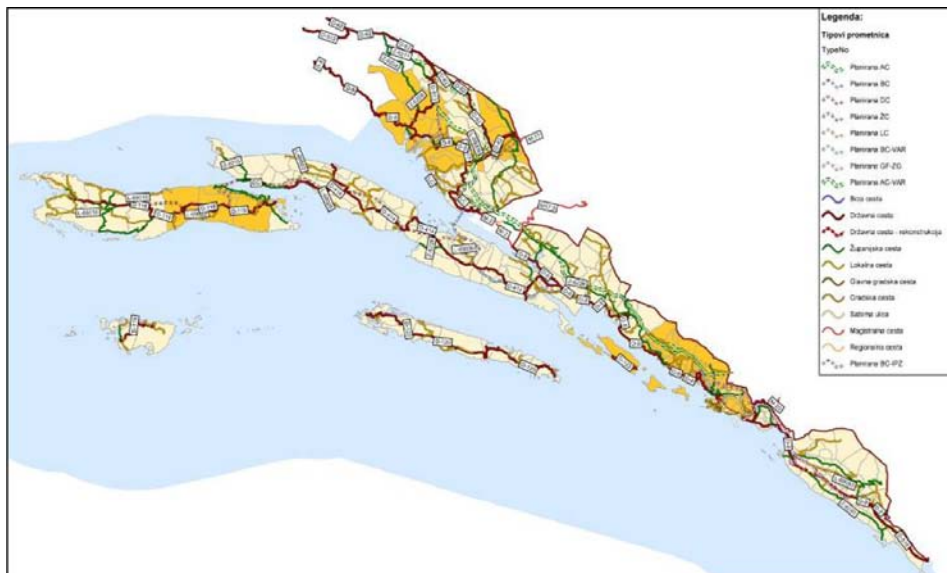


Figure 2 Model of the Dubrovačko-neretvanska County network

The newly proposed solutions for the planned road network in the Osojnik – Dubrovnik – Čilipi – Debeli Brijeg area were elaborated on the preliminary design level in DMR25 (digital

relief model 1:25.000), in order to check design's technical accuracy and the feasibility or the prospects of technical execution of the planned construction project. Alignment was executed in conformity with the principle of preserving the exceptional natural and urban value of the area through which the road alignment passes.

Network attributes:

- Links
- Initial node
- Terminal node
- Link type (AC, BC, DC, ŽC, LC)
- Transport system
- Link length
- Lanes
- Capacity per direction
- Allowed speed

2.3 Traffic effects and evaluation

Evaluation is made by the estimation of the effects of the traffic planned in 2018. The difference between traffic effects in the planned network and the effects of the existing network is being calculated, as well as between the network in 2008 with the traffic in 2018. The scenario which has kept the existing network (network in 2008, hereinafter the scenario 180) provides only for the maintenance of the existing system without the construction of the new network sections. The scenario is also called as the reference scenario, while in theory it is referred to as the “do minimum” scenario.

Table 1 Savings in the traffic system brought about by the construction of the road system according to the scenario 184

Costs component	Scenario 180	Scenario 184	Difference in cost	
Maintenance costs	22,296	23,392	1,096	
Investments costs	0,000	0,000	0,000	
Total COSTS	22,296	23,392	1,096	
Benefits component	Scenario 180	Scenario 184	Difference in benefits	Shares %
Vehicle costs	152,737	155,348	-2,611	23,161
Time related costs	102,558	97,614	4,944	43,861
Accidents related costs	48,269	45,037	3,232	28,670
Harmful effects costs	0,461	0,474	-0,013	0,118
CO ₂ costs	18,243	18,715	-0,472	4,190
Total BENEFITS	322,269	317,189	5,079	100,000

All values in Mio. EUR/a.

The positive value in difference of the estimated traffic effect in a planned scenario and the “do minimum” scenario is identified as a benefit. The scenario with the positive benefits is an indicator of project feasibility. Should there be more variants of one solution, the solution with the highest benefits is to be proposed. The components of savings and their relations in the total savings are presented in the example of the scenario 184 (Table 1).

3 Network scenarios

The planned network was divided into road “packages” or the section groups making a single traffic unit. The Figure 3 presents individual road “packages” included in the evaluation. The scenarios were formed by the combination of the road “packages” for the planned network (see Table 2).

Three traffic corridors are being tested for the Dubrovnik area, namely:

- Highway corridor north of the Dubrovačka River (the corridor according to the EIS)
- Highway corridor in the Srđ hinterland
- Highway corridor in front of Srđ.

Table 2 Review of scenarios and traffic savings

Scenario	Traffic	Network system	Note	Reference	Scenarios	Benefit
				cost S180	cost	
				<i>mil. €</i>		
80	2008	Existing status 2008				
180	2018	B+C+D+E+G	East part AC - Pelješac - Dubrovnik Bridge	322,27		
183	2018	B+C+D+E+F+G	SUO Osojnik - Debeli Brijeg	322,27	318,38	3,89
184	2018	B+C+D+E+G+H	GF Osojnik - Ilijina glavica - Debeli Brijeg	322,27	317,19	5,08
187	2018		Highway behind Srđ connection with Ilijina Glavica (tunnel Brgat) D8 no connection to the Dubrovnik Bridge	322,27	320,76	1,51
188	2018		Highway behind Srđ connection with Ilijina Glavica (tunnel Brgat)	322,27	318,21	4,05
189	2018		Highway behind Srđ connection with Ilijina Glavica (tunnel Brgat) and center of Dubrovnik (tunnel Susjegan)	322,27	318,20	4,07
190	2018		Highway behind Srđ connection with Ilijina Glavica (tunnel Brgat) and center of Dubrovnik (tunnel Susjegan); D8 no connection to the Dubrovnik Bridge	322,27	319,89	2,38
191	2018		S184 + conection Mokošica and Nuncijata	322,27	316,98	5,28



Figure 3 Road “packages” for the evaluation

4 The finding and analysis

The findings are explained on the basis of traffic volumes on the network or planned network of individual scenarios, and on the network's saturation. The section's length to be found for the new road corridor is ca 12,00km.

Scenario 80 - the existing status in 2008. Dominant traffic volumes are recorded from Ilijina Glavica towards Župa (airport) with extreme point at Župa 17.137 vehicles/day. The network at the city's access from the Župa side saturated >100%. The traffic at the city's access halts.

Scenario 180 – “nothing should be undertaken” in Dubrovnik zone (Figure 4). An increased traffic caused by the construction of connection to the highway features capacity limit at Gruž, crossing capacity limits at Ilijina Glavica – city, Ilijina Glavica – Orsula. Extreme volumes from Ilijina Glavica towards Župa with extreme point at Župa 20.506 vehicle/day. Traffic at the city's accesses comes to a halt.

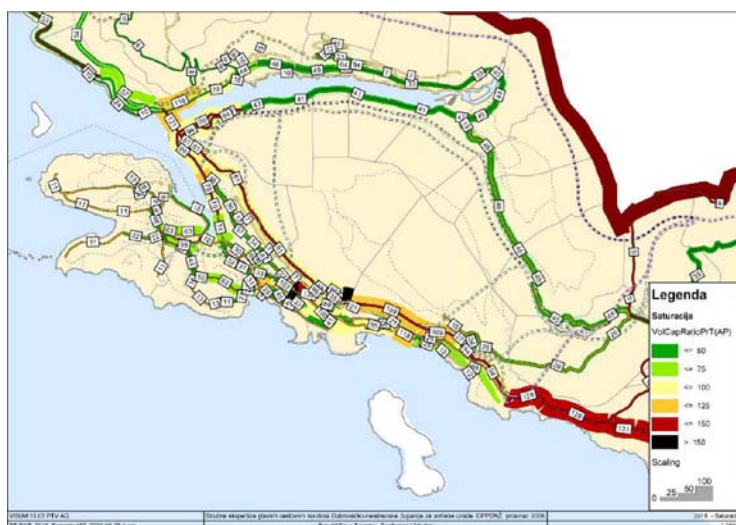


Figure 4 Saturation of network 2018. – Scenario 180

Scenario 183 – according to suo Osojnik – Debeli Brijeg, the corridor north from the Dubrovačka rijeka (Figure 5). The Dubrovnik bridge – Mokošica section is congested. Ilijina Glavica – city section features an extreme traffic 20.782 v/day. The access and exit from the city on Ilijina Glavica comes to halt, is not operating at all. The D-8 state road in front of Srđ is relieved from the transit traffic. Traffic volumes at Župa are optimal.

Scenario 184 – highway corridor in front of Srđ, connected Brgat tunnel (Figure 6). The bridge sections Dubrovnik – Mokošica and Ilijina Glavica node are overloaded.

A section's redesign required. The whole traffic network is uniformly overloaded significantly beyond capacity boundaries.

Scenario 187 – highway corridor behind Srđ, connected Brgat tunnel, D-8 has no connection to the Dubrovnik Bridge. The sections Dubrovnik bridge – Mokošica, Sustjepan – Gruž and Ilijina Glavica node are overloaded. The redesign of the mentioned sections is required. The whole traffic network is uniformly overloaded significantly beyond capacity boundaries.

Scenario 188 – highway corridor behind Srđ, connected Brgat tunnel, D-8 connected to the Dubrovnik bridge. The sections Dubrovnik bridge – Mokošica and Ilijina Glavica node are overloaded. The redesign of the mentioned sections is required. The whole traffic network is uniformly overloaded significantly beyond capacity boundaries.

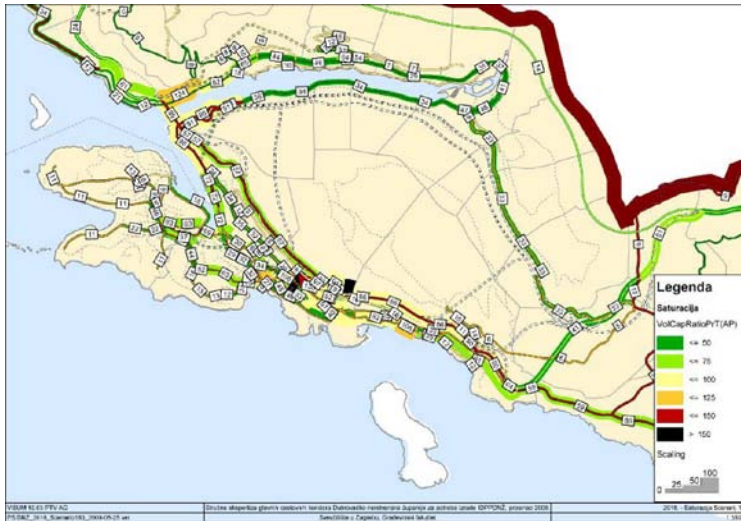


Figure 5 Saturation of network 2018. – Scenario 183

Scenario 189 – highway corridor behind Srđ, Sustjepan tunnel connected, Brgat tunnel connected, D-8 linked to the Dubrovnik Bridge. The sections Dubrovnik bridge – Mokošica and Ilijina Glavica node are overloaded. City’s network, at the Sustjepan tunnel exit is overloaded. The redesign of the mentioned sections is required. The whole traffic network is uniformly overloaded, significantly beyond capacity boundaries

Scenario 190 – highway corridor behind Srđ, connected to the Sustjepan tunnel, connected Brgat tunnel, D-8 has no connection to the Dubrovnik Bridge. The sections Domovinski most – Mokošica and Ilijina Glavica node are overloaded. The urban network at the Sustjepan tunnel exit is overloaded. The redesign of those sections required. The whole traffic network is uniformly overloaded, significantly beyond capacity boundaries.



Figure 6 Saturation of network 2018. – Scenario 184

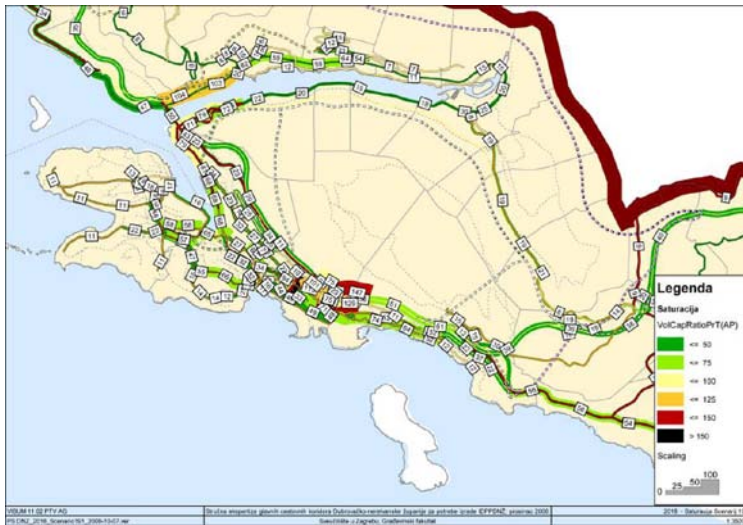


Figure 7 Saturation of network 2018. – Scenario 191



Figure 8 Visualization corridor in front of Srđ

Scenario 191 – highway corridor in front of Srđ, nodes in two levels before and behind Dubrovački bridge, highway in the city's zone in tunnels, a visible part of the road above the city in 1500m length (Figure 7). An overloaded city entrance in the zone of Ilijina Glavica. This part of the city needs an intervention. The whole transportation network is uniformly loaded, significantly beyond capacity limits. A part of the corridor concept in front of Srđ is shown in Figure 8. A decision on solution choice, among all the alternatives is not a satisfying option as there are no traffic effects calculations and savings in the traffic system. According to traffic savings the Scenarios 184 and 191 feature as the dominant ones. Public expert opinion holds the Scenario 184 to be inadequate and questionable. Scenario 191 proves the necessity to open traffic corridor in front and behind Srđ to solve the basic problem of connecting Dubrovnik to the network of future.

5 Conclusion

Corridor solution for the road system of high level serviceability including highways and express highways has to be reached with cutting edge instrument for transportation modeling and design. Such attempt is shown in Dubrovačko – neretvanska district and should become a planning practice.

A level of suggested design solutions should comply with spatial characteristics of the relevant area. Technical solutions selected only according to lowest construction costs cannot be suggested as optimal variant in current design practice.

A technical solution for a region of Dubrovnik representing the world heritage should base on the criterion of the least possible intervention into the space instead on the lowest construction costs.

Planning and designing of cities' bypassing should be conducted through calculation of traffic effects for the city. Such an approach often points at the inadequacy of the city's transportation system for future traffic.

The paper addresses the method of finding solution through modern planning and design. The selection of solution has been proved by stating savings criteria in transportation system as a dominant factor for reaching adequate decision relevant for the area of special significance.

References

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