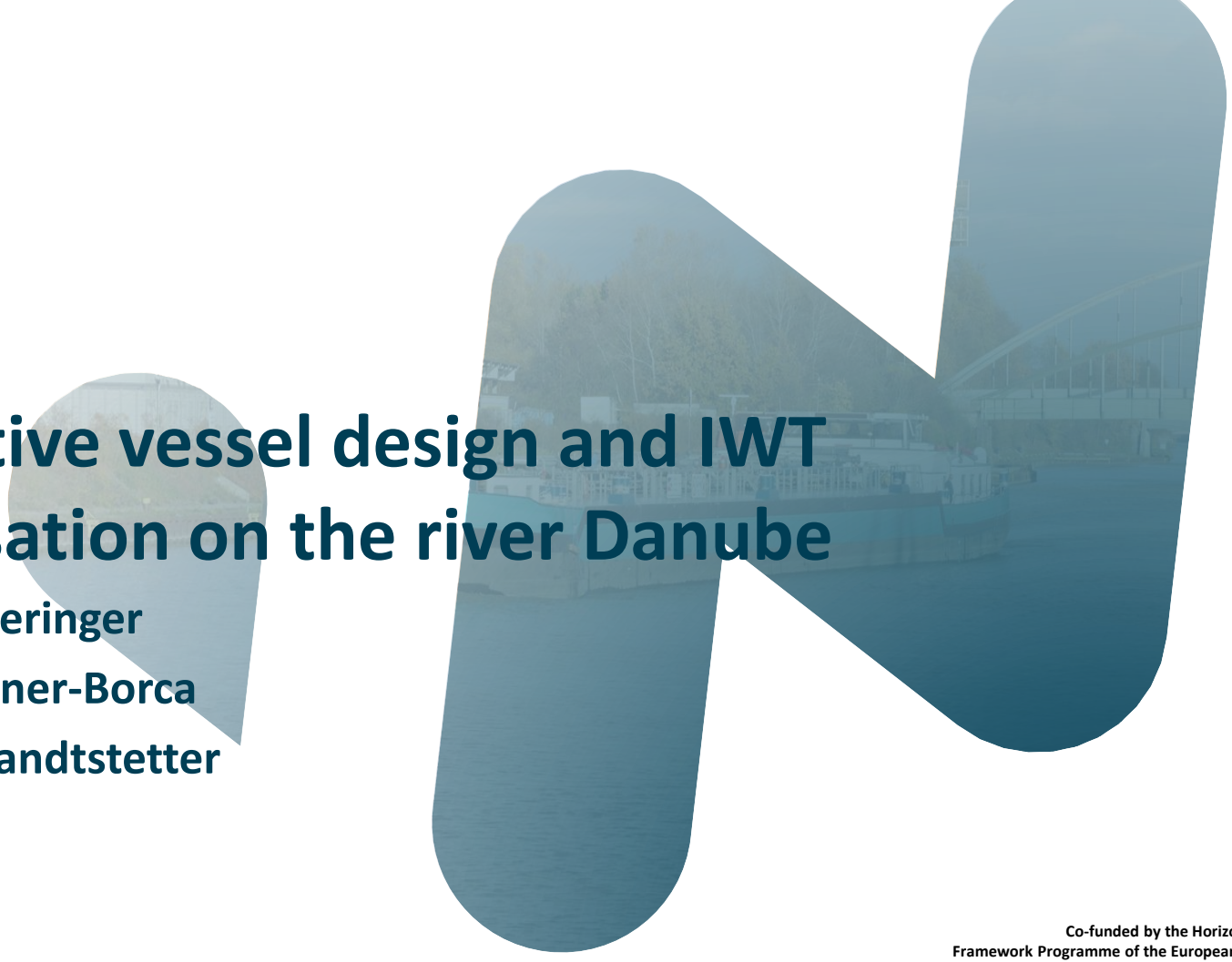

10/16/2023

Innovative vessel design and IWT optimisation on the river Danube

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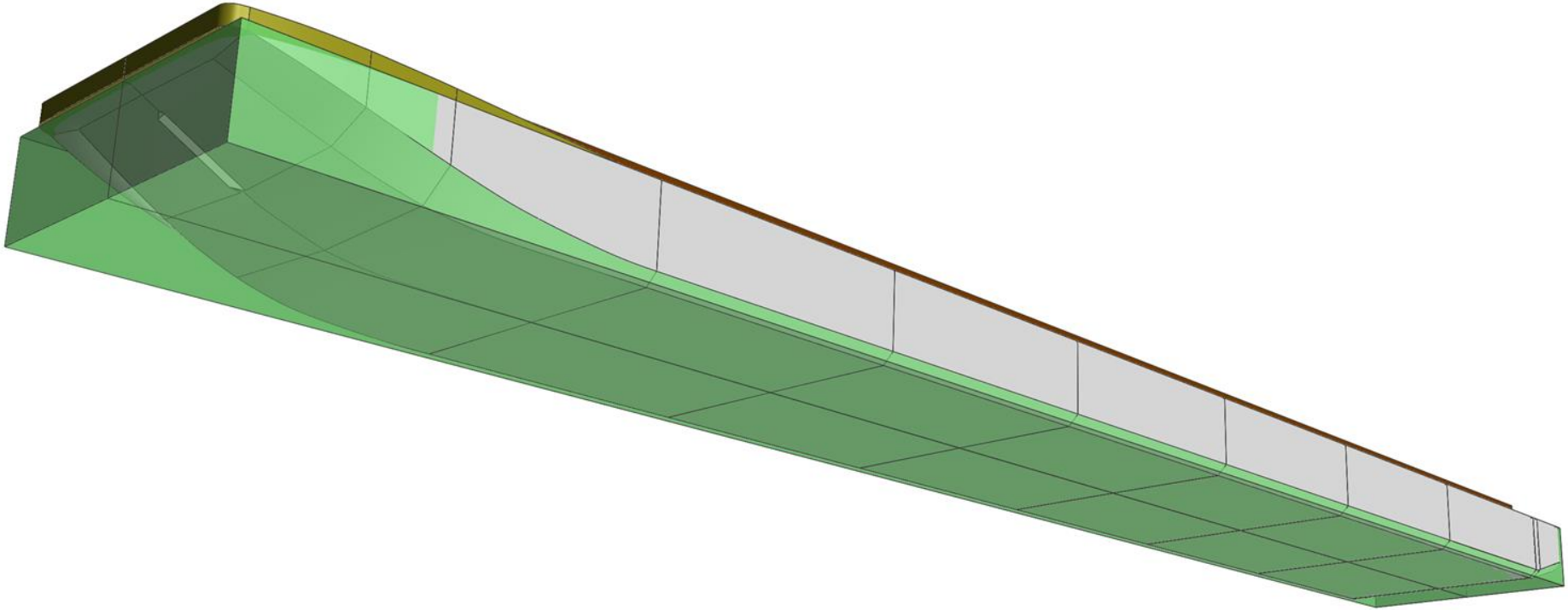
New Design Options for Improved Navigability

Considerations on status quo

- Transport of containers by inland waterway in Danube corridor with considerable margins for improvement
- Available barges not specifically designed for container transport
  - Europa 2b – 24 45ft high-cube units in 2 layers
  - Europa 3a – 30 24ft high-cube units in 2 layers
- Barges should be capable of accommodating in particular 45‘ pallet-wide high-cube units in order to ensure seamless integration in logistic chains
- Existing infrastructure has an impact on possible/feasible barge dimensions
  - → Waterway infrastructure analysis
  - → Port infrastructure analysis

You can‘t cheat on good old Archimedes



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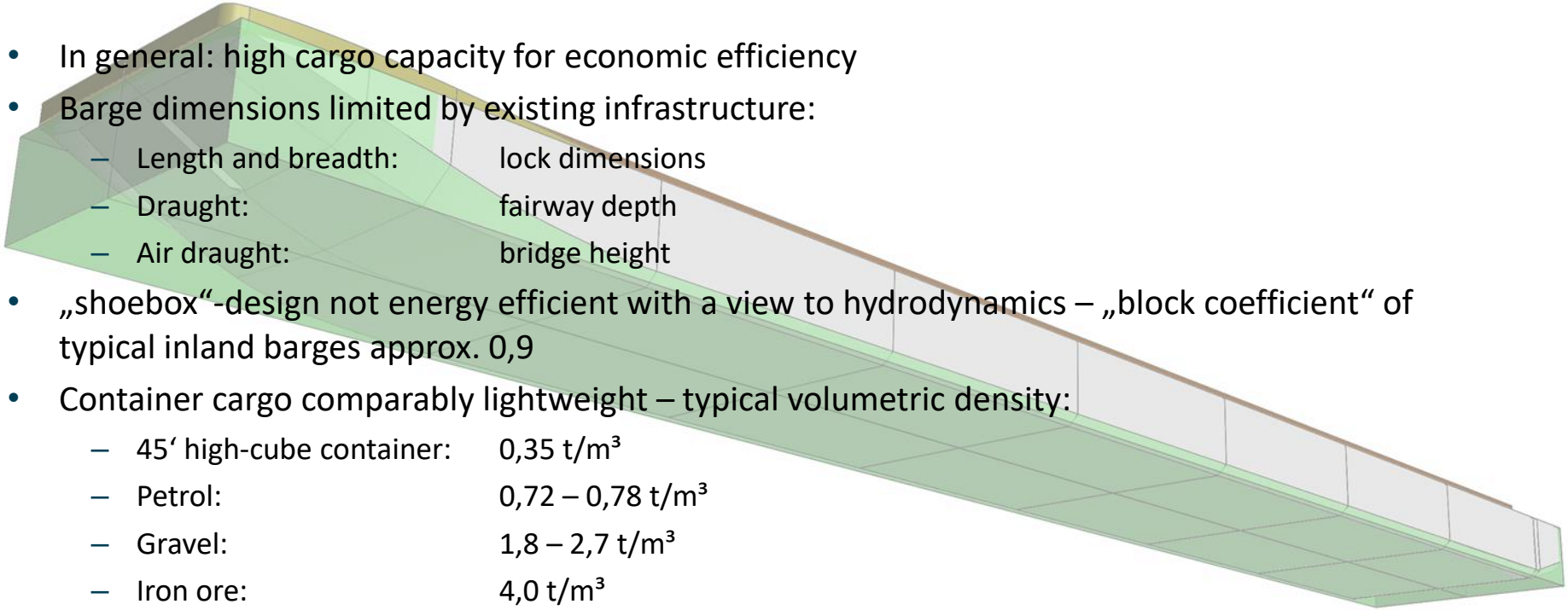
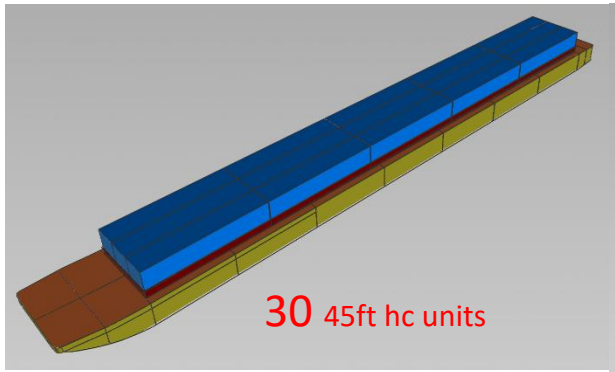
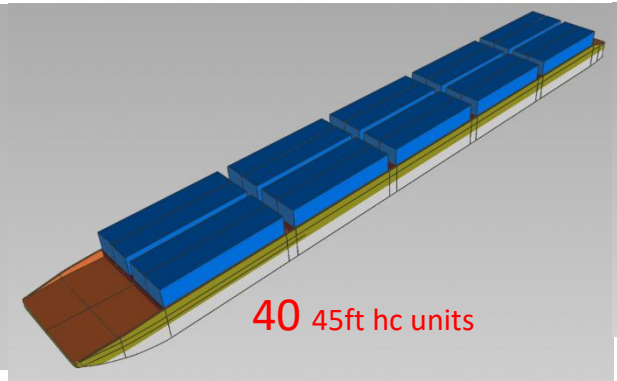


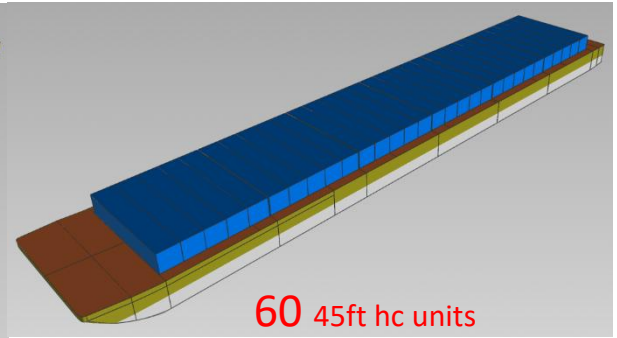
- In general: high cargo capacity for economic efficiency
- Barge dimensions limited by existing infrastructure:
  - Length and breadth: lock dimensions
  - Draught: fairway depth
  - Air draught: bridge height
- „shoebox“-design not energy efficient with a view to hydrodynamics – „block coefficient“ of typical inland barges approx. 0,9
- Container cargo comparably lightweight – typical volumetric density:
  - 45‘ high-cube container: 0,35 t/m³
  - Petrol: 0,72 – 0,78 t/m³
  - Gravel: 1,8 – 2,7 t/m³
  - Iron ore: 4,0 t/m³

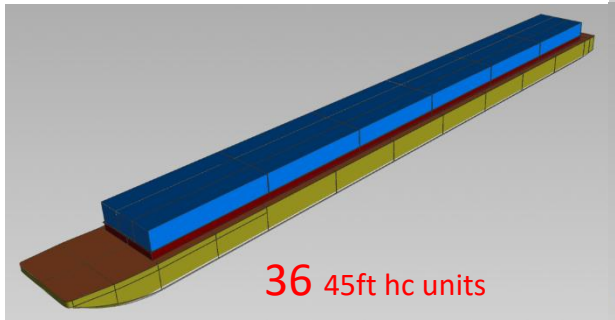
New design options for barges

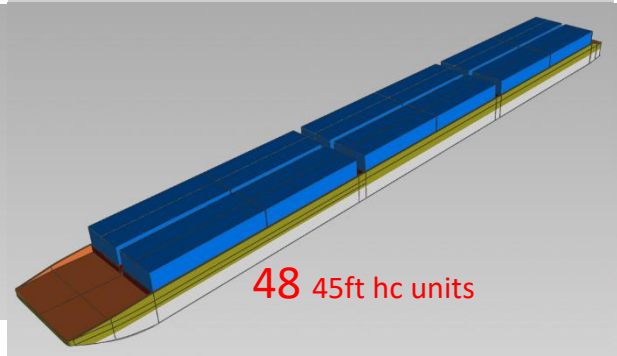
- 6 new barge types developed

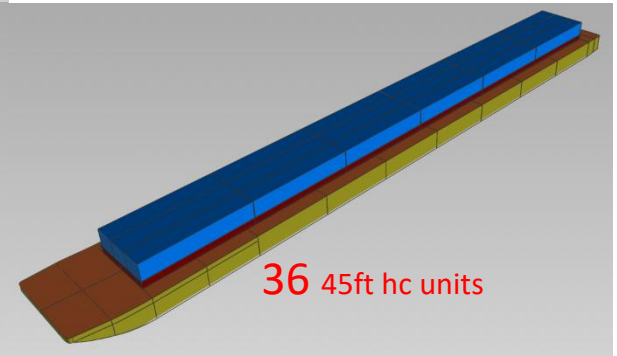






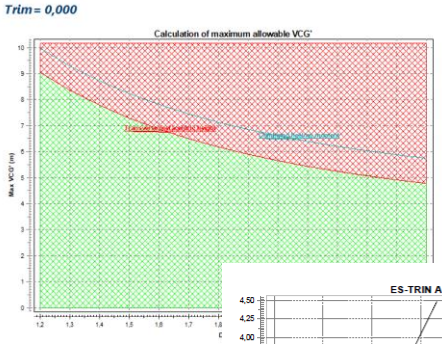


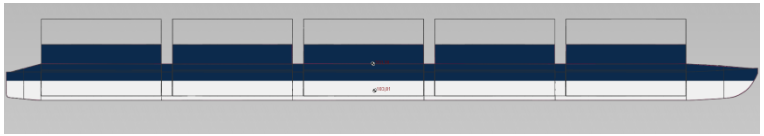


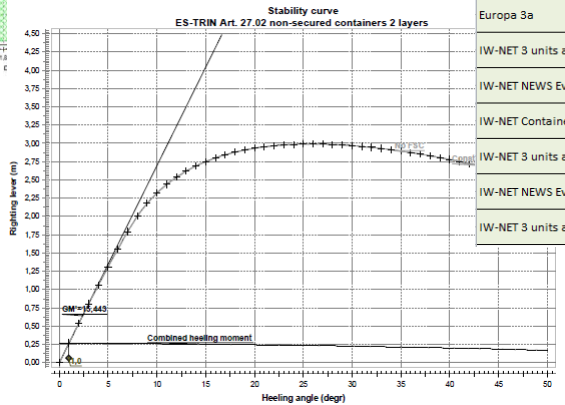


Stability assessment

- In accordance with Chapter 27 of ES-TRIN 2021 for non-secured containers







Stability assessment - Position of actual VCG vs. Maximum allowable VCG					loading condition					
					2 layers			3 layers		
Vessel type	Project ID	length	breadth	side height	empty	70 % full	100 % full	empty	70 % full	100 % full
Europa 2b	001	76,50	11,45	3,20						
Europa 3a	002	90,00	11,45	3,25						
IW-NET 3 units abreast	003	81,00	9,50	3,20						
IW-NET NEWS Evolution v2	004_v2	85,92	11,45	4,10						
IW-NET Containers transverse v2 (Solidworks)	005_v2	89,80	16,28	4,00						
IW-NET 3 units abreast long	006	94,77	9,50	3,20						
IW-NET NEWS Evolution long	007	97,32	11,45	4,10						
IW-NET 3 units abreast long/shallow	008	94,77	11,45	3,20						

Sightlines assessment

- Checked against requirements of CEVNI – Article 1.07
  - Pusher with fixed wheelhouse
  - Pusher with elevating wheelhouse

Pusher Type 1 (fixed wheelhouse)

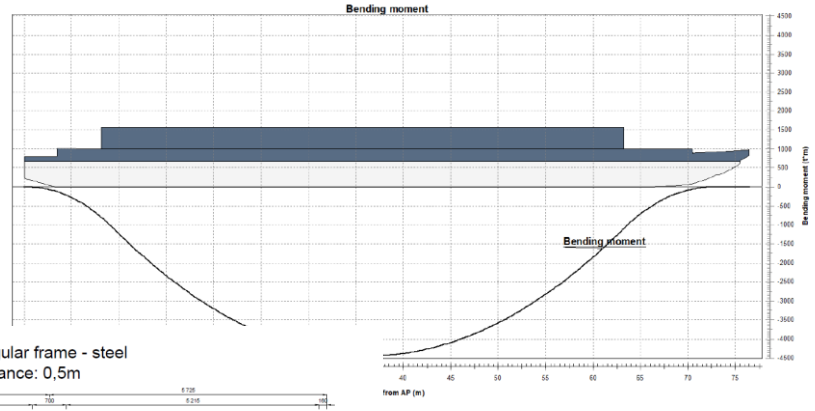
Vessel type	Project ID	length	breadth	side height	pushed convoy one barge length, loading condition: empty	2 layers: 70 % full	2 layers: 100 % full	3 layers: empty	3 layers: 70 % full	3 layers: 100 % full
Europa 2b	001	76,50	11,45	3,20						
Europa 3a	002	90,00	11,45	3,25						
IW-NET 3 units abreast	003	81,00	9,50	3,20						
IW-NET NEWS Evolution v2	004_v2	85,92	11,45	4,10						
IW-NET Containers transverse v2 (Solidworks)	005_v2	89,80	16,28	4,00						
IW-NET 3 units abreast long	006	94,77	9,50	3,20						
IW-NET NEWS Evolution long	007	97,32	11,45	4,10						
IW-NET 3 units abreast long/shallow	008	94,77	11,45	3,20						

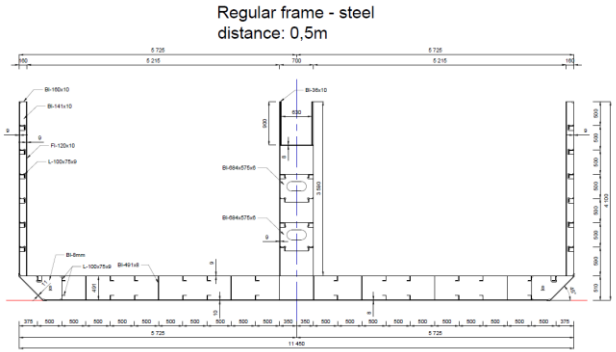
Pusher Type 2 (elevating wheelhouse)

Vessel type	Project ID	length	breadth	side height	pushed convoy one barge length, loading condition: empty	2 layers: 70 % full	2 layers: 100 % full	3 layers: empty	3 layers: 70 % full	3 layers: 100 % full
Europa 2b	001	76,50	11,45	3,20						
Europa 3a	002	90,00	11,45	3,25						
IW-NET 3 units abreast	003	81,00	9,50	3,20						
IW-NET NEWS Evolution v2	004_v2	85,92	11,45	4,10						
IW-NET Containers transverse v2 (Solidworks)	005_v2	89,80	16,28	4,00						
IW-NET 3 units abreast long	006	94,77	9,50	3,20						
IW-NET NEWS Evolution long	007	97,32	11,45	4,10						
IW-NET 3 units abreast long/shallow	008	94,77	11,45	3,20						

Assessment of longitudinal strength – different construction materials

- Benchmark: section modulus for typical cross-section in grade A shipbuilding steel
  - Aluminium
  - Girders in high-tensile steel (S355, S460)
- Aluminium
  - ca. 30 % lighter than steel
  - on average 0,14 m less draught
  - 2,5 – 3 x building costs
- High-tensile steel
  - ca. 10 % lighter than grade A
  - on average 0,05 m less draught
  - Building costs nearly on par





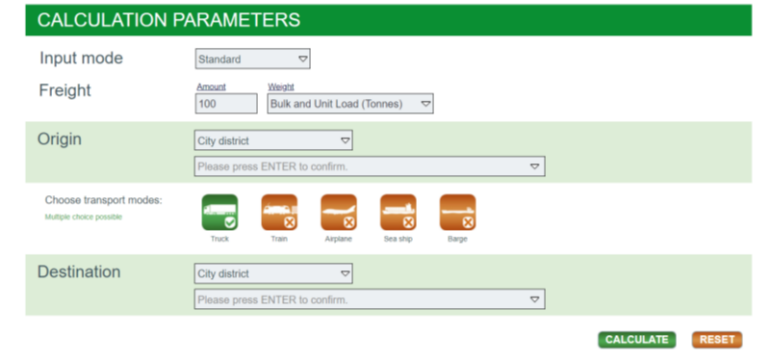
GHG emission calculations in the IWT sector

- for many companies, tracking GHG emissions from supply chain transportation is a challenge – little information is directly available from carriers
- calculations with primary data, with program data, with detailed modeling or with default data
- standards and tools for logistics emission calculation

Global Logistics Emissions Council Framework

for Logistics Emissions Accounting and Reporting

Smart Freight Centre · GHG · GLEC



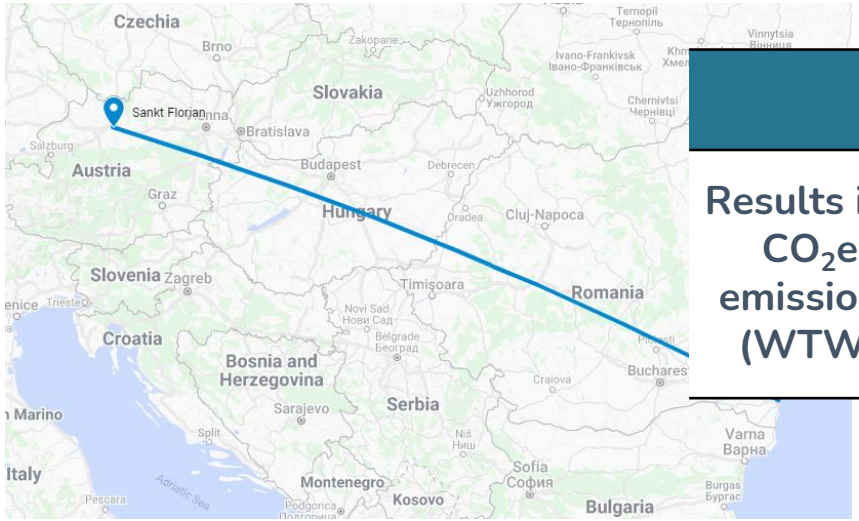
EcoTransIT

Methodology for calculation and declaration of energy consumption and GHG emissions of transport services (freight and passengers)

EN16258

carboncare REDUCE EMISSIONS

Transport example: Comparing CO2e emissions savings by using IWT instead of road transportation



		GLEC Framework 2.0	EcoTransIT World
Results in t CO_2e emissions (WTW)	Road	57.78	46
	Inland Waterway (multimodal)	16.94	24.11

Conclusion

- great potential to save CO2 when using multimodal transport
- results are different depending on the input parameters and the data source
- calculation of many transport examples and the comparison with different methods and tools could provide important further insights into savings
- it should be a goal to get more primary data (fuel consumption) or actual emissions for calculating transport emissions - very challenging
- handling is not included in the calculations, although it is an important component in multimodal transport

Data-driven Navigability

Visualisation Tool

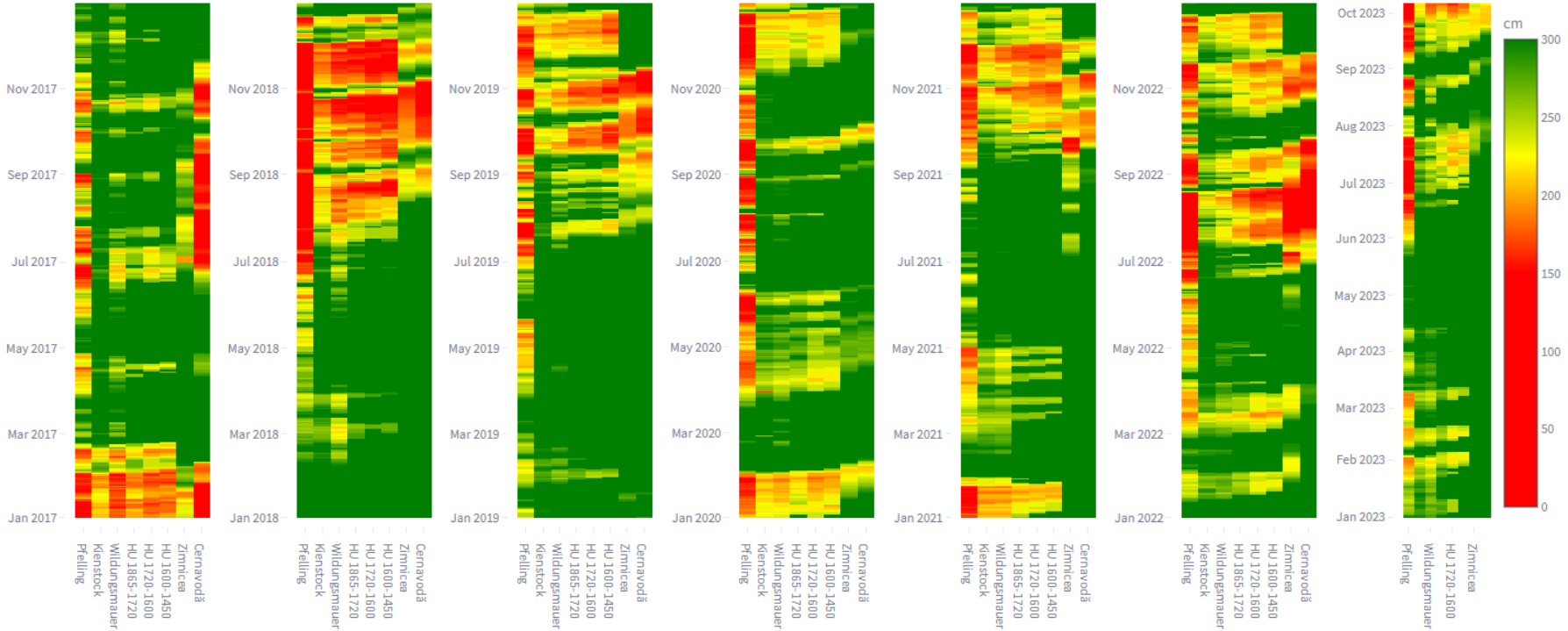
Basic Idea

- Assessing the feasibility of river transportation based on (historic) data
  - Water level
  - Departure location
  - Arrival location
  - Loading Draught
  - Travel speed
  - Operating hours

Goal

- Build a basis for analysing (especially) economic feasibility
  - How is the overall water level situation?
  - Is my specific route prone to incidents?
  - How was the situation over the last years?

Water level along the Danube over the time



Single Trip Information

- ○ Historical water levels
- ◉ Trip Simulation
- ○ Advanced functions

Port of origin

Constanța

Port of destination

Regensburg

Departure

2019/04/16

Average speed over ground per operating hour (km/h)

10,00 − +

Operating hours per day

18

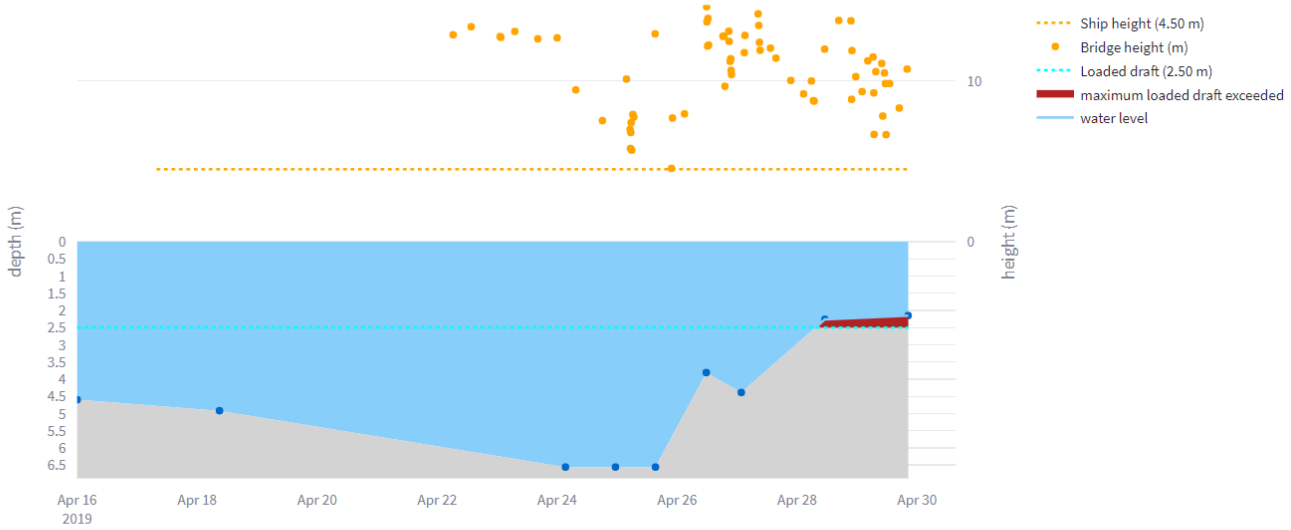
14 24

Loaded draft (m)

2,6 − +

Press Enter to apply

Constanța⟶Regensburg



Statistical Evaluation

Historical water levels
Trip Simulation
Advanced functions

Charts

Shallowest part … ×

Port of origin

Constanţa

Port of destination

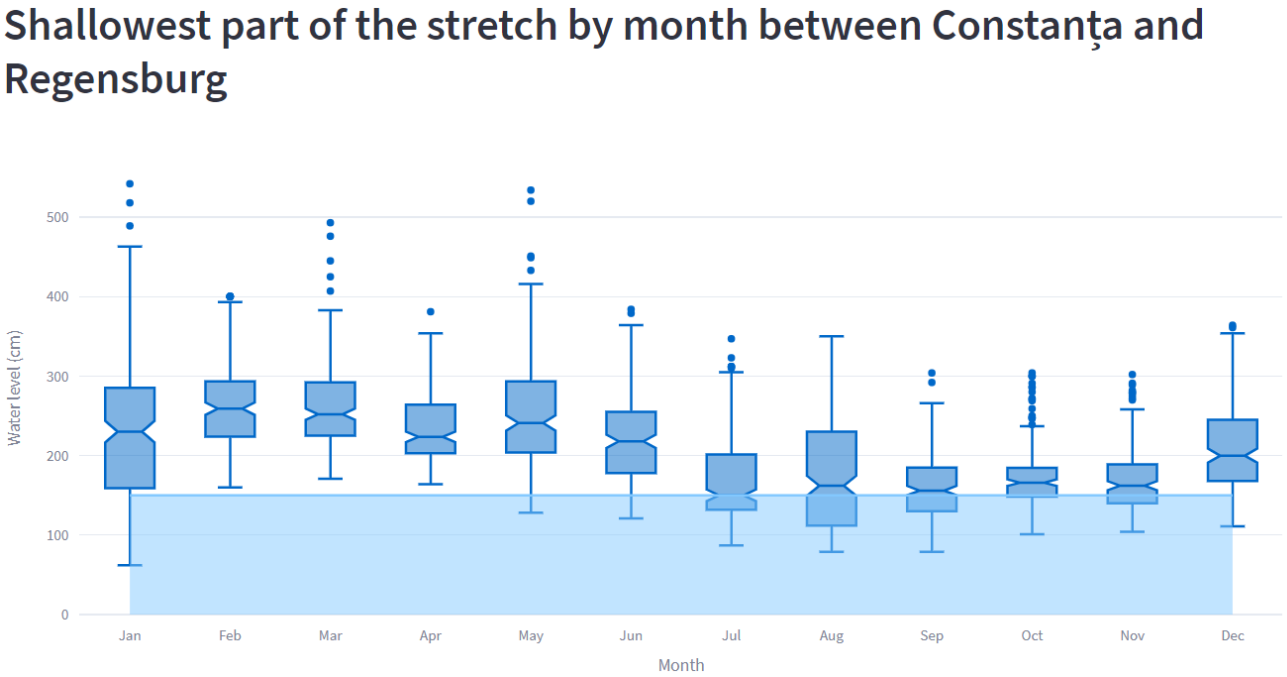
Regensburg

Loaded draft (m)

1,50 − +

Fix height above baseline (m)

7,00 − +



Further development of the visualisation tool

- The tool will be further developed in accordance with AIT
- Project within the context of a doctoral thesis on the topic „Economic evaluation of resolving nautical bottlenecks on inland waterways“
- The aim is to compare transport flows derived from historical data, with theoretically feasible transport flows after removing bottlenecks, and thus, evaluating the economic benefit
- Transportation data (e.g. port of departure, port of destination, type of goods, amount, vessel type incl. unloading depth) will be included in the tool to visualize these transport flows