Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 154 (2016) 146 – 153

Procedia Engineering

www.elsevier.com/locate/procedia

12th International Conference on Hydroinformatics, HIC 2016

Assessment procedure of the trafficability of inland waterways

Dennis Harlacher[a,]*

[a]*University of Duisburg-Essen, Institute of Ship Technology, Ocean Engineering and Transport System, Bismarckstr. 69, 47057 Duisburg, Germany*

Abstract

A sophisticated procedure on the basis of a geographic information system (GIS) was developed to contribute to the assessment and evaluation of the trafficability of inland waterways. Besides the given geometry of a free flowing river, the results of hydrodynamic numerical river basin models (HN-model), the ship dynamic parameters of an inland vessel and additional information from the Inland Electronic Navigational Chart (Inland ENC) are taken into consideration in the assessment procedure *RiNA* (*River Navigation Assessment*). After the transmission of various, complex initial data into a mutual system, firstly the so-called single potential areas are generated from the nautically relevant parameters (e.g. flow depths, flow velocities, draught, safety distance, fairway, berths, regulation of the traffic). Then those single potential areas are transferred to total potential areas by suitable combination. The total potential areas represent a surface distribution of the navigable areas of waterways and show the trafficability. These total potential areas are prepared regarding different discharge scenarios, types of ships, changes in the draught, direction (up-/downstream) and then validated by recorded passages of vessels. With this procedure an assessment and evaluation of waterways according to nautical criteria (among others flow velocity, draught, driving rules) can be performed and critical points (e.g. bottlenecks) can be shown, which in future leads to an optimized use of the waterways. On the basis of different case studies of the river Rhine in Germany the application of the assessment procedure were shown.

Peer-review under responsibility of the organizing committee of HIC 2016

Keywords: Geographic Information System (GIS); Hydrodynamic-numerical model; Inland Electronic Navigational Chart (Inland ENC); ship dynamic parameters; inland waterways; River Navigation Assessment (RiNA);

* Corresponding author
E-mail address: dennis.harlacher@baw.de

Peer-review under responsibility of the organizing committee of HIC 2016
doi:10.1016/j.proeng.2016.07.432

1. Introduction

Hydrodynamic-numerical (HN-) models for simulating flows in bodies of water and methods for modelling ship manoeuvring have for some time now played an integral role in the field of hydraulic engineering. In engineering practice high-resolution HN-models for the temporal and spatial simulation of flows and, if required, sediment transport, are widely applied in the assessment and evaluation of extension and maintenance measures of the inland waterways. Over the past decades, the modelling of ship manoeuvring which is used, for example, to determine the required swept area width has been further developed, from simple geometric estimations in canals to increasingly sophisticated and complex methods taking account of riverine geometry, flow characteristics in bodies of flowing water as well as the dynamics of a ship's movements.

Variable parameters such as discharge and flow characteristics, climate change, evolution of traffic, increasing vessel dimensions, etc. must be taken into account and appropriate maintenance and extension planning be provided to ensure or enhance the long-term performance of waterways. A recurrent issue in this respect is that of determining whether the trafficability of inland waterways is ensured under continuously changing boundary conditions and requirements. This is a permanent task which must be supported by the proper tools and simulation methods and procedures.

It involves, on the one hand, increasing the economic efficiency of inland navigation by using ever larger vessel dimensions (more capacity for the transport of goods), improved equipment on board ships (more powerful manoeuvring units) and the provision of inland navigation information services (e.g. the electronic information system about German inland waterways ELWIS). The aim of river information services is to contribute to a safe and efficient transport process and thus to intensive utilisation of the capacity of inland waterways [3]. On the other hand, the economic operation of waterways depends on natural determining factors such as hydrologic and, consequently, discharge conditions. A major requirement regarding high-capacity inland waterways is a fairway which is adapted to approved vessel dimensions, i.e. ensuring sufficient fairway width and depth to enable safe, easy and economically efficient operation throughout the year. Appropriate river engineering measures increase the usable flow depth, thus improving the trafficability of a waterway during low and mean water periods in particular. On the River Rhine for example, Germany's major waterway, such measures include the construction and maintenance of regulating structures (e.g. transversal and longitudinal groynes). Despite the variability of boundary conditions a sufficient width and depth of the fairway should be maintained over the largest possible reach or even the entire network of navigable waterways.

There is no universal method for assessing and evaluating the navigability of inland waterways and for visualising the surface distribution of the navigable areas and showing the trafficability. The approach used to determine a waterway's trafficability depends on the underlying question and objective. In many cases, very different methods and a variety of input data are used. Depending on the requirements relating to waterways, different procedures have been developed over time to deal with problems and issues in an efficient way. This may involve field investigations, laboratory measurements, the modelling of ship manoeuvring and application of hydrodynamic-numerical methods or the use of on-board supporting systems such as the inland navigation information services.

2. Development of an assessment procedure

This study aims at developing a procedure (*RiNA - River Navigation Assessment*) for assessing and evaluating the trafficability of inland waterways and visualising navigable areas. Different elements from several disciplines will be used to characterise trafficability (see Fig. 1). These are the geometric properties of the river and the navigation channel, the vessel characteristics and the flow characteristics and their interactions. This approach also considers the inland navigation information services supporting navigation as well as navigation rules. The nautically relevant information from the different departments will be used, processed and augmented across disciplines. The information can then be appropriately combined for evaluation purposes.