

Recommended speed limits in Inland Waterways

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1. Introduction

The regulations with respect to maximum allowed speed of inland vessels in the waterway network in Flanders/Belgium are not always adapted to the present fleet and waterway dimensions. The Maritime Technology Division of Ghent University was requested by two inland waterway authorities (Waterwegen en Zeekanaal NV and De Scheepvaart NV) to formulate recommended speed limits for several ship types and loading conditions. For this purpose, a methodology has been developed, based on three criteria:

- Critical speed (to avoid excessive fuel consumption)
- Maximum wave height near banks (to avoid damage)
- Maximum forces on moored vessels (to avoid breaking mooring lines)

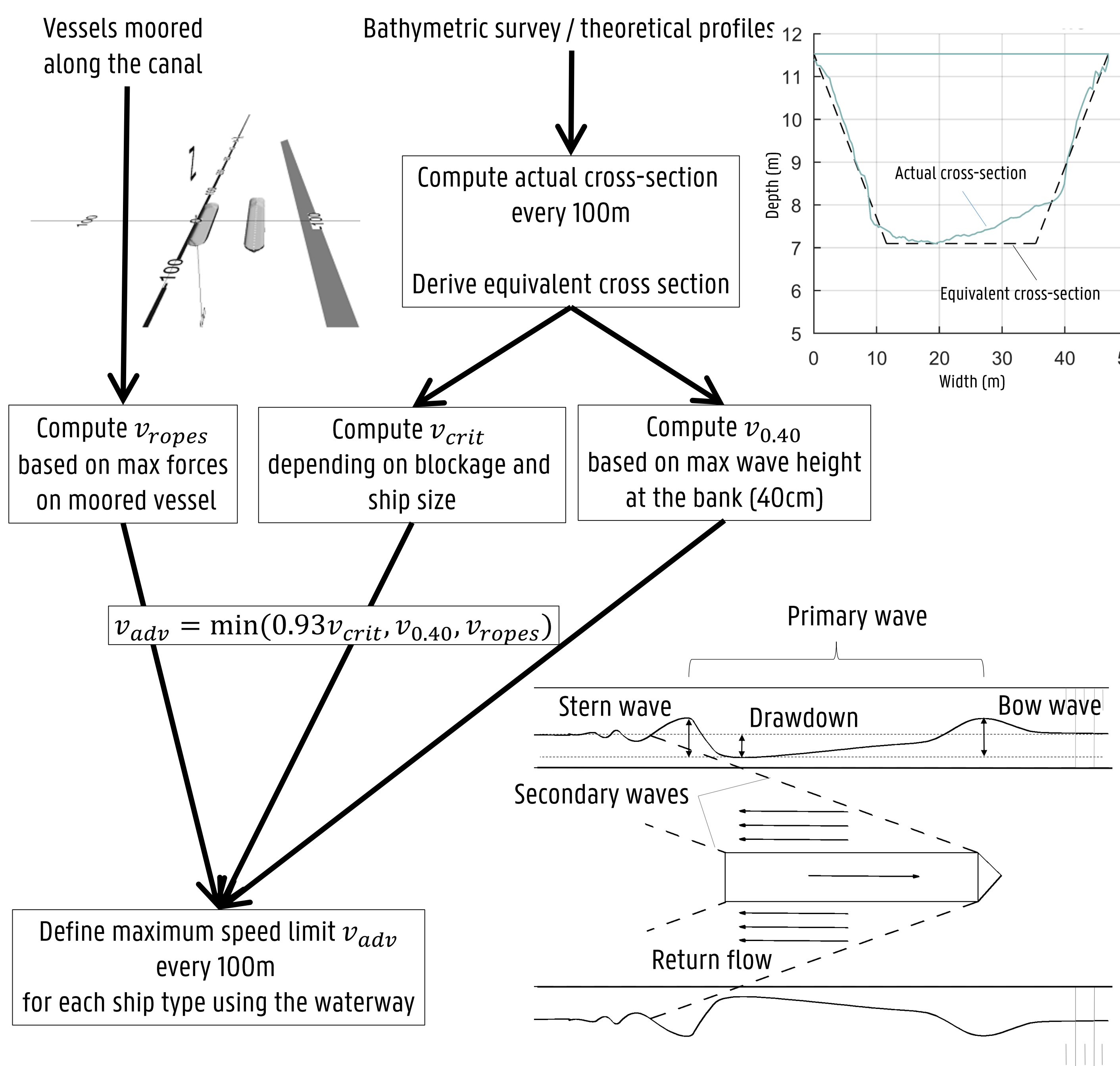
2. Methodology

The first criterion is based on the critical speed of a ship in a confined waterway section. A vessel sailing in a confined waterway moves a large amount of water. This water displacement induces a return flow, pressure differences (drawdown) and waves which result in forces on banks and ships in the vicinity. As all hydrodynamic phenomena (e.g. squat, bank effects, ship-ship interaction), particularly in shallow and confined water, these forces increase with the sailing speed, but increase dramatically when the speed approaching the critical speed v_{crit} resulting in excessive fuel consumption.

The second criterion is based on the methodology of BAW [1] to assess the speed $v_{0.40}$ at which the ship induced waves at the bank reach a height of 0,40m above the calm waterline, which should not be exceeded to avoid damage to banks and infrastructure.

The third criterion is a speed limit v_{ropes} related to the forces acting on moored vessels, for which a limit value has been defined based on the minimum breaking strength of the mooring lines using a dedicated software package (ROPES).

For a broad range of waterways and vessels, the first two criteria were applied using both theoretical cross-sections and cross-sections derived from bathymetric surveys. The third criterion was checked for a selection of terminals along each waterway. These three criteria are finally combined to define maximum sailing speeds along different waterways for a representative selection of ship types and dimensions. The results are compared to the maximum speed according to the present official regulations (v_{reg}).



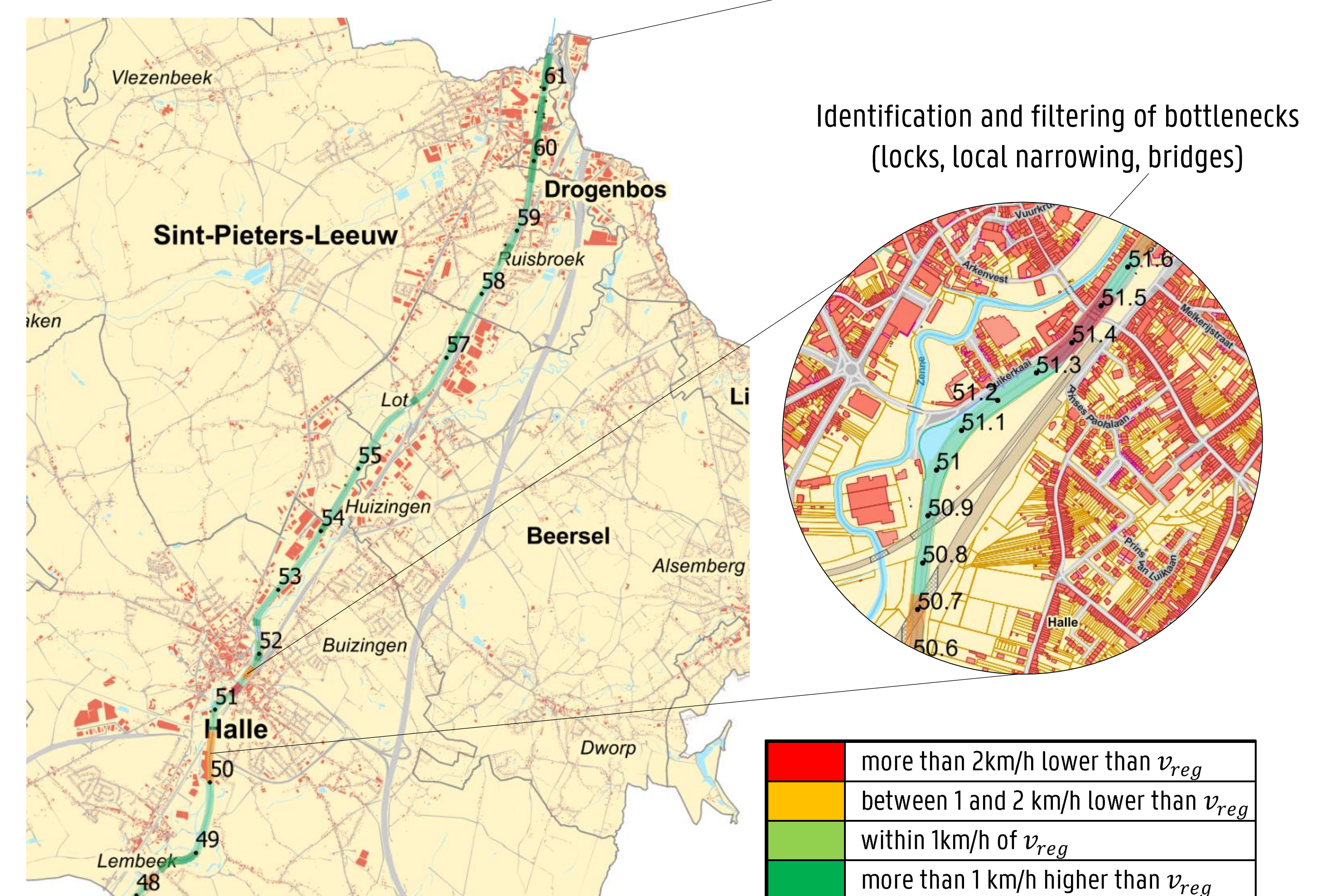
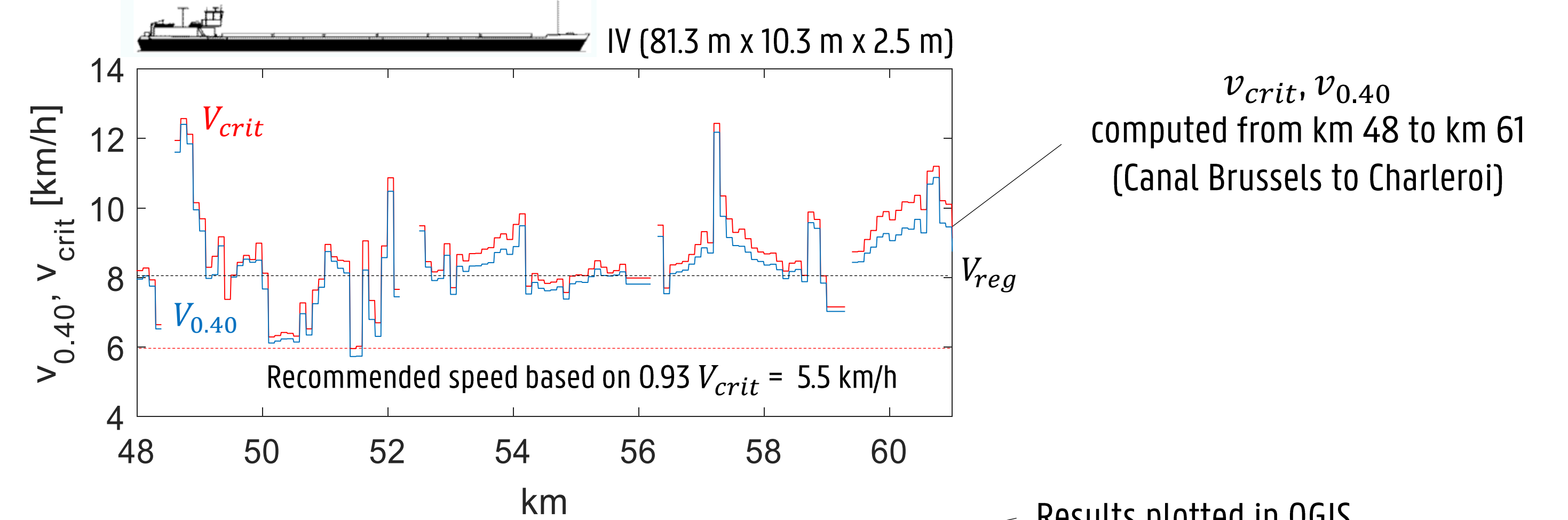
A particular waterway may be subdivided into several sections, e.g. in between locks and for each section recommended speed limits where obtained for different type of ships.

ECMT Class	L [m]	B [m]	T [m]
I	38.5	5.05	2.5
II	50.0	6.60	2.6
III	67.0	8.20	2.7
IV	80.0	9.50	3.0
Va	110.0	11.45	3.5
Vib	195.0	22.80	4.0

[1] BAW. (2005). Principles for the Design of Bank and Bottom Protection for Inland Waterways. Bulletin No. 88 of the Federal Waterways Engineering and Research Institute (Bundesanstalt für Wasserbau, Bundesanstalt für Wasserbau, pp.153

3. Results

The methodology has been applied to more than 800 km of inland waterways, varying from ECMT class I to VI. As an example, the results of the Canal Brussels to Charleroi are shown:



Section (km)	V_{reg} [km/h]	Class IV		Class II	
		T = 2.5 m	T = 1.5 m	T = 2.5 m	T = 1.5 m
47.0 – 48.4	8	6	8.5	8	10
48.6 – 52.2		5.5	8.5	8	10
52.4 – 55.9		7	9.5	9	11
56.2 – 59.1		6.5	9	8.5	10.5
59.3 – 61.6		8	10.5	10	12

Summary of most restrictive speed limits per section and per ship

4. Recommendations & further research

Recommended speeds were validated and discussed in group meetings organized by the inland waterway authorities where end users and stakeholders were represented. Recommendations for further research are:

- Impact of the waterway cross section on recommended speeds → Sensitivity analysis
- Validation of ROPES for high blockages → Towing Tank for Manoeuvres in Shallow Water (FHR)
- Estimation of more realistic mooring lines forces and ship motions → VLUGmoor (Ghent University)
- Develop methodology for small craft (wave generation at high speeds, impact on marinas...)

5. Acknowledgements

The content of this poster is based on research projects commissioned by Waterwegen en Zeekanaal NV and De Scheepvaart NV (nowadays in a merger operation forming De Vlaamse Waterweg nv).

The results of the analysis were discussed with representatives and stakeholders of the inland navigation sector and other users of the Flemish waterways, whose valuable input is acknowledged.

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