ECCONET: climate change and adaptation to inland waterways

Transport & Mobility Leuven

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Outline presentation

- Project plan and objectives ECCONET
- Methodological issues
- Effect of climate change on Rhine and Danube
- Impact on modal share (Rhine only)
- Adaptation measures

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- Effects of Climate Change on the inland waterway network
- 7th Framework Program, European Commission
- 10 partners, 5 countries, 5 disciplines:
  - Meteorology
  - Hydrology
  - Infrastructure Management
  - Shipbuilding
  - Economics/Logistics

Methodology and modeling

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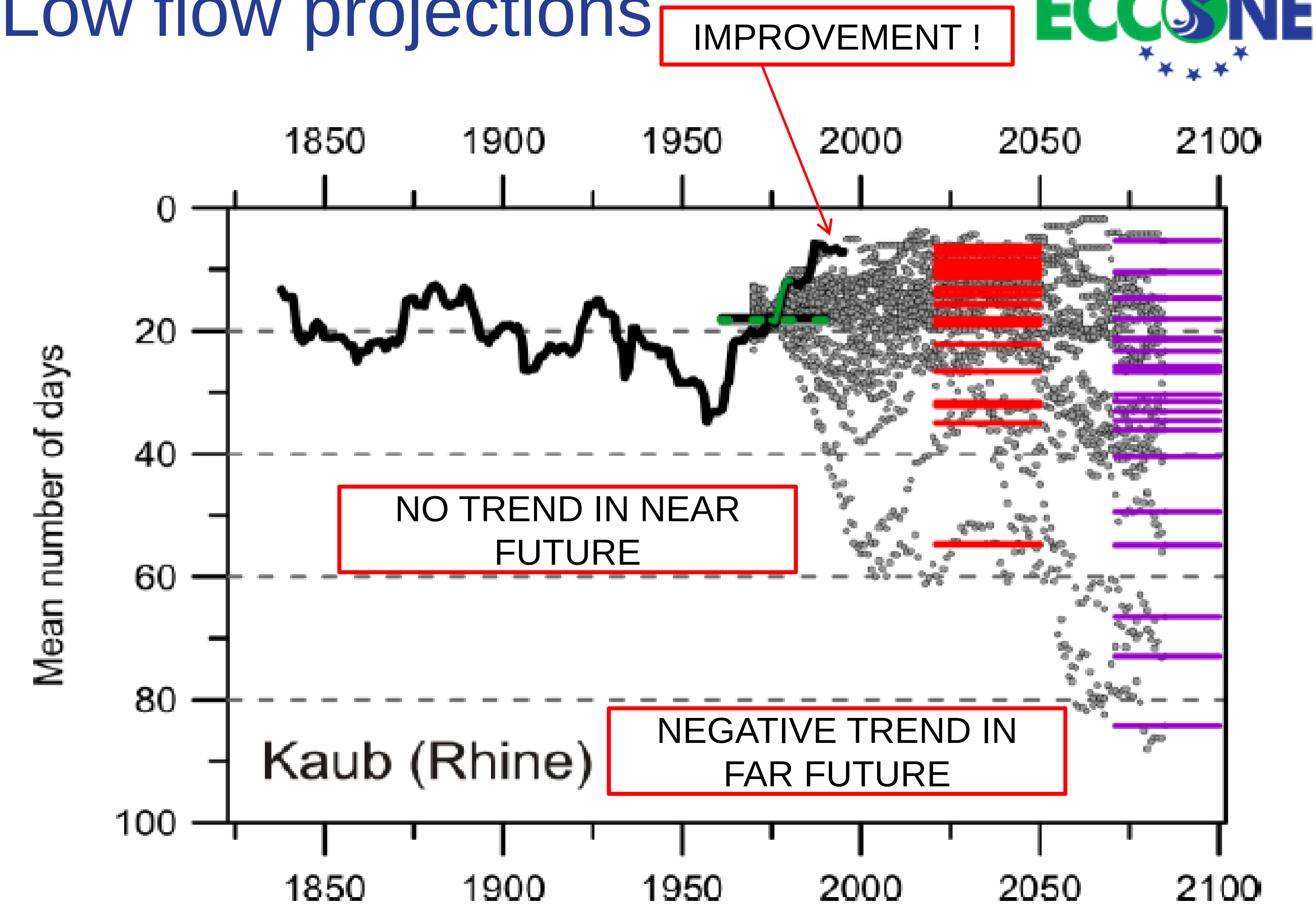
	Time span	Important output variables	Complications
Climatological models	30 year-averages for example:1960-1990, 1991-2021, 2021-2050, 2040-2070, etc.	precipitation, temperature	Bias-prediction, regional climate scenarios, large set of model chains (ensembles), uncertainty
Hydrological modelling	Daily and even hourly variations for all modelled years (30 years)	water levels/water depths on different river stretches based on nature of river	Added uncertainty due to regional variance and anthropogenic factors. Large running time
Transport-economic modelling	Based on an OD-matrix for 1 year. Predictions should be based on averages or should be composed of different characteristic situations	Flow of goods by transport mode (inland waterways are 1 of the modes) Costs of transport (minimized by model)	Difficult to handle sub-annual information (for example seasonal variance) Uncertainty in OD matrix. Only a limited set of model runs is possible

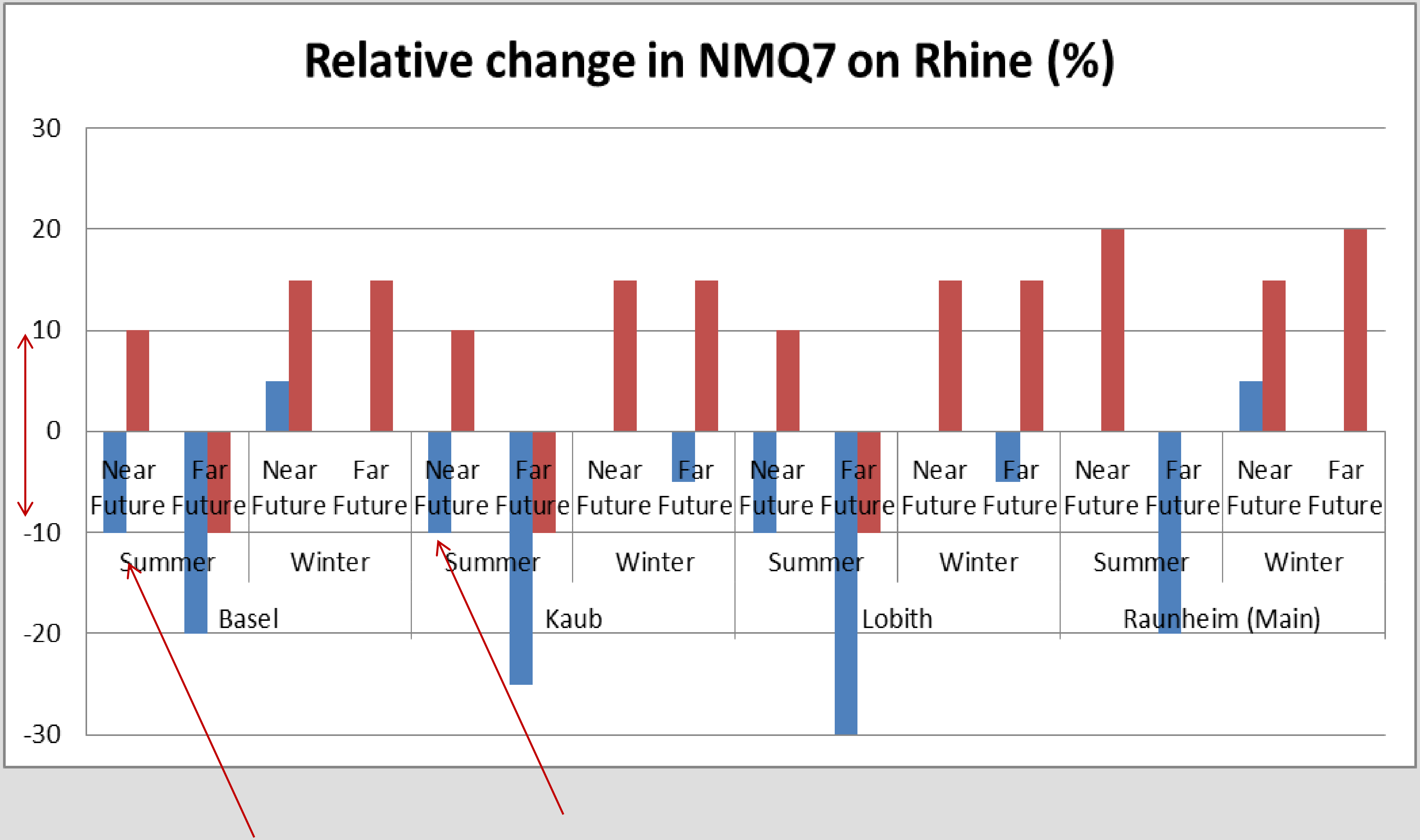
EFFECT OF CLIMATE CHANGE

- Rhine
- Danube

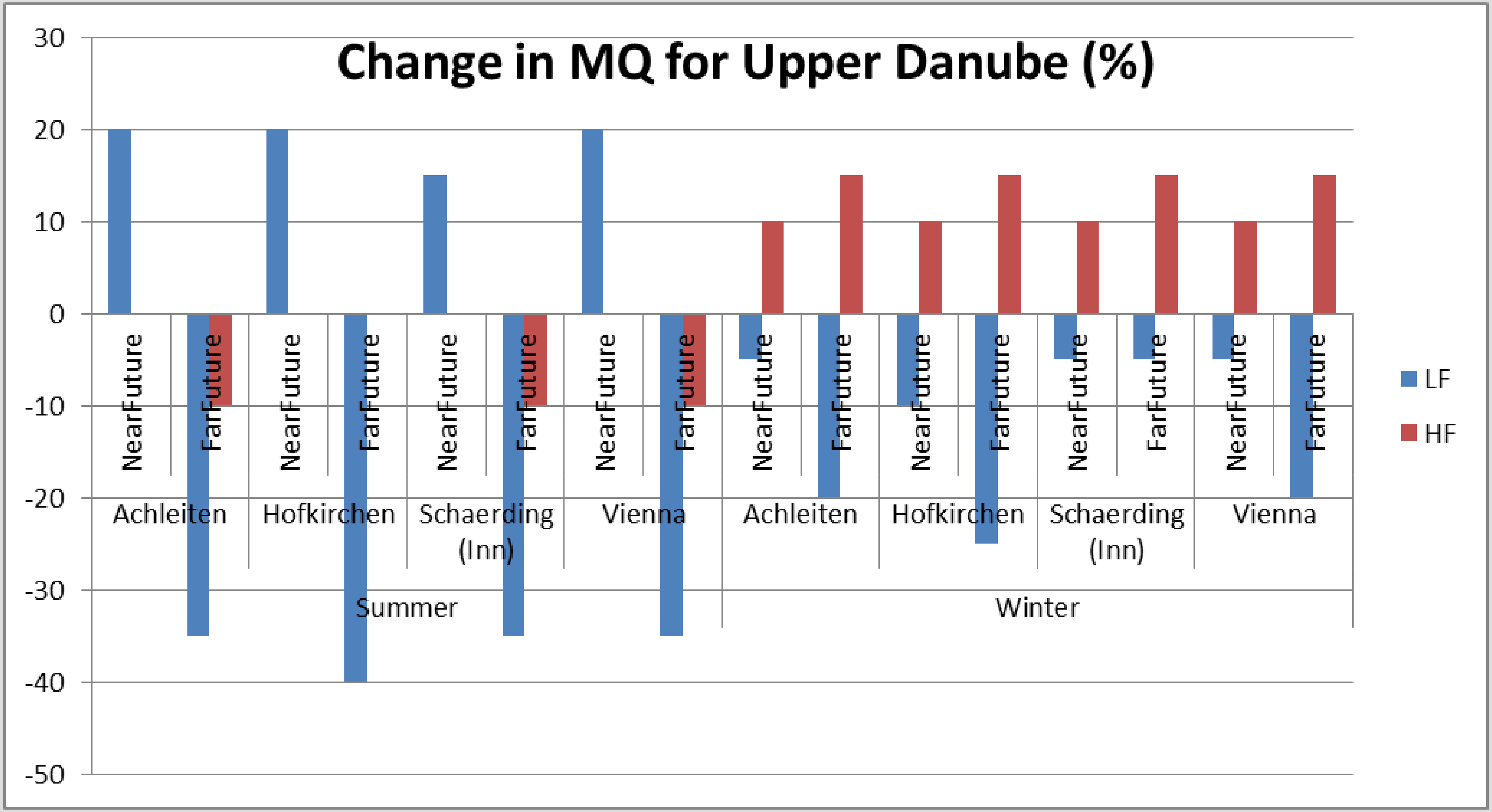
Low flow projections



Effect of climate change on hydrology (1)



Effect of climate change on hydrology (2)



Impact of climate change

Phenomenon	Period	Middle Rhine	RMD canal	Upper Danube
Low flow	1950-2005	positive effect	no effect*	positive effect
	Middle of 21st century	no effect	unknown	negative effect*
	End of 21st century	negative effect	negative effect*	negative effect*
High flow	1950-2005	no effect	no effect	no effect
	Middle of 21st century	negative effect	no effect*	no effect*
	End of 21st century	negative effect	no effect*	unknown
River ice	1950-2005	positive effect	positive effect	positive effect
	Middle of 21st century	no effect*	positive effect*	positive effect*
	End of 21st century	no effect*	positive effect*	positive effect*
Visibility (fog)	1950-2005	positive effect	positive effect	positive effect
	Middle of 21st century	unknown	unknown	unknown
	End of 21st century	unknown	unknown	unknown

Impact on modal share

- Rhine
- (Danube forthcoming)

Effect of low water

Table 2: The Kaub case in 2005

Water depth	Days frequency								Average cost per ton/km Boat Va Upstream Dry bulk	% Payload Boat Va
	1993		1989		1985		2005			
	Nbr	%	Nbr	%	Nbr	%	Nbr	%		
> 4.3 m									0.0122	100.00%
at 4 m									0.0122	100.00%
at 3.4 m									0.0136	84.00%
at 3 m									0.0157	68.00%
at 2.70 m									0.0180	56.00%
at 2.40 m									0.0221	44.00%
at 2 m	0	0,00%	0	0,00%	11	3,01%	0	0,00%	0.0333	28.00%
Total	**365**	**100,00%**	**365**	**100,00%**	**365**	**100,00%**	**365**	**100,00%**		

Costs rise quickly under low water conditions
Below 1.6 meter, most inland waterway transport becomes impossible

Representative years

	Reference		Model 1977-2006		Model 2022-2050	
			Dry	Wet	Dry	Wet
	Nbr	%				
> 4.3 m	55	15,07%				
at 4 m	97	26,58%				
at 3.4 m	129	35,34%				
at 3 m	55	15,07%				
at 2.70 m	20	5,48%				
at 2.40 m	7	1,92%				
at 2 m	2	0,55%				
Total	**365**	**100,00%**				

Does it really matter?

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Model relevancy evaluation

Climate impacts with 2050 demand & network

Scenario	Mode	Observations	Climate scenario 1977-2006		Climate scenario 2020-2050		Climate scenario 2020-2050	
		2005 Data	2005 Data		2005 Data		2050 Data	
			Dry	Wet	Dry	Wet	Dry	Wet
Average	**IWW**	10,82%	10,79%	10,82%	10,78%	10,84%	9,38%	9,45%
	Rail	16,67%	16,68%	16,67%	16,68%	16,66%	11,52%	11,50%
	Road	72,51%	72,53%	72,52%	72,54%	72,50%	79,10%	79,05%

Climate impacts if demand & network remain identical

Relative effect by ship type (1)

#	CEMT class	Name (type of ship, train)	Length (m)	Beam (m)	Draught min. (m)	Draught max. (m)	Payload at max. draught (t)
1	**II**	**Kampine**	55	6.6	1.40	2.50	600
2	**III**	**Gustav Koenigs**	80	8.2	1.10	2.50	1,080
3	**IV**	**Johann Welker ("Europe"-ship)**	85	9.5	1.20	2.80	1,560
5	**Va**	**GMS 110**	110	11.4	1.35	3.50	2,873
6	**Vb**	**GMS 110 + 1 x E-II Rhine**	185	11.4	1.35	3.50	5,292
7	**VIb**	**PB + 2 x 2 Rhine E-II barges**	193	22.8	1.70	4.00	11,356

Relative effect by ship type (2)

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Climate effect 2005			
Class of ship	Dry scenario	Wet scenario	Change dry-wet
II	10.51	10.51	**0.00**
III	19.03	16.69	**14.02**
IV	40.11	39.49	**1.57**
Va	34.37	36.51	**-5.86**
Vb	12.47	12.94	**-3.63**
VI	23.76	24.11	**-1.45**

Conclusion climate effects

- Until +- 2003 improvements in flow on Rhine river
- Very little change on Rhine and Danube basin until 2050
- Consistently more effects in ‘far future’ case until 2100
- Trend in far future towards drier summers and wetter winters is confirmed
- Infrastructure related and autonomous transport-economic effects far dominate possible climate change related threats for the sector
- When disaggregating impact over ship types, advantages for ships until CEMT class IV on Rhine
- Trend towards larger ships tends to increase vulnerability of IWT sector for variability in water level

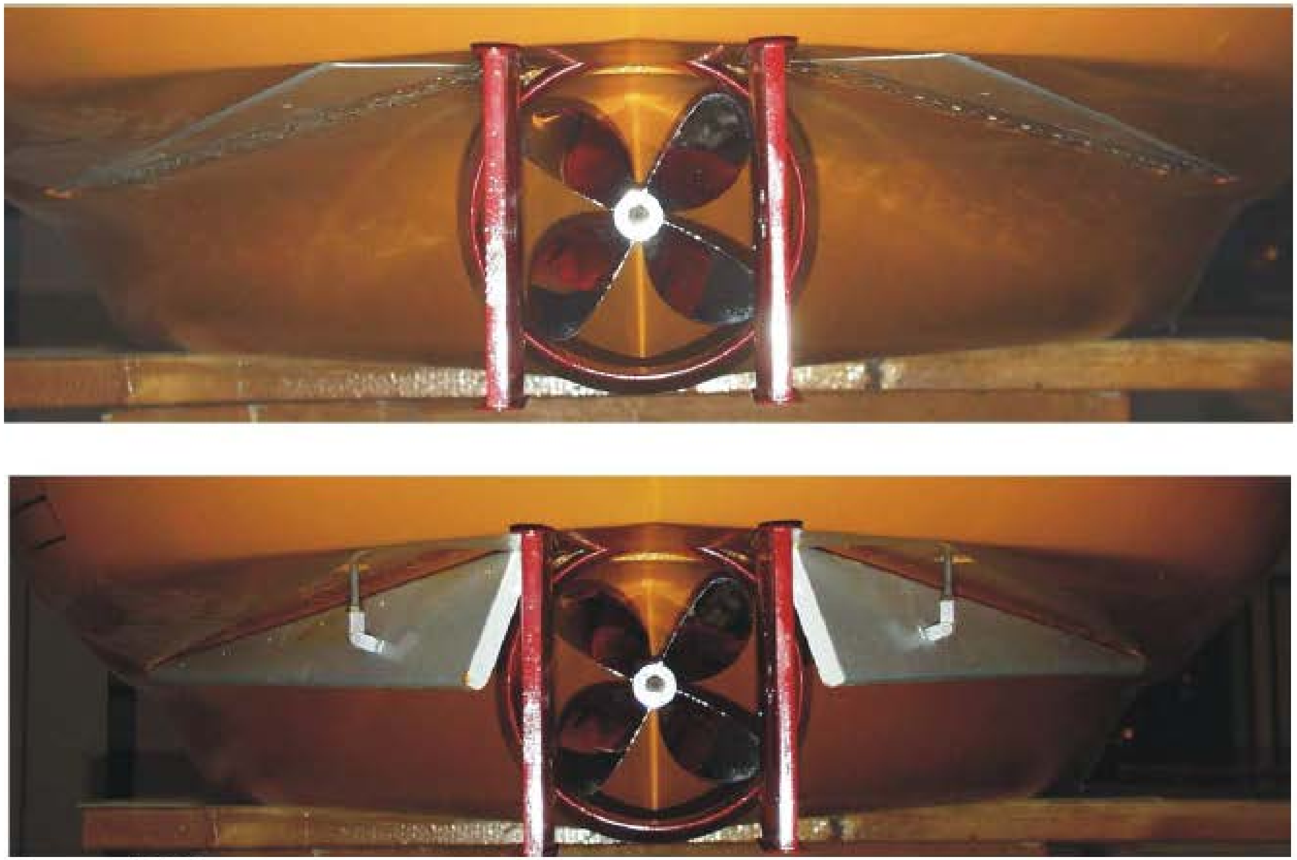
ADAPTATION MEASURES

- Fleet adaptation
- Infrastructure
- Prediction
- Logistics

Fleet adaptation

Measure		Primary effect	Preliminary assessment
A1	Lightweight structure	Reduction of own weight causing lower draught	Further research necessary on technical solutions
A2	Adjustable tunnel	Navigation in lower water levels	In combination with A1
A3	Side blisters	Payload gain between 115 and 260 tonnes	Theoretical approach, handling provides to be difficult
A4	Flat hulls (multiple screw push boats)	Draught reduction from 1.7 to 1.4 meter	**Promising approach** especially for push boat technology, even at increased construction cost
B1	Small instead of large vessels	Small vessels are less water sensitive	Goes contrary to scale effect
B2	Upgrade of small vessels to continuous operation	Increased performance	**Promising approach**
B3	Coupling convoys	Redistribution of load	**Promising** due to increased scale effect
C1	Strategic alliance between IWT and other modes	Co-operation with other modes	Capacity limits of rail and high prices make this difficult

Adjustable tunnels



Source: DST

Fig. 4: *Adjustable tunnel aprons (in functional model scale)*

- to be retracted into the hull if the ship utilizes its full draught in deep water (above)

- to be extracted when the ship operates with small draught in low water (below)

Side blisters

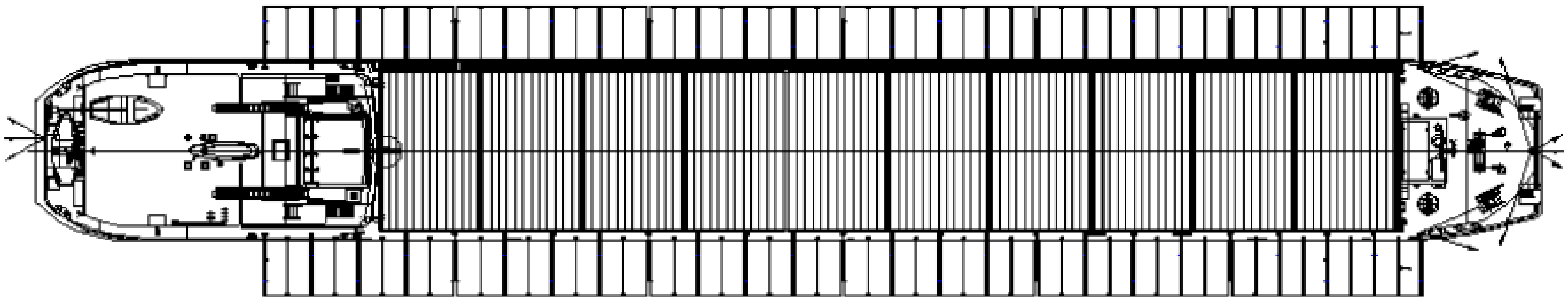


Fig. 7: General arrangement plan of a ship with laterally extractable buoyancy elements

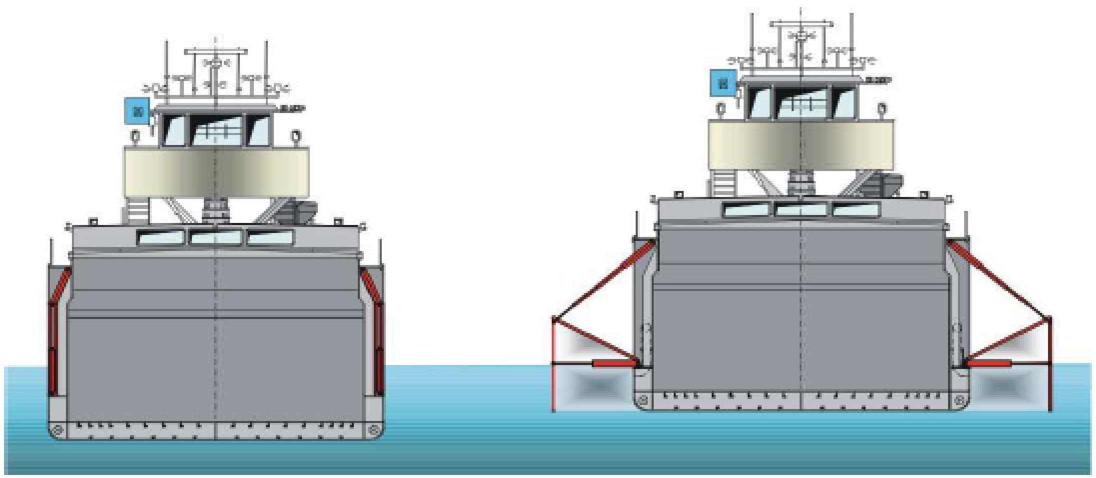
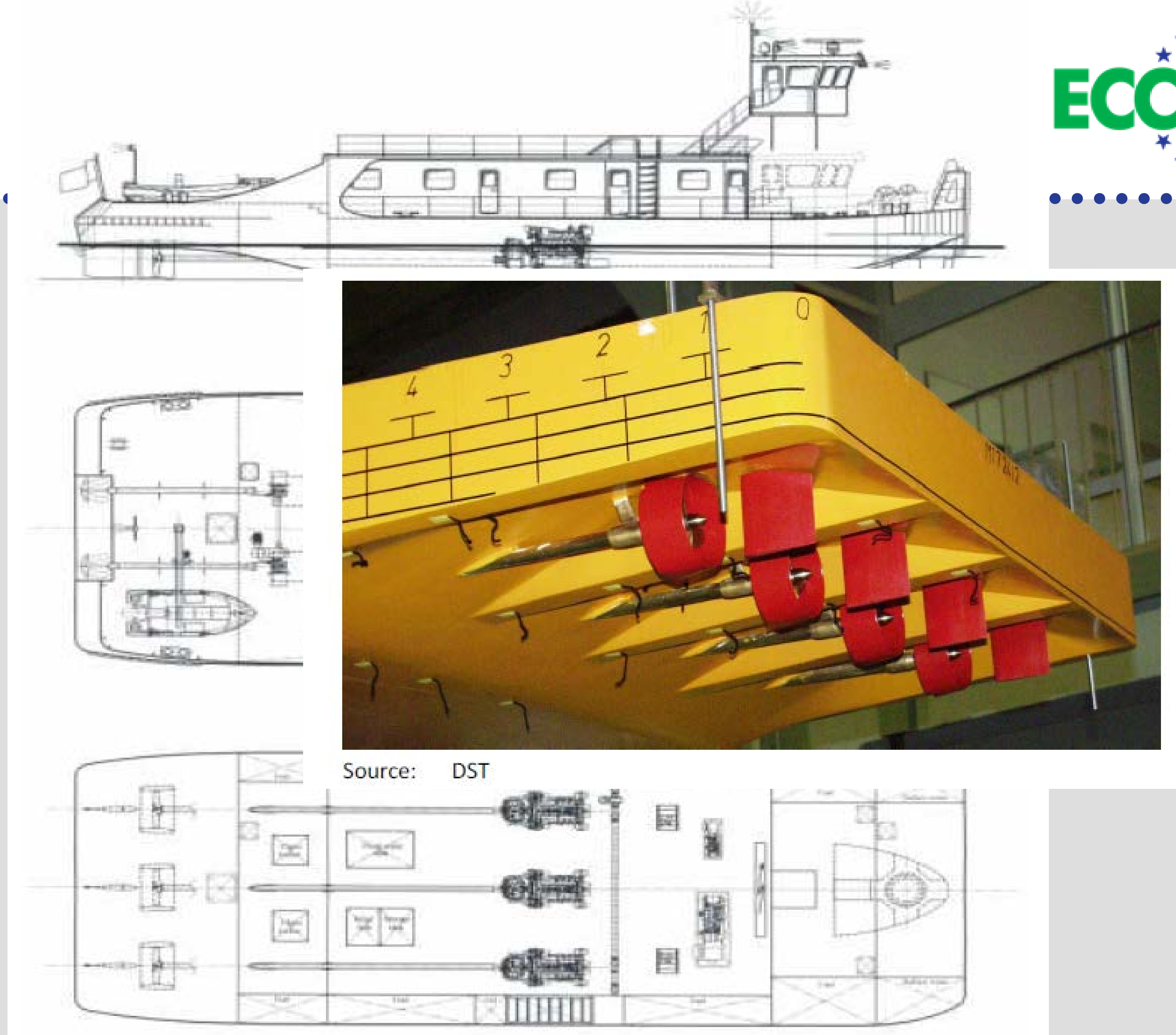


Fig. 8: Cross section of a ship with laterally extractable buoyancy elements



Source: DST

Infrastructure: information & dredging

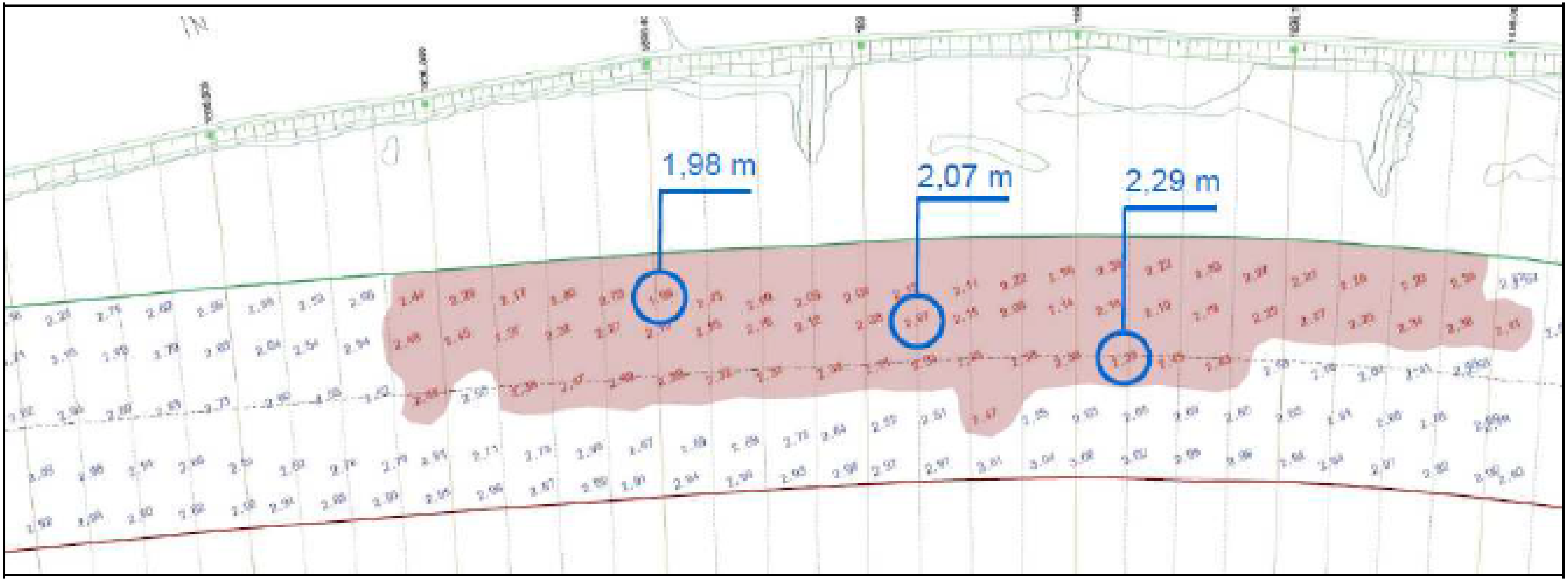


Figure 3.6: Track plot of fairway depth information of a shallow, available at the DoRIS website. Source: via donau.

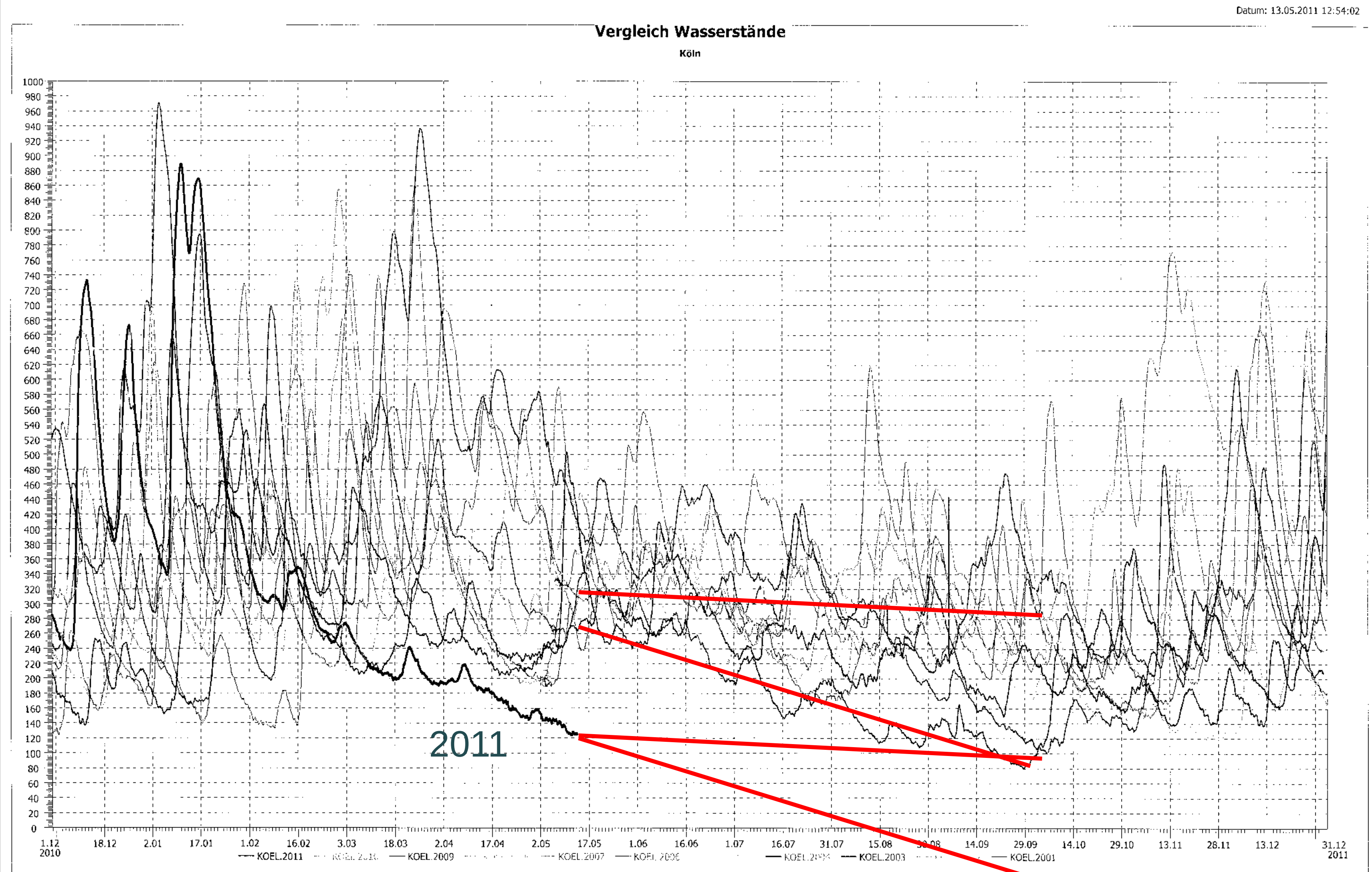
Infrastructure adaptation: engineering

Figure 3.7: Measures within the Pilot Project Witzelsdorf. Source: via donau.

Seasonal prediction methods

- Improved prediction of water level situation (currently 3-5 days)
- Possibility of 1-3 months predictions and more was studied
- **Conclusion:** theoretically very appealing, also large interest from the sector..
  Unfortunately:
  - High R&D costs with a relatively low success rate for actual ‘trustworthy method’
  - Possible: extraction of trends in seasonal forecast…
  - From our data: 2011 could have been as bad as 2003 for inland waterway transport, if the summer had not been that ‘wet’.

More knowledge than service for economic activity at this point



Adaptation by industry

Table 4.2: Preferred adaptation measures

	First best	Second best	Third best	*Total*
Smaller ship		1		*1*
Lighter ship	2	1		*3*
Storage capacity	1	2	3	*6*
Alternative transport	5	2	1	*8*
Shutdown production			1	*1*
Relocation production				
Koppelverband		1		*1*
Total	*8*	*7*	*5*	*20*

INLAND WATERWAY TRANSPORT IS USED FOR ITS RELIABILITY

	Measure	Review method		
Dimension	**Adaptation measure**	**Lit. review**	**Stakeholder view**	**Overall assessment**
FLEET	Lightweight structure	Feasible	Ship owners	Feasible
	Adjustable tunnel	Feasible	Ship owners	Feasible, but costly
	Side blisters	Feasible	Ship owners	Feasible, but costly
	Flat hulls	Feasible	Ship owners	Feasible
OPERATION	Smaller vessel	Not realistic	Not realistic	Less feasible
	Continuous operatior	Feasible	Feasible	Feasible
	Coupled convoys	Feasible	Feasible	In operation
	Rail and IWT alliance	Market dependent	Inflexible contracts	Feasible, but not for all goods
INFR	Maintenance	Necessary	Necessary	Feasible and necessary
	River engineering	Necessary	Necessary	Feasible and necessary
PREDICTION	Improved prediction	Reliability?	Important	Necessary if reliable
PROCESS	Storekeeping	Feasible	Costly	Short run solution
	Relocation of product	Less feasible	Very costly	Low feasibility

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ECCONET website

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