Multiscale ENC Data Management on Eastern Coast of the Adriatic Sea as an Archipelagic Sea Area

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ABSTRACT

According to the UN convention, the Adriatic Sea belongs to Archipelagic Seas. This paper briefly outlines characteristics of the Adriatic Sea as an archipelagic sea and its coverage with paper charts and ENCs. The production of Electronic Navigational Charts (ENC) at the Hydrographic Institute of the Republic of Croatia (HIRC) started in 2001. Production of ENCs is based on the theory of multiscale data management. Multiple representation of ENC data is controlled by SCAMIN attributes. This paper presents a solution to the problem of multiscale data management as a part of ENC data production for archipelagic sea areas, using the Adriatic Sea as an example. This study is based on a long-standing experience in the production of paper charts and recently ENC production for eastern coast of the Adriatic Sea, which is supposed to be the second largest archipelagic area in the Mediterranean. A new method of using SCAMIN attributes for archipelagic seas was proposed, based on Canadian method.

1. INTRODUCTION

Hydrographic Institute of the Republic of Croatia (HIRC), as a national institution responsible for all hydrographic activities on the east coast of the Adriatic Sea, issues about 100 navigational charts of different scales and purposes and 30 nautical publications.

In 2001, the HIRC began the production of ENC covering the area of the northern Adriatic in conjunction with the international pilot project, the Virtual Regional Electronic Navigational Chart (VRENC) (Altamura, 2003). The VRENC pilot project was completed in 2003 and HIRC started its own production of ENC data.

When ENC production captured the area of the Middle Adriatic, which is an archipelagic sea, it was concluded that the problem of too many objects caused clutter on ECDIS display. Solution of this problem is to apply on-line generalization and multiscale data management, using SCAMIN attribute values. By studying the world literature on this topic, it was found that only two methods of using SCAMIN attributes, the German (7Cs) and the Canadian ones, were available (Bisset and Fowle, 2003a).

The purpose of this paper is to describe the methodology used to assign SCAMIN attribute values to ENC data in the archipelagic sea area of the Croatian part of the Adriatic Sea.

2. SPECIFIC FEATURES OF THE ADRIATIC SEA

According to the United Nations Convention on the Law of the Sea, Part IV - Article 46 (http://www.un.org/), the term of Archipelagic State is defined as a state constituted wholly by one or more archipelagos and may include other islands. “Archipelago” means a group of islands, including parts of islands, interconnecting waters and other natural features which are so closely interrelated that such islands, waters and other natural features form an intrinsic geographical, economic and political entity, or which have been historically regarded as such.
The Croatian islands area (Fig 1) makes the second largest archipelago in the Mediterranean. The Adriatic Sea with 79 islands, 525 islets, and 642 rocks and rocks awash (1,246 total) extends on 4,398 km of insular coastline length and 6,278 km of coastline length (Duplančić Leder et al., 2000). Countless straits, passages and other areas dangerous for navigation along this coast cause this area to be an exceptionally difficult and complex navigational area and therefore demands a rigid regime of navigation. Croatian coast belongs to the best indented coasts in the world, next to Greece it is the best indented coastline in the Mediterranean.

The Adriatic Sea is a deeply indented gulf (cca 800 km long and 200 km wide) of the Mediterranean, belonging to semienclosed seas. The shallowest part of the Adriatic Sea is in the Gulf of Trieste, and its deepest part is in the South Adriatic Pit (1 233 m).

In the Adriatic Sea, tides are of mixed type with pronounced inequality in height. Tidal amplitudes are small rising from the south (0.23 m in Dubrovnik) to the north (0.68 m in Trieste), and have no influence on the safety of navigation (Leder, 2004).

Surface circulation in the Adriatic Sea can be described as a cyclonic meander with a north-west-going current along the eastern coast and south-east-going current along the western coast (Orlić et al., 1992). Currents have little influence on the safety of navigation in the open sea area. Mean current speeds in the open sea are about 0.5 kn (Leder, 2004).

The Adriatic Sea is a warm sea with surface temperature ranging from 6°C in winter (North Adriatic) to 25°C in summer (open Adriatic). Freezing of the sea surface is a rare occurrence (Leder, 2004).

In the eastern part of the Adriatic coast, there are no navigable rivers with the exception of a shallow area navigable only by small boats, which make ECDIS display very special for that area.

In the coastal area there are no mangroves, salt marshes or swamps that make navigation and berthing complicated.

3. SCAMIN ATTRIBUTES AND EXPERIENCES OF OTHER COUNTRIES

According to S-57 standards, ENC database was build up as a multiscale database, which stores nautical data at different scale levels (several digital dataset – ENC cells). This makes it possible that the data be provided to the ship as a set of “navigational usage”, allowing the navigator to adapt appropriate usage to the situation. As the ship moves from the open sea towards port, the navigational usage shifts from an overview (least detailed), through general, coastal, approach and harbour level to berthing level (most detailed). The same area and ENC cell objects could be used on different representation levels in different themes or navigational usage, called Multi-representation database.

When zooming out the compilation scale or using ENC cell for other navigational purposes, ECDIS display becomes crowded. Therefore, for reducing clutter on ECDIS display it is necessary to use SCAMIN attributes. Generalization can be defined as selection and simplified representation of detail appropriate to the scale and/or purpose of the map (ICA, 1973).
SCAMIN is the IHO S-57 attribute designed to provide the means for controlling on-line generalization and multiscale ENC data management in the ECDIS (Vachon, 2003). SCAMIN attribute represents the minimum scale at which the object may be used (e.g., for an ECDIS presentation). In order to optimize the performance and clarity of the ENC data, it is strongly recommended that SCAMIN is used (IHO S-57 Appendix B1 Annex A, 2000). SCAMIN attribute allows optimal nautical data representation for any scale and purpose.

Experiences of other countries in using SCAMIN attributes, reported by Bisset and Fowle (2003a), indicate that most of the hydrographic offices mainly use one of two methods: semi-automatic method proposed by an expert group from the Canadian Hydrographic Service (Vachon, 2003), and automatic method suggested and initiated by the expert group of SevenCs, a German producer of the software package for ENC cell creation (Ulrich et al., 2003; SevenCs, 2003).

German (7Cs) and Canadian (CHS) methods of assigning SCAMIN attribute values are based on their own experiences. In analysing these methods we determined that neither of them was entirely suitable for archipelagic sea areas (e.g., eastern Adriatic, Croatia, Greece, Sweden, Norway, Finland, etc.). Therefore we proposed a new method, of using SCAMIN attributes for archipelagic seas, of using SCAMIN attributes for archipelagic seas.

4. USING SCAMIN ATTRIBUTES FOR MULTISCALE DATA MANAGEMENT ON THE EAST ADRIATIC COAST

The generalization method for selecting objects of ENC data does not differ from the same method applied for compiling paper charts. However, paper charts are different from ENC cells in terms of representation of data, different resolution - 1000 dpi versus 100 dpi, and way of usage. Among available methods, we took the Canadian method of online generalization and then modified and adjusted it further for an archipelagic sea such as the Middle Adriatic.

Table 1 presents a new method (called the Croatian method) of cartographic rules for applying SCAMIN objects coding based on the tradition of compiling charts at the HIRC (Duplančić Leder and Lapaine, 2005). According to navigational purposes, objects appearing on ENCs are classified into five groups following the recommendations presented in IC-ENC (Bisset and Fowle, 2003a, b). Each group includes objects that should be used for the particular navigational purpose. The objects on harbour and berthing charts belong to the same group which is in compliance with the traditional production of charts at the HIRC.

Formula for calculating SCAMIN values was:

\[ SCAMIN \_value = (CSCL * SCAMIN \_factor) * 0.9 \]  

(1)

where CSCL is compilation scale of ENC cell.

We omit some Geo object classes that do not exist or have negligible significance on the Adriatic Sea, as well as the phenomena or conditions which do not exist or have negligible significance on the Adriatic Sea. These objects are irrelevant for the presentation on ENCs of the Adriatic Sea according to IHO standard S-57.

Table 1. – Assignment of S-57 Geo object classes according to ENC navigational purposes – a new proposal for archipelago seas

<table>
<thead>
<tr>
<th>SCAMIN factor</th>
<th>GEO OBJECT CLASSES</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Skin of the Earth Objects</td>
</tr>
<tr>
<td></td>
<td>Meta and Collect. Objects</td>
</tr>
</tbody>
</table>
Generalization of data by choosing objects is shown in the example of a wider area of approach to the Šibenik harbour (see Fig 2). Wider area of approach to Šibenik harbour is one of the most demanding navigational areas, therefore it is a very good example of clutter on the ECDIS display.

The left side of Figure 2 shows ENC HR31021 at the scale of 1:200 000 without using SCAMIN attributes and consequently the screen display is very crowded. The right side shows the same area by applying Croatian method of usage of SCAMIN attributes as in Table 1. According to the suggestion presented in Table 1, for usage bands of general charts the objects disappearing from the screen are ACHARE, BCNISD, CBLSUB, CURRENT, DEPCNT, LIGHTS, PIPSOL. On the right of Figure 2 it can be noted that there are less objects on the screen, therefore the clutter has been reduced.

Figure 2. - Wider area of approach to Šibenik harbour (scale 1:200 000) a)without SCAMIN (left) b) with SCAMIN (right)

5. CONCLUSION

ENC database was build up as a multiscale database. The same ENC cell could be used on different representation levels or navigation usage. During ENC production of the Croatian part of the east coast of the Adriatic Sea area, which
is a very complex navigational area, considered as an archipelagic sea, object density on the computer screen was apparent. In order to reduce clutter or density of objects on the display, especially when zooming out, SCAMIN attribute coding was used. Cartographic rules for applying SCAMIN attribute coding for on-line generalization were developed by using a modified Canadian method. Our method is in compliance with the traditional production of charts at the Hydrographic Institute of the Republic of Croatia and was presented on a wider area of approach to the Šibenik harbour. With slight modifications, this method could be applied to other archipelagic sea areas.

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BIOGRAPHIES

Tea Duplančić Leder has been working with the Hydrographic Institute of the Republic of Croatia since 1987. She has nearly twenty years of experience in nautical chart production and five years of experience in ENC chart production. She was the head of Cartographic Department from 1994 to 2003. Her current research interest is focused on generalization of ENC objects. She is a vice-president of the Croatian Cartographic Society for marine cartography. From 2005 she is a Ph.D. candidate at the Faculty of Geodesy, University of Zagreb.

Nenad Leder is assistant director of the Hydrographic Institute of the Republic of Croatia. He is oceanographer and has more than twenty years of experience in hydrographic, oceanographic and cartographic research and work. The main topics of his scientific reasearch are tides, waves and currents. He won Ph.D. degree with the thesis "Barotropic and baroclinic waves in a wider area of the Lastovo Channel" at the Faculty of Natural Sciences, University of Zagreb.
Miljenko Lapaine is a full professor at the Faculty of Geodesy, University of Zagreb. He gives lectures on Cartography and GIS, Multimedia Cartography, Transformations in Cartography and History of Geodesy. His main interests include the application of mathematics and computer sciences in geodesy and cartography. He is the founder and the first president of the Croatian Cartographic Society and Editor-in-chief of the Kartografija i geoinformacije journal.