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Extension of Coding CEVNI Signs and Marking for European Waterways

Ivica Ruzic[1], Jadranka Pecar-Ilic[1] and Laszlo Redly[2]

Abstract

This paper presents a new method of coding for signs and marking, which is based on the extension of signs and marking described in Annexes 7 and 8 of the European Code for Inland Waterways (CEVNI). Being members of three European expert groups, we have proposed these new codes of waterway signs and marking and recommend them for cases where they can be efficiently used. The main goal is to enable the use of these codes in databases, GIS systems and Web applications for efficient maintenance of waterway information. In addition, they will also contribute to international data exchange for creating standardised electronic messages described by ERI and NtS working groups. The intention is not to amend the existing coding from the Inland ECDIS Standard, which was developed for creation of Electronic Navigation Charts (ENCs). For example, the use of these new codes is tested through the Web GIS application for presentation of inland waterway signs and marking on the Danube River in Croatia. The application examples concern automatically generated reports on the position, characteristics and functioning of different waterway signs and river navigation marking located on the digital map.

1. Introduction

River Information Services (RIS) is a concept for harmonised information services to support traffic and transport management in inland navigation, including interfaces to other transport modes. Directive *2005/44/EC* of the European Parliament and the Council (so called *RIS Directive)* has entered into force (European Parliament and the Council of EU 2005a). Based on it, the RIS guidelines describe the principles and general requirements for planning, implementing and operational use of river information services and related systems (European Commission 2007). The general objectives of RIS are: enhancement of inland navigation safety in ports and rivers; provision of local and regional traffic information for safety monitoring; enabling information exchange between vessels, locks and bridges, terminals and ports; providing information on the status of fairways; providing traffic and transport information for an efficient calamity abatement process; cross-border traffic and transport information.

A number of concepts and standardisation proposals for river information services have been developed within the 4th Framework Research and Demonstration Project "Inland Navigation Demonstrator for River Information Services" (INDRIS 2001). The concept for RIS architecture was developed by the WATERMAN thematic network, an action under the Fifth Framework Programme for Research and Technological Development of the EU in the fields of VTMIS (maritime navigation) and RIS (WATERMAN-TS 2003). Using these achievements, the RIS architecture was elaborated in detail in the research and development project COMPRIS of the European Union (COMPRIS 2005). EU countries have already developed parts of their River Information Services, as mentioned in the COMPRIS Final

[1] Division for Marine & Environmental Research of the Rudjer Boskovic Institute, Bijenicka 54, HR-10000 Zagreb, Croatia, E-mail: ruzic@irb.hr, pecar@irb.hr
[2] Department of Inland Water Management, VITUKI, Water Resources Centre, Kvassay Jenoe Ut 1, HU-1095, Budapest, Hungary E-mail: redly@vituku.hu

Report (COMPRIS 2005). BICS (Binnenvaart Informatie en Communicatie Systeem) in the Netherlands is an inland shipping information and communication system - electronic reporting application (developed in 2006). Three Fairway Information centres work in the Netherlands and Belgium (Flanders and Walone), while ELWIS is the German Internet site for Fairway Information Services. The German fairway information system ARGO (Advanced River Navigation) provides inland waterway skippers with data on fairway conditions and on actual water depths, in real time, on Inland ECDIS maps.

According to Article 5 of Directive 2005/44/EC, technical specifications are defined for Inland Electronic Chart Display and Information System (Inland ECDIS), electronic ship reporting, notices to skippers, vessel tracking and tracing and compatibility of the equipment necessary for using RIS. In Annex II, section 3(b), the use of internationally accepted code lists and classifications possibly complemented for additional inland navigation needs is requested (European Parliament and the Council of EU 2005b). From this point of view, waterway signs and marking are of special importance for navigation safety. Therefore, efficient coding of signs and marking for inland waterways are discussed in three RIS relevant European expert groups for Inland ECDIS, Electronic Reporting International (ERI) and Notices to Skippers (NtS).

The concept of the proposed coding method, which is based on the classification of signs and marking from Annexes 7 and 8 to CEVNI, is described in Chapters 2 and 3. The main goal is to enable the use of these codes in databases, GIS systems and Web applications for efficient maintenance of waterway signs and marking as illustrated in Chapters 4 and 5. In the Conclusion, the main advantages of the proposed coding method are mentioned.

2. A method for coding inland waterway signs and marking

2.1 European Code for Inland Waterways: CEVNI

The European Code for Inland Waterways, CEVNI**,** underwent its 3rd revision in 2007. In Annexes to CEVNI, no. 7 "Waterway signs and marking" and no. 8 "Buoyage and marking of waterways, lakes and broad waterways", the main and auxiliary signs, as well as buoys and marks on land are classified and described (UNECE 2007). Originally, the CEVNI classification of inland waterway signs and marking was not intended to be used widely for computerised coding. In Section I, Annex 7 to CEVNI, only the main signs are specified in a way enabling the corresponding classes to be used directly for computerised coding. This classification of signs and markings is also extensively used within the European Standard Inland ECDIS Edition 2.0, which was developed for creation of Electronic Navigation Charts (ENCs). For example, in its Catalogue of features and attributes, such classification was used in enumeration for attribute *function/17063*, while the corresponding CEVNI classes are listed as attributes *catnmk/17052* to feature *notmrk/17050* (IEHG 2006).

2.2 Extension of coding CEVNI signs and marking

In our approach, we perform specialisation of classes for signs and marking from CEVNI Annexes 7 and 8 according to their position on the waterway (see Fig. 1). Main signs are coded by using capital letters from *A* to *E* and this coding is extended in this paper in order to provide additional information on signs and marking (see grey filled squares on the left side of Fig. 1). New coding of other CEVNI signs and marking is performed using numbers (see the middle and right side of Fig. 1).

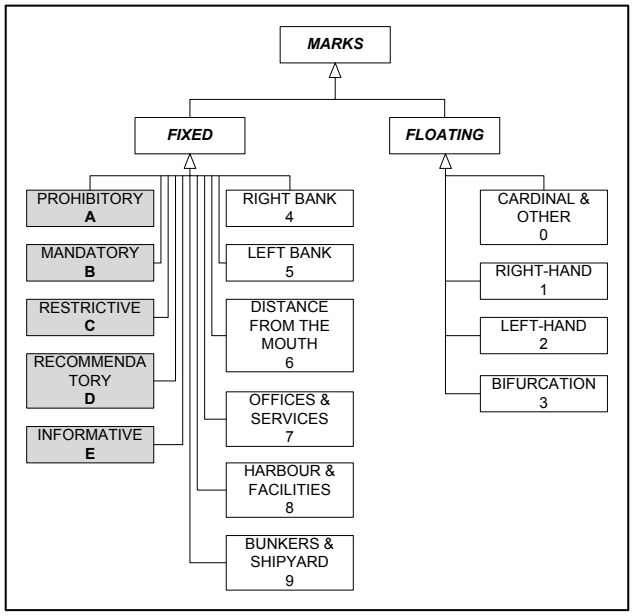

Fig. 1: Specialisation of waterway signs and marking with the codes proposed

There are also a number of subclasses for signs and marking, which are described by the corresponding symbols from CEVNI Annexes 7 and 8. To uniquely define the signs, we have defined appropriate codes for all these subclasses. For that purpose we use the following concepts:

1. Addition of small letters and numbers to the basic codes for signs (similar to the original CEVNI classes)
2. Extension of coding with information presented on the body of the signs or on auxiliary signs (panels and pointers)
3. Definition of the new coding system for signs and marking using numbers in combination with letters (from Annex 8, Sections II to IX)

3. Explanation of proposed codes

Table 1 presents examples of the newly proposed codes for signs and marking from Section I, Annex 7, and Sections II-IX, Annex 8, of CEVNI. Columns in Table 1 include enumeration of attributes *catnmk* and *catlam* of the Inland ECDIS standard, CEVNI classes, symbols and descriptions and our new codes proposed for these classes. For example, the proposed code A1a in Table 1 represents a different version of the original code A1, both of which have the same purpose but different symbols. Addition of small letters to the basic code often represents different directions associated with the sign (B2a, B2b) and sometimes its different components. In a few cases, codes composed of small letters together with numbers represent different signs. For example, code D1a represents the recommended channel for both directions, while codes D1b1 and D1b2 represent the recommended channel only in one direction (not shown in Table 1).

Inland ECDIS attributes		CEVNI - ANNEX ES 7 and 8			New CODE proposed
catnmk	*catlam*	Class	Symbol	Class description	
1		A.1		no entry	**A1**
2		-		no entry	**A1a**
25		B.2(a)		move to the side of the channel on your port side	**B2a**
26		B.2(b)		move to the side of the channel on your starboard side	**B2b**
56		E.5.1		berthing permitted on the stretch of water of 60 m breadth measured from the sign	**E5.1_60**
	7	II.1.		right-hand side of the channel, with light	**1A**
	8	II.2.		left-hand side of the channel, with light	**2A**
	10	II.3.		bifurcation of the channel, with light	**3A**

Tab. 1: Examples of codes proposed for signs from CEVNI Annexes 7 and 8

We also propose special coding of signs containing additional text. For example, code B6_12 represents the sign for speed limit of 12 km/h. Code E23 represents announcing nautical information by radiotelephone and E23_11 a special case for channel 11. In Table 1, code E5.1_60 represents berthing permitted within the breadth indicated in meters (60 m), while code E5.2_30-60 represents berthing permitted at distances from 30 to 60 m (not shown in Table 1). The main signs in Section I of CEVNI Annex 7 may be supplemented by different auxiliary signs such as panels and pointers (triangles), which are described in Section II (UNECE 2007).

In Figure 2, the coding of positions of panels and pointers (triangles) as auxiliary signs is given with examples. Different positions of auxiliary signs are indicated by numbers 1 and 2 for panels and from 3 to 5 for pointers (pursuant to the Inland ECDIS standard, these numbers are specified within the attribute *addmrk/17050*). According to this approach, we have extended the coding by information presented on the body of the sign or on auxiliary signs (panels and pointers) so that all cases could be uniquely identified. For example, in Figure 2, code B5_1.1000 identifies the main sign B5 which means stop (_1 identifies the panel that is placed above the sign) with the distance (1000 m) where applicable. Panel placed below the main sign can contain additional explanation, for example B5_2.DOUANE is a code with stop sign for customs. Code E5_4.1000 represents berthing permitted (_4 identifies the triangle pointing to the left direction) with the distance (1000 m) where applicable (see Fig. 2). CEVNI classes from Annex 8 are divided among nine sections (from I to IX). Formats for the corresponding CEVNI classes are quite different from those of Annex 7. After detailed analyses, we found out that there were no classes at all in section VIII for buoys for miscellaneous purposes (white colour, sometimes with pictograms), CEVNI classes with a single digit number in Section IX for entrances to harbours and Section VII for prohibited and restricted areas (different colours and shapes are used). Finally, in Section II three digits are used for buoyage of channel limits in the waterway, (digit "1" for red cylindrical buoys or floats, "2" for green conical buoys or floats and "3" for red-green spherical buoys or floats).

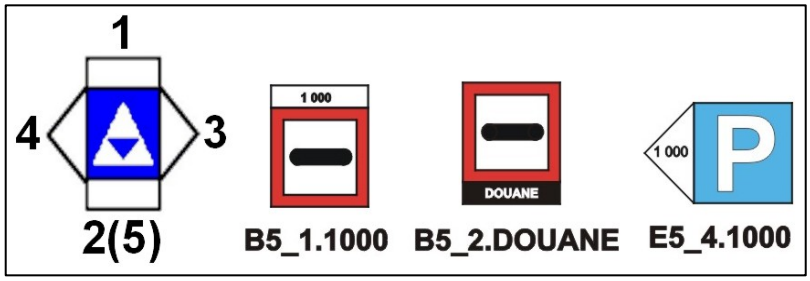

Fig. 2: Proposed coding positions of panels and pointers, with examples

CEVNI classes from Annex 8 whose formats consist of a combination of letters and numbers (similar to those for Annex 7) represent a problem because the same combination of letters and numbers is used for different purposes. For example, classes A.1 and A.2 are used for four different signs, B.1 and B.2 for three different signs, while a single letter B is used only once (UNECE 2007). We have therefore developed a new coding system for signs and marking from Annex 8, sections II to IX, which are also encoded in the Inland ECDIS Standard within features *bcnlat/17028*, *boylat/17028*, *dismar/17004*, *BOYCAR/14* and others. Identification of individual CEVNI classes in the Inland ECDIS Standard requires also encoding of the corresponding attributes for categories, shapes, colours and their patterns, which makes identification very complicated. Therefore, the extension of coding CEVNI signs and marking presented in this paper is very important for efficient management of relevant information.

4. Web GIS applications for the Danube waterway data management in Croatia

Since 2000, we have been conducting research activities that will improve the waterway (fairway) related data management in Croatia at both national as well as Pan-European levels (Pecar-Ilic/Ruzic 2006). At the national level, development of a specialised geographic information system for surveillance of the Croatian segment of the Danube River (*i.e.*, *River IS*) was started, and in 2003 it continued in cooperation with the CROatian programme for River Information Services (CRORIS). We have already described some of earlier activities carried out by the Division for Marine and Environmental Research of the Rudjer Boskovic Institute and the Directorate for Inland Navigation within the Croatian Ministry of the Sea, Transport and Infrastructure (Pecar-Ilic/Ruzic 2004, 2006).

The architecture of *River IS* is based on the architecture of the integrated information system for temporal and spatial presentation of complex data (Pecar-Ilic/Ruzic/Skocir 2002). Based on the performed WEB-GIS-DBMS integration, it is possible to analyse all the necessary types of information, so that presentations such as maps, reports, time series diagrams and others could be obtained in due time. In addition, use of the eXtensible Markup Language (XML) and the supporting XML technologies (such as XSL, SVG, *etc.*) in developed Web applications could enable exchange of data among participants in CRORIS, their partners, and the competent authorities (Bec/Pecar-Ilic/Skocir 2006, Pecar-Ilic/Ruzic 2004). A high level view of our *River IS (River Information System)* shows provision of information for various user groups, such as the Directorate for Inland Navigation and its responsible agency for waterway management, Harbour Masters' Offices, skippers and other authorised users.

To develop this *River IS*, the Object-Oriented approach was applied, which includes iterative and incremental development and concepts and diagram techniques of the standard Unified Modeling Language (UML). The Autodesk MapGuide™ was used as the Internet GIS, spatial and attribute data were managed

by Oracle® ORDBMS. For application development, Active Server Pages (ASP) and ActiveX Data Objects (ADO) were used and for data exchange and manipulation use was made of the supporting XML technologies such as XSLT, Xpath and SVG. Instead of Microsoft, the Java platform could also be used for the development and deployment of our applications.

Developed Web applications enable the following functionalities (Bec/Pecar-Ilic/Skocir 2006, Pecar-Ilic/Ruzic 2006):

1. Automatic generation of digital river maps with reports based on specified user input;
2. Reporting on selected objects from the digital map (river navigation marks, water level data, parameters measured at monitoring stations, *etc.*);
3. Automatic generation of reports on water level values such as tables and SVG time-series diagrams;
4. Automatic display of water level data of river profiles (momentary and averages), and finally
5. Automatic control and alarm reporting from equipment and sensors installed on navigation marks and electronic displays installed on bridges accompanied by water level data.

Use of the extension of coding CEVNI sings and marking, proposed in this paper, was also tested through the developed Web GIS application for presentation of waterway signs and marking on the Danube River in Croatia.

5. Example of the application for waterway signs and marking

Application architecture was based on the *three-tier client-server* architecture for the Web. Use of digital maps for spatial presentation of waterway signs and marking can significantly improve their management and enable access to databases with information on their existence, purpose and functionality. Each individual waterway sign or marking located on the digital map is identified by a simple unique numeric ID code in the river navigation database. In addition to the ID, the code for the type of waterway sign or marking, information about its position, characteristics and functioning are also stored in a database. Data in the database can be updated independently of the digital map. Since objects in map layers are connected with the database through numeric ID codes, changes in the database are reflected on the digital map and dynamically generated reports on selected objects.

The Web GIS application for presentation of waterway signs and marking is presented in the Internet Explorer browser through several frames, as shown in Figure 3. The digital map consists of the following layers: the Danube River banks, coloured river depths, fairway of the Danube River, distance from the mouth of the Danube River, bridges, signs and marking and the corresponding raster background of the Batina place. In the left frame of Figure 3, the thematic layer of waterway signs and marking is presented. It consists of the picture of each sign and its code proposed according to the method described earlier in this paper. For example, code E6_3 is for the anchoring permitted sign on the right river bank (_3 identifies the triangle pointing to the right direction). Besides the common map manipulation operations (*e.g.*, zoom, pan, view distance, *etc.*, as shown in the right frame of Fig 3), it is possible to select navigation signs and marking and generate their reports. When the anchoring permitted sign is selected from the map, its general as well as detailed reports can been automatically generated from the database (see Fig. 3). General report contains the picture of the anchoring permission sign, its description, information about its position within the river, distance to the mouth and direction (see pop-up window in Fig. 3). Detailed report contains several groups of additional data (as shown in the bottom frame of Fig. 3). The first group of data includes a description of the sign (code, ID, name, function, auxiliary sign and its content if available). The second group of data includes the direction and position of the sign on the map (minimum scale, distance from the mouth in km, direction, angle, code of existence, position and geographic coordinates). The third group of data includes displacement from the original sign position (displacement code and description, displacement in m, angle and new geographic coordinates). The last group of data includes the sign status (status code and description, as well as its technical description if available).

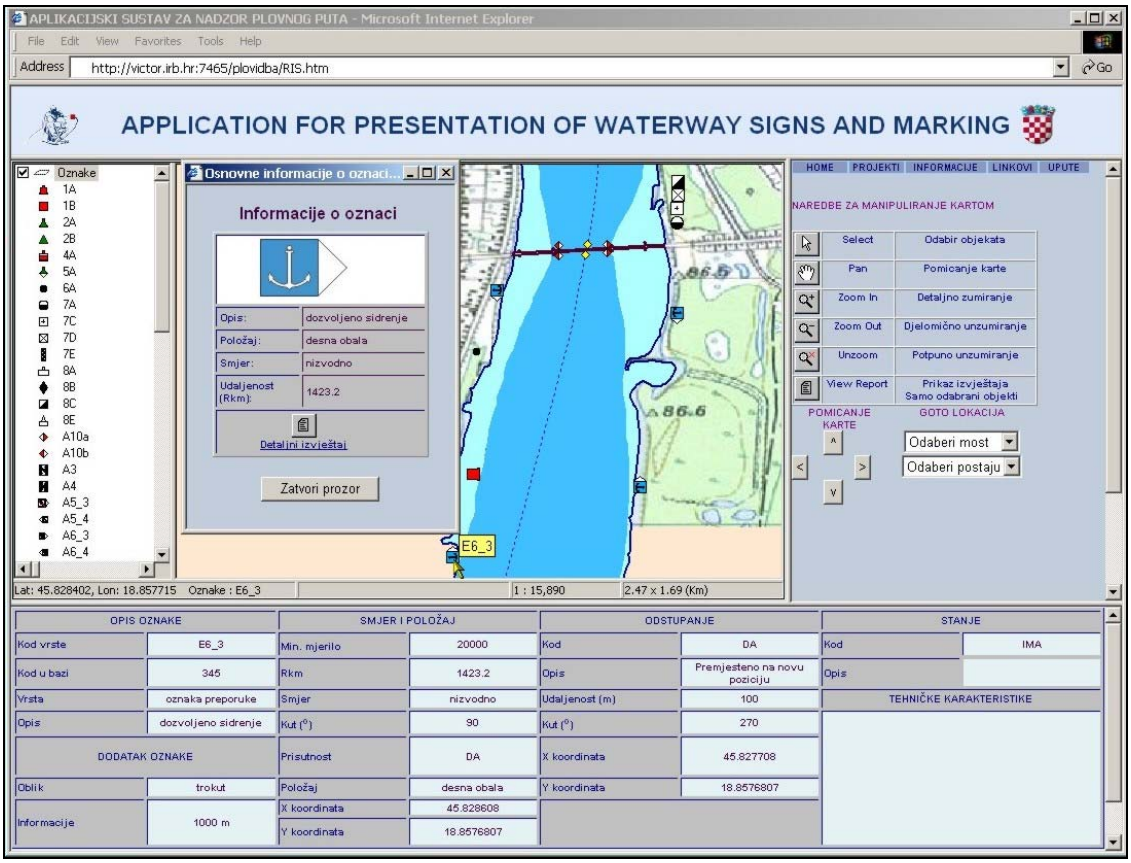

Fig. 3: Example of a Danube river map with reports for selected anchoring permitted sign

Recently, additional functionality has been added by the alarm reporting application developed using event-based SVG technologies. It should provide automatic control of the work of navigation aids (devices) in the form of timely map reporting about their regular working status, or produce alarms. Devices to be controlled are floats and buoys situated along the fairway and electronic displays installed on the bridges (Bec/Pecar-Ilic/Skocir 2006).

6. Conclusions

In this paper, we have described a new coding method, which is based on the extension of coding signs and marking described in Annexes 7 and 8 to CEVNI. The CEVNI classification of signs and markings is extensively used within the European Standard Inland ECDIS Edition 2.0. Our intention is not to amend the existing coding from the Inland ECDIS Standard, which was developed for creation of Electronic Navigation Charts (ENCs).

The extension of coding CEVNI signs and marking, presented in this paper, is very important for efficient management of waterway (fairway) information by using database, GIS and Internet technologies. Additionally, being members of different European expert groups, our coding proposal is recommended for cases where such codes can be used for Inland ECDIS, ERI and NtS. In our approach, we have applied different concepts to uniquely define the inland waterway signs and markings. The main signs from Annex 7 to CEVNI are coded by using capital letters from *A* to *E* and this coding is extended in order to provide

additional information on signs and marking. For this purpose, small letters and numbers are added to these basic codes and coding is extended with information presented on the body of the signs or on auxiliary signs (panels and pointers). We have also defined the new coding system for signs and marking using numbers in combination with letters for CEVNI classes from Annex 8, Sections II to IX.

The use of codes proposed in this paper was also tested through the developed Web GIS application for presentation of waterway signs and marking on the Danube River in Croatia. The application architecture is based on the *three-tier client-server* architecture for the *Web.* Application examples concern information about the position, characteristics and functioning of different waterway signs and river navigation marking. The main principle of this application is to dynamically create an appropriate digital river navigation map with selected contents. Automatic generation of relevant reports from the database is enabled for selected waterway signs on this map.

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