Newsletter 4

November, 2012

The ECCONET, or "Effects of Climate Change on the inland waterway NETwork," project is a 3-year Coordination and Support Action funded by the European Commission (DG MOVE) in the context of the 7th Framework Programme. Coordinated by Transport & Mobility Leuven and conducted by an interdisciplinary consortium of 10 partners, it is now in its final stage of execution. The first objective of ECCONET is to assess the future navigation conditions, taking into account the influence of climate change on the waterway network. In parallel, ECCONET also analyses possible adaptation strategies in order to improve the performance of inland waterway transport (IWT) in the light of climate change.

The first ECCONET newsletter presented a summary of the results of a general assessment of climate change effects on European inland waterways (IWW), providing a good overview of the state of the art as well as indications for necessary complementary investigations.

In addition to novel knowledge on climate change impacts on navigation conditions in the Rhine-Main-Danube corridor, the second and third ECCONET newsletters presented different types of adaptation measures that were considered to counter the effects of climate change on the inland waterway network, concluded by considerations related to the assessment of feasible adaptation strategies.

In this ECCONET newsletter the usage of cost functions in order to determine the relationship between water levels and transport costs on inland waterways between origins and destinations is discussed.

More details on the project including relevant public deliverables can be found here: http://www.ecconet.eu.

Upcoming event: ECCONET Final Meeting

On Tuesday, 11 December 2012, the ***ECCONET Final Meeting*** will take place in the ***Inntel Hotel Rotterdam City Centre*** *(www.inntelhotelsrotterdamcentre.nl), Schiedamsedijk 140, Rotterdam.* The Panorama room is booked for presentations of the project's main results, as well as interactive discussions with the project partners, the European Commission and stakeholders. All interested parties are welcome to attend free of charge.

For the latest agenda and registration please consult the project website www.ecconet.eu, or e-mail Ms Cassie Wilson (c.wilson@panteia.nl).

Introduction

ECCONET assesses the effects of climate change on the transport network, taking inland waterways as a case study. The effects are made clear by means of cost functions giving the relationship between water levels and transport costs on inland waterways. When water levels rise, the costs for inland waterway transport generally decrease leading inland waterway transport to a more competitive and favourable position compared with competing modes such as road and railways. Moreover, the larger vessels are at normal and higher water levels able to utilise their economies of scale, and, therefore, they are more attractive in those times compared to smaller vessels. However, in case of low water levels, it becomes clear that larger vessels cannot benefit from their economy of scale sufficiently anymore and the competitiveness of smaller vessels is becoming closer to the one of larger vessels.

The NODUS transport model

Within ECCONET the NODUS model was used to assess the effects of water level changes and the consequences in terms of modal split between road, rail and inland waterway transport, and ship type selection for the Rhine and the Danube. The modelling work is based on assumptions about future transport demand and new infrastructure. The reference data are the 2005 matrixes of Continental Europe origin-destination transport flows per mode and per type of commodities, as well as transport cost data. Transport costs include variable and fixed costs of carrying goods by the three modes; road transport costs to places of loading/unloading wagons or vessels; as well as the costs associated with these operations. In the analysis the Rhine and Danube markets are separated because of differences in operational framework conditions present on the two rivers, in the vessels' costs and in the hydrology as evaluated at specific places. The modal split levels for the reference scenario are calculated and compared with the future water level situations in order to determine the climate change effects.

Modelling transport demands and traffic with NODUS classically proceeds in three steps by constructing the transport networks as a virtual network. First, the global demand in the relevant region is generated. The second step is the distribution of the global demand among origins and destinations in sub-regions or localities, and the creation of a cargo flow matrix of origins and destinations (OD matrix). Both steps involve various types of macro or spatial economic analyses. Also, they may take into account the demands and traffic for different types of freight transports and commodities, which will lead to a set of OD matrixes for the different demand segments. Third, given an OD matrix, the NODUS approach directly assigns the traffic on the networks by selecting the mode, the transport means, as well as the itinerary minimizing the generalized transport cost for each origin and destination relation. A set of routes can be chosen for different modes or means, each of them being the cheapest for the several modes/means combinations ("multi-flow" algorithm).

Assessment of climate change effects on the transport network

The main conclusion from the macro level analysis is that the possible climate changes from 2005 to 2050 and their impact on the Rhine market, as modelled by the two long term dry and wet scenarios, are not likely to be strong enough to induce any significant shift in modal shares (Table 1). Moreover, for the Rhine River there is no clear indication for the near future whether the modal share will increase or decrease. The wet and dry scenarios were selected in such a way that they represent the span of climate and discharge projections which were acquired during the project (see Newsletter 1, wet = high signal = optimistic scenario, dry = low signal = pessimistic scenario).

Table 1: Simulated climate change impacts on the modal share in the Rhine region over the period 2005-2050, within the ECCONET framework.

Modal relevancy evaluation (Observation; Climate scenario 1977-2006, 2005 Data)

2050 demand and network impacts (Climate scenario 1977-2006 and 2020-2050, 2050 Data)

Mode	Observation	Climate scenario 1977-2006		Climate scenario 2020-2050		Climate scenario 1977-2006		Climate scenario 2020-2050	
	2005 Data	2005 Data		2005 Data		2050 Data		2050 Data	
		Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]	[%]
IWW	10.82	10.79	10.82	10.78	10.84	9.39	9.42	9.38	9.45
Rail	16.67	16.68	16.67	16.68	16.66	11.52	11.51	11.52	11.50
Road	72.51	72.53	72.52	72.54	72.50	79.09	79.07	79.10	79.05

Climate change impacts if demand & network remain identical (2005) (Climate scenario 1977-2006 Wet and 2020-2050, 2005 Data)

Climate change impacts if demand & network remain identical (2050) (Climate scenario 1977-2006 Wet and 2020-2050, 2050 Data)

Shift in modal share and changes in the type of vessel used

Despite these very limited changes between the modes, there are some significant changes in the vessel type most suitable to carry the goods under the climate change scenarios considered. The analyses indicate that a drier scenario would justify maintaining more small vessels in operation. In particular the CEMT Class III vessels (Table 2) seem to be the most robust ones and will be more popular in case of lower water levels (dry scenario) as a difference of 12% was observed in their share (in tons carried) between the wet and dry scenario on the Rhine (Table 3). On the other side, in particular the Class Va vessels profit from the 'wet scenario'.

Table 2: Types of vessels on the Rhine and their characteristics.

CEMT class	Name (type of ship, train)	Length	Beam	Draught min.	Draught max.	Payload at max. draught
		[m]	[m]	[m]	[m]	[t]
II	Kampine	55	6.6	1.40	2.50	600
III	Gustav Königs	80	8.2	1.10	2.50	1,080
IV	Johann Welker ('Europe'-ship)	85	9.5	1.20	2.80	1,560
Va	GMS 110	110	11.4	1.35	3.50	2,873
Vb	GMS 110 + 1 Rhine E-II lighter	185	11.4	1.35	3.50	5,292
VIb	Pusher + 2 x 2 Rhine E-II lighters	193	22.8	1.70	4.00	11,356

Table 3: ECCONET climate change impact on the use of different types of ships operating on the Rhine. The two average climate scenarios refer to the 1977-2006 period with the demand, infrastructure and costs in 2005.

2005 demand, infrastructures and costs			
Class of ship	**Average dry scenario [million tons]**	**Average wet scenario [million tons]**	**Difference**
II	10.51	10.51	0%
III	19.03	16.69	-12.28%
IV	40.11	39.49	-1.54%
Va	34.37	36.51	6.23%
Vb	12.47	12.94	3.70%
VI	23.76	24.11	1.48%

To conclude the Rhine market analysis, it is important to underline some methodology limitations. First, the basic data about freight transport activities in 2005 are themselves derived from a European freight transport model. These are not really observed data, which, actually, do not exist at this level of detail. Furthermore, they are yearly data, which means that the analysis proceeds as if the corresponding traffic is equally spread over the year. Secondly, the NODUS model does not fully integrate the fleet capacity constraint, even though the 'IWW only' model used is calibrated on the existing fleet operating on the Rhine. The NODUS model simulations assume that transport costs are minimised. This hypothesis is quite reasonable in the framework of a freight transport analysis, but does not take into account the full complexity of shipping decision making. However, the calibration of the cost functions integrates into some extent the missing factors into the model.

Cost analyses on effects of freight flows for different water levels

In addition to the high level NODUS analysis, a detailed review was done of a few voyages that are sensitive to changing water levels.

This information is compared with the market prices in order to validate the effects. When water levels are favourable (higher), larger vessels have lower unit costs than smaller vessels, which is due to their higher load factors and higher speeds. The energy use of larger vessels is, in terms of litre fuel per ton km lower compared to smaller vessels. Economies of scale are realized for the largest vessels (except the JOWI-type) and pushed convoy. When water levels decrease, costs increase more sharply for larger vessels than for smaller vessels.

For the near future (2021-2050) costs of inland waterway transport may go up or down. This is mainly due to the indifferent change of discharges. However, for the distant future (2071-2100), it is evident that the costs of inland waterway transport will increase to some extent. For the Rhine market considered, most significant impacts are observed on the origin-destination pair Rotterdam – Basel for the transport of 'wet bulk' in the distant future.

Using the pessimistic scenario, the analysis reveals for inland waterway transport on the Rhine River an increase of transport costs per ton by approximately 20%. This is valid for dry and wet cargo, as well as for containers when conducting the transport with a large motor cargo vessel (L=110 m or 135 m), or a coupled formation consisting of a motor cargo vessel and a lighter. The transport costs are projected yearly average transport costs in the period 2071-2100. The different cost items, e.g. fuel price, are based on present values.

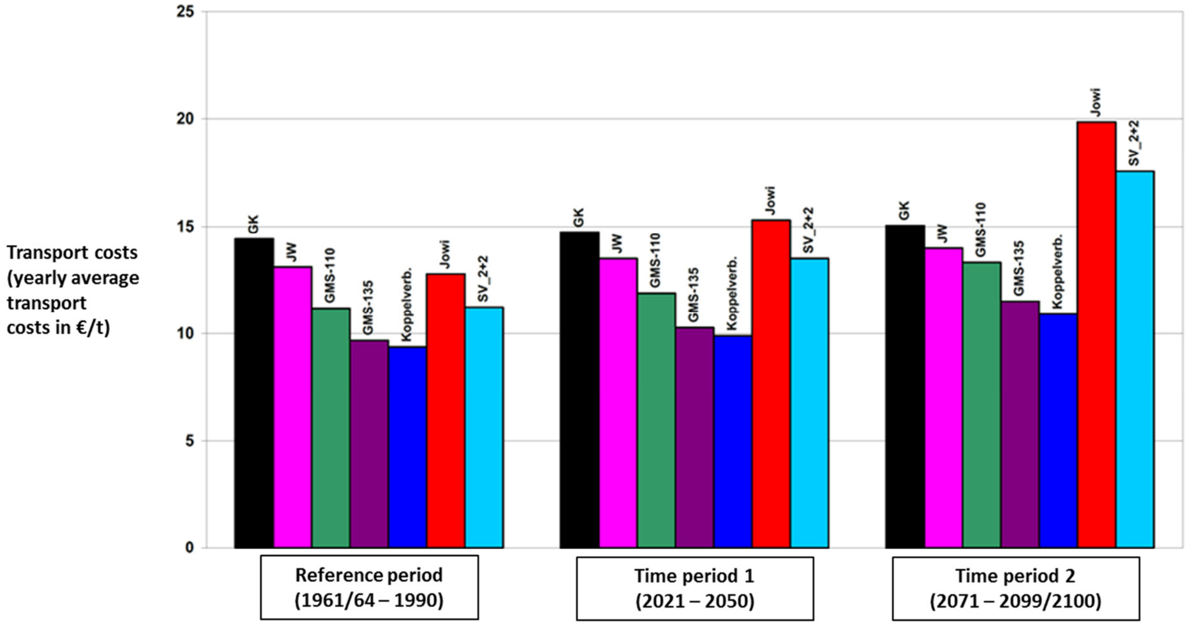

Figure 1: Example for the development of average transport costs over three time periods (1961/64-1990, 2021-2050, 2071-2099/2100) in [€/t] for different vessels. Route: Rotterdam-Basel. Cargo: dry bulk. Climate scenario: pessimistic scenario. Ship types: GK = Gustav Königs, JW = Johann Welker, GMS 110 = large motor cargo vessel (length = 110 m), GMS 135 = large motor cargo vessel (length = 135 m), Koppelverb. = motor cargo vessel + lighter, Jowi = Jowi class vessel, SV_2+2 = pushed convoy (pusher + 4 lighters). Modified figure, based on KLIWAS (www.kliwas.de).

Analyses on market prices for different cargo shipments

In addition to cost modelling a market price analysis was carried out, using actual market prices of the past years (for the river Rhine, e.g. see Table 4 on the next page). It was based on a large dataset with information about market prices on the spot market for different cargo shipments. The analysis confirmed the patterns that were observed by means of NODUS and the cost/price approaches used. Increasing water levels lead to lower market prices, with similar effects for Kaub and Ruhrort. Secondly, large vessels have some economies of scale during the occurrence of normal water levels. The market price which may be asked for is lower than the one for smaller vessels. However, these economies of scale seem to wear out during the occurrence of low water levels when the estimated prices are very similar for different vessel sizes.

The key conclusion is that the modal split impact of climate change seems to be negligible based on the current knowledge. As a result there is less urgency to change logistic chains and related planning instruments/procedures due to climate change. However, it also became clear that already today there are significant variations in the water levels, and, therefore, in the costs and market prices during the year. This is a situation that affects also the competitiveness of inland waterway transport. Therefore, in any case, the inland waterway transport mode will benefit from measures reducing its sensitivity to low water situations in particular.

Table 4: Estimated market prices and costs for inland waterway transport between Rotterdam and Duisburg (market prices and costs are given in Euro per ton cargo transported).

Comparison of market prices and cost estimates 2003						
Rotterdam-Duisburg (230 km)						
Ship type	Maximum capacity	Est. market prices	Est. costs	Price	Costs	Ratio price/costs
		[€]	[€]	[cent/tkm]	[cent/tkm]	
GK	900	5.64	5.09	2.45	2.21	1.108
JW	1250	5.52	4.66	2.40	2.03	1.184
GMS-110	3000	5.24	4.04	2.28	1.76	1.298
GMS-135	3800	5.18	3.52	2.25	1.53	1.473
Comparison of market prices and cost estimates 2006						
Rotterdam-Duisburg (230 km)						
Ship type	Maximum capacity	Est. market prices	Est. costs	Price	Costs	Ratio price/costs
		[€]	[€]	[cent/tkm]	[cent/tkm]	
GK	900	5.058	4.97	2.20	2.16	1.018
JW	1250	4.784	4.49	2.08	1.95	1.065
GMS-110	3000	4.149	3.58	1.80	1.56	1.159
GMS-135	3800	3.999	3.13	1.74	1.36	1.278

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ECCONET - Assessing effects of climate change on the inland waterway network and developing adaptation strategies
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