

THE ANALYSIS OF THE CURRENT PROBLEM OF OVERLAP OF THE ELECTRONIC NAVIGATION CHART DATA IN THE ADRIATIC SEA AND A PROPOSAL FOR THE SOLUTION

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ABSTRACT

Electronic Chart Display and Information System (ECDIS) and Electronic Navigation Chart (ENC) will become, due to the amendments to the SOLAS Convention (International Convention for the Safety of Life at Sea) that are to be enforced on 1st January 2011, mandatory navigational tools for particular classes of vessels, with the implementation period from 2012 to 2018. Both for ECDIS and ENC there are production standards that the producers will have to comply with, which would be a guarantee for a high reliability of the newly implemented navigational tool. Croatia has established the right and responsibility for the production of ENCs for the territory of its jurisdiction on its national regulations and on recommendations of the International Hydrographic Organization (IHO), as well as on the recent provisions of the SOLAS Convention related to hydrographic activity. According to the aforementioned provisions, national hydrographic offices will have, in the countries where they have been constituted and where they are operating, the main mission to provide quality navigational charts and publications for the territory of the country's jurisdiction at sea. In Croatia, the mission has been given to the Hydrographic Institute of the Republic of Croatia (HHI) that has been fulfilling the task for a century, providing quality paper charts and publications to end users. After the new regulations related to the implementation of mandatory ECDIS and ENC have been enforced, HHI designed its project of ENC production, thus covering the areas of jurisdiction of the Republic of Croatia at sea. ENC is a digital database and is produced in compliance to the IHO production specification S-57. It contains all relevant data needed for safe navigation, such as coastline, bathymetry, buoys, lights etc. Geographic coverage, which most often corresponds to the coverage of a paper chart, is the basic measuring unit for ENC and is called a cell. According to their compilation scale and their navigational purpose, ENCs have been classified into six user groups. As with other official producers of ENCs, Croatian ENCs are produced on the basis of the existing paper charts. The fact that the ENC cell coverage is based on the coverage of a paper chart created the problem of overlap of ENC data, i.e. the presence of two ENC cells for the same geographic navigational area. Observing the IHO recommendations and because of the problem that the end user might have when using ENCs in navigation along the area, such situation is considered as untenable and urges hydrographic offices to solve the problem of overlap where it occurs. The problem of overlap has been identified for the area of the Adriatic Sea between two current official ENCs producers for that area, precisely in navigation groups of Overview ENC and General ENC. Through the work of the Mediterranean and Black Seas Hydrographic Commission (MBSHC), the two parties have for some time been engaged in solving the problem of overlap for the territory of the Adriatic Sea, but unfortunately without much success, which is, on long term basis, untenable, i.e. which should be resolved in compliance with valid regulations and IHO recommendations by the date of enforcement of the mandatory ECDIS and ENC.

In this paper an analysis of the current overlap of ENC data for the Adriatic Sea has been presented, including the existing solutions for other areas. Taking into consideration what has been achieved so far, and conforming to regulations related to the responsibility of national hydrographic offices in charting the areas under their competence and to IHO recommendations, concrete proposals for solving the problem of overlap of ENC data for the Adriatic Sea have been given.

1. INTRODUCTION

Electronic Chart Display and Information System (ECDIS) and Electronic Navigation Chart (ENC), due to the amendments of the SOLAS Convention (International Convention for the Safety of Life at Sea), enforced on 1st January 2011, have become mandatory navigational tools for particular classes of vessels, with the implementation period from 2012 to 2018. According to the aforementioned provisions, national hydrographic offices will have, in the countries where they have been constituted and where they are operating, the main mission to provide quality navigational charts and navigational publications for the territory of the country's jurisdiction at sea. In Croatia, the mission has been given to the HHI that has

been fulfilling the task for a century, providing quality paper charts and publications to end users. Recently, a several-year project has been designed aimed at launching a new digital production line that comprised and joined all processes, starting from collecting, processing and publishing data in final products, either paper or digital ones. Until 1st July 2008, which was the closing date for providing official ENC's for the first group of vessels with mandatory ECDIS, the HHI produced and covered the priority areas of shipping routes for High Speed Crafts (Figure 1) and thus fulfilled the task providing to the end users a total of 80 ENC cells (Table 1).

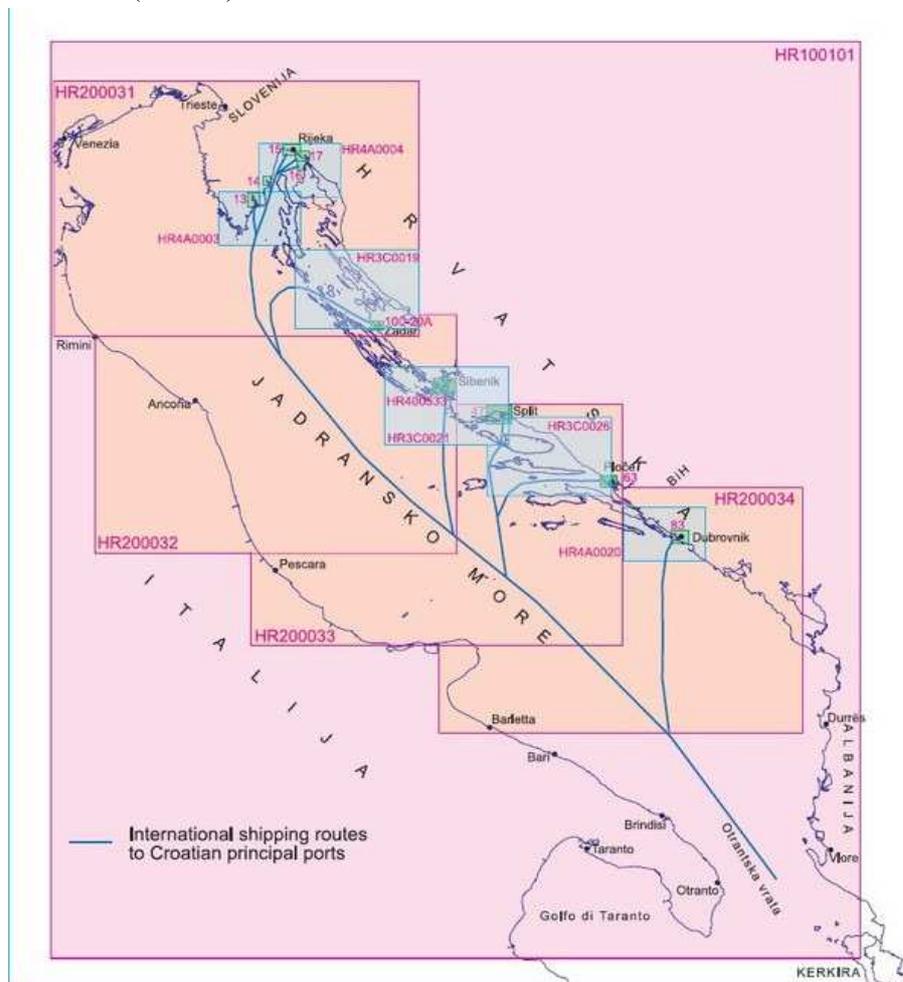


Figure 1. Croatian ENC priority plan

As the new regulations relating to mandatory use of ECDIS and ENC's will be effective as of 1st July 2011, the HHI has, by continuing the project of ENC production, provided almost entire coverage of the territory under the jurisdiction of the Republic of Croatia at sea. All waterways for international navigation, access navigational routes towards the Croatian ports open for international navigation and areas around such ports are fully covered by ENC's for all navigational purposes (Table 1)

Table 1. Presentation of Croatian ENC's and covered areas

User band	Navigational purpose	1 July 2008		1 July 2009		1 January 2011	
		No of Cell	Area coverage (%)	No of Cell	Area coverage (%)	No of Cell	Area coverage (%)
1	Overview	1	100%	1	100%	1	100%
2	General	4	100%	4	100%	4	100%
3	Coastal	15	100%	15	100%	15	100%
4	Approach	9	72%	11	77%	12	81%
5	Harbour	31	77%	33	80%	37	84%
6	Berthing	20	74%	21	77%	22	80%
TOTAL		80	87%	85	89%	91	91%

All ENC are produced in compliance to the valid IHO standards; they are grouped into all the six navigational groups and the range of ENC cells corresponds to the range of particular paper charts. End users on vessels may obtain them through the two official ENC distribution centres – British centre IC-ENC and Norwegian centre PRIMAR.

2. EXPLANATION OF THE PROBLEM

ENC is a digital database and is produced in compliance to the production specification of IHO for using ECDIS. The responsible entity for the production and quality of ENCs is an institution authorised by the government, which is usually the national hydrographic office. ENC contains all relevant data necessary for safe navigation, such as coastline, bathymetry, buoys, lights etc. The detailed production standards and principles have been established, which the producers are required to observe, thus guaranteeing a high reliability of the newly introduced navigational tool. The geographic range of ENCs most frequently corresponds to the range of paper charts (Figure 2a), and the basic unit is a cell (Figure 2b).

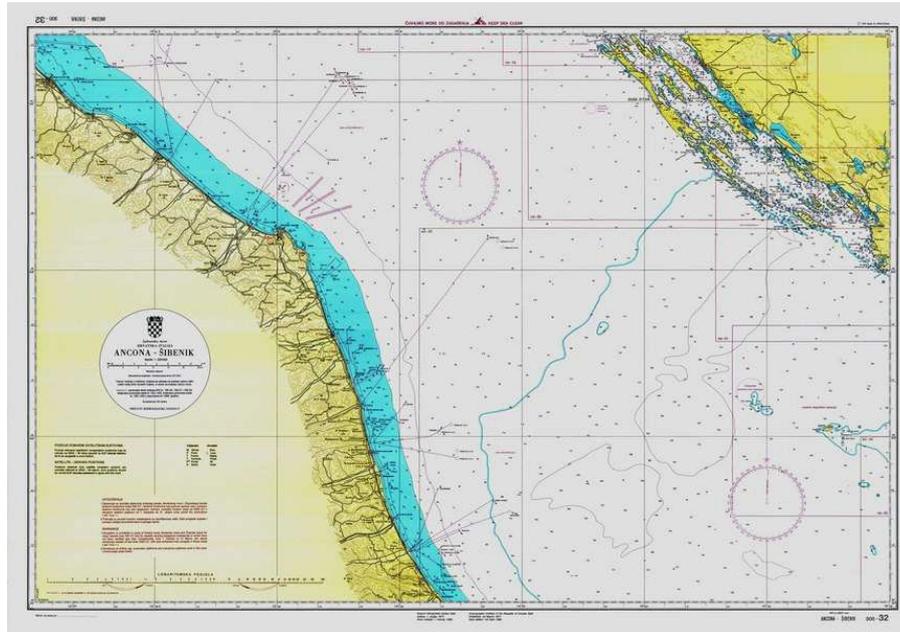


Figure 2a. Paper chart HR 300-32

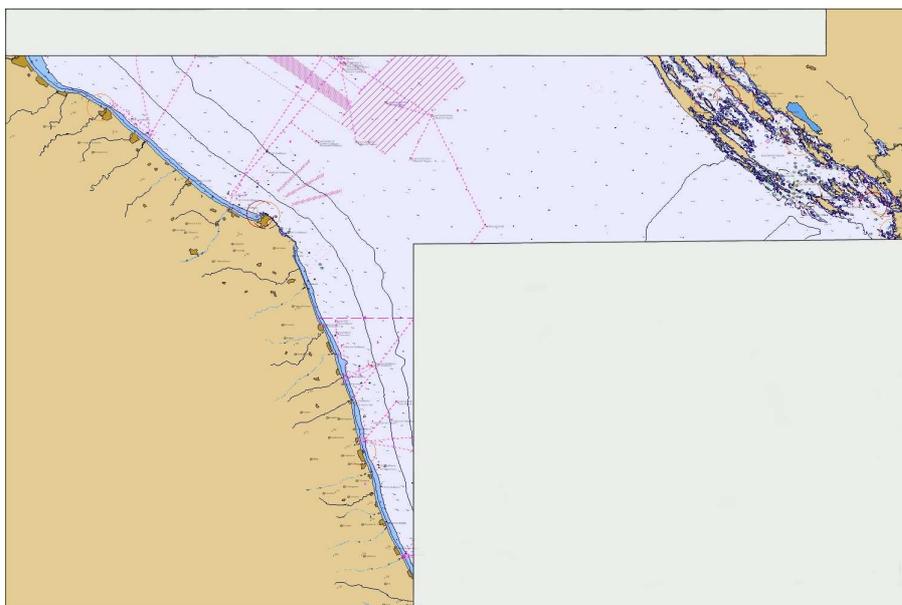


Figure 2b. ENC HR 200032

ENCs have been grouped into six groups of users according to the compilation scale and navigational purpose (Table 2).

Table 2. Classification of ENCs according to the compilation scale and navigational purpose

<u>Navigational purpose</u>	<u>Name</u>	<u>Scale Range</u>	<u>Available Compilation scale</u>	<u>Definition for intended use</u>
1.	<u>Overview</u>	<1:1499999	3000000 and smaller 1500000	<u>For route planning and oceanic crossing.</u>
2.	<u>General</u>	1:350000 - 1:1499999	700000 350000	<u>For navigating oceans, approaching coasts and route planning</u>
3.	<u>Coastal</u>	1:90000 - 1:349999	180000 90000	<u>For navigating along the coastline, either inshore or offshore</u>
4.	<u>Approach</u>	1:22000 - 1:89999	45000 22000	<u>Navigating the approaches to ports or major channels or through intricate or congested waters</u>
5.	<u>Harbour</u>	1:4000 - 1:21999	12000 8000 4000	<u>Navigating within ports, harbours, bays, rivers and canals, for anchorages</u>
6.	<u>Berthing</u>	>1:4000	3999 and larger	<u>Detailed data to aid berthing</u>

As many other officially produced ENCs, Croatian ENCs are made on the basis of the existing paper charts. The fact that the ENC cell range is based on the range of a paper chart led to the problem of overlap of ENC data within the same navigational purpose band. In practice, it refers to the presence of a minimum of two ENC cells, produced by two authorised producers for the same navigational area within the same navigational purpose band. IHO, the central organisation competent for this issue, address it to regional hydrographic commissions and recommends the implementation of the principles of the Worldwide Electronic Navigational Chart Database (WEND). One of the most important principles is the right and responsibility of a coastal state, party member of the SOLAS Convention, to chart the areas of national jurisdiction at sea. Accordingly, the borders of the charts are determined by the borders of the area in which the competent state has the right and responsibility to gather hydrographic data. The principle could be referred to as “no data limits”. The other major principle indicates the need for cooperation and agreement of the neighbouring states aimed at harmonising ENC production plans, maximisation of production, enhancement of efficiency and coverage, and to ensure cross-border consistency including also the overlap of ENC data within the same navigational purpose band. There are numerous factors affecting

a successful solution of the issue of overlap of ENC data and full implementation of the WEND principles. Special difficulties for the regional hydrographic commission for the Mediterranean and the Black Sea (MBSHC) are historical and political issues and delimitation at sea between several member states, thus denying the competence for charting the disputed areas. Therefore, member states are increasingly producing the charts of the same areas with undetermined borders, which led to the problem of overlap. Although the above reason may be characteristic for the group of ENCs that belong to the category of coastal charts, it is possible that it may be the cause of overlap also for smaller scale ENCs, i.e. for the categories of General and Overview.

3. APPLIED METHODOLOGY

Through the work of the MBSHC, the interest parties have for some time tried to solve the problem of overlap of ENC data within the usage band 1 and 2 for the area of the Adriatic and beyond, but without any significant progress. Such a situation is untenable on long-term basis and it should be resolved by date of implementation of the mandatory use of ECDIS and ENC, in compliance with the valid IHO rules and principles. Despite all attempts to achieve progress in establishing the agreed ENCs scheme for band 1 and 2, a part of present proposals that intervene into rights and responsibilities of the competent member state to produce its own ENCs is considered unacceptable. The authors' guidelines in selecting the methodology of solving the problem are based on the facts specified during the research through an analysis of the area where similar issues were satisfactorily solved and on valid regulations and IHO principles observed. It is important to apply the methodological approach in which the regulation and principle implementation, upon which the competent hydrographic offices are to act, are duly ranked. According to the above, the authors give priority to the implementation of the principle «no data limits» according to which a coastal state is guaranteed the formal status of the issuing authority and is thus given the right and responsibility to produce ENCs (in terms of SOLAS V 2.2). Giving priority to this principle is also supported by the technical aspect of ENCs, since the cell borders can easily be “cut” so that they precisely follow the borders of jurisdiction and responsibility of the coastal state for data collection and the quality of data in ENCs (Figure 2b). The authors accept the principle according to which in congested navigational areas a country may produce ENCs on behalf one another country or a group of countries. However, such a solution needs to be agreed in the form of a document that will regulate all consequential aspects of such an act. As for compilation scale, the WEND principle and the CL 47/2004 recommendation are applied, proposing the change of compilation scale of previously produced ENCs to such extent that will not jeopardise the usage value for the user, which is directly related to the configuration of the coast and islands of the countries belonging to the Adriatic Sea.

4. THE ANALYSIS AND THE REVIEW OF THE CURRENT STATE

In compliance to the determined methodological approach and with the aim to design a proposal for the solution for the Adriatic Sea it is necessary to analyse the current state of the areas for which the issue of overlap of ENC data within the same band has been adequately solved. The current state of overlap for the Mediterranean and the Adriatic is analysed and the solution is searched for.

4.1. Description and review of the current state in the North Sea and Baltic Sea Hydrographic Commission

In the area of regional hydrographic commission of the North Sea (NSHC) and Nordic HC (NHC) there is no overlap at the cells of overview purpose, while there are inconsistencies in compilation scale at the border between ENCs and navigational purpose (Figure 3). There is overlap at the border of NSHC and Eastern Atlantic HC (EAHC) between GB and FR. In that area, there is overlap within cells GB 1:350 000 and FR 1:1 500 000. The borders of review ENCs follow to a great extent the borders of the state's jurisdiction at sea, however, it may be concluded that certain states publish ENCs for the areas of other countries even in the case when the hydrographic service of the competent country already exists.

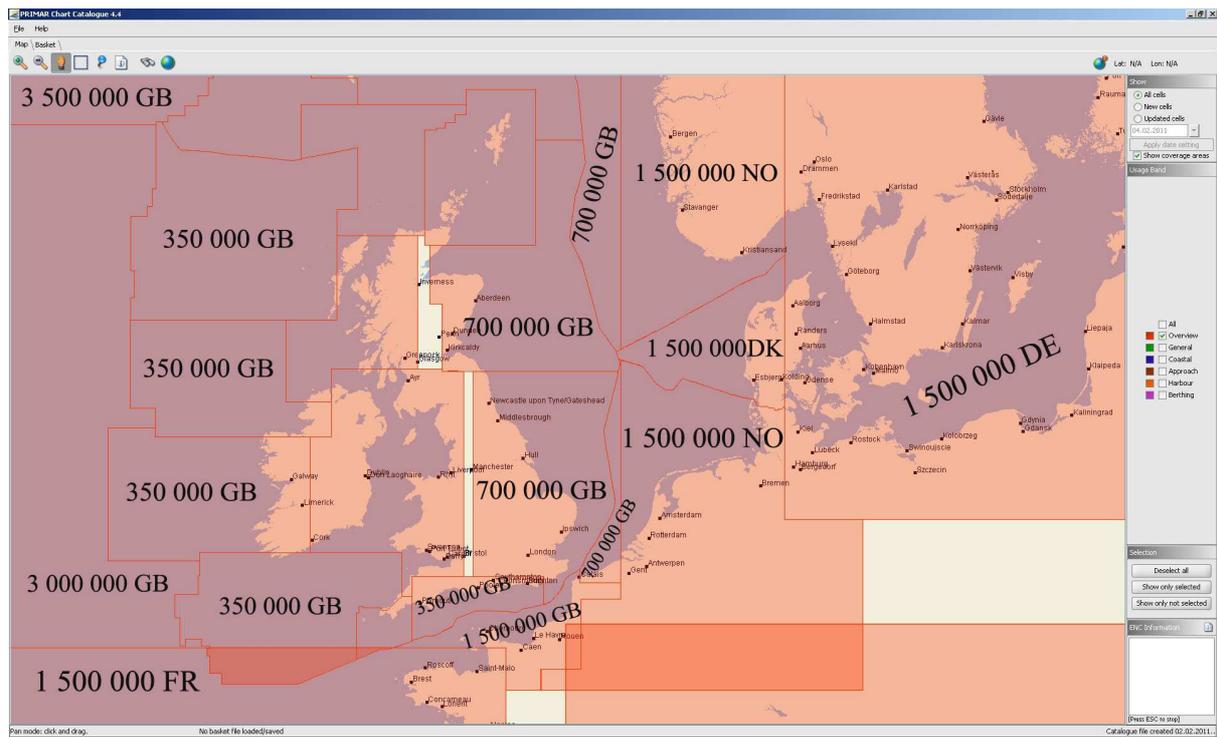


Figure 3. Overview ENC for the North and the Baltic Sea

Within the cells of the general navigational purpose there is no overlap of data, but there are a number of cases with inconsistencies in compilation scale in a lot of areas. In general ENCs, cell borders are consistent with the borders of a country's jurisdiction at sea, but it may be concluded that, the same as with overview ENCs, certain countries publish ENCs for the areas of other countries, even though there is a hydrographic service established by the country that has the actual jurisdiction of the area (Figure 4). It may be concluded that in some cases the reason is related to observing the WEND principle that for complex navigational areas with traffic separation scheme, two or more states agree that only one of them will be the producer nation. However, such situation will at the same time indicate the violation of the principle "no data limits" and will imply that is necessary to enter formal agreements which would permit such situation and which would regulate the establishment of a reliable model for providing the data from the true owner to the office of the other country that produces ENCs on the basis of obtained data. It requires establishing the process of quality control of the produced ENCs before being published by the responsible coastal state (owner of the data). Such a solution opens the issue of responsibility in case of a maritime accident, if the information provided by the country responsible for the quality of data has been wrongly displayed or coded by the ENC producer nation.

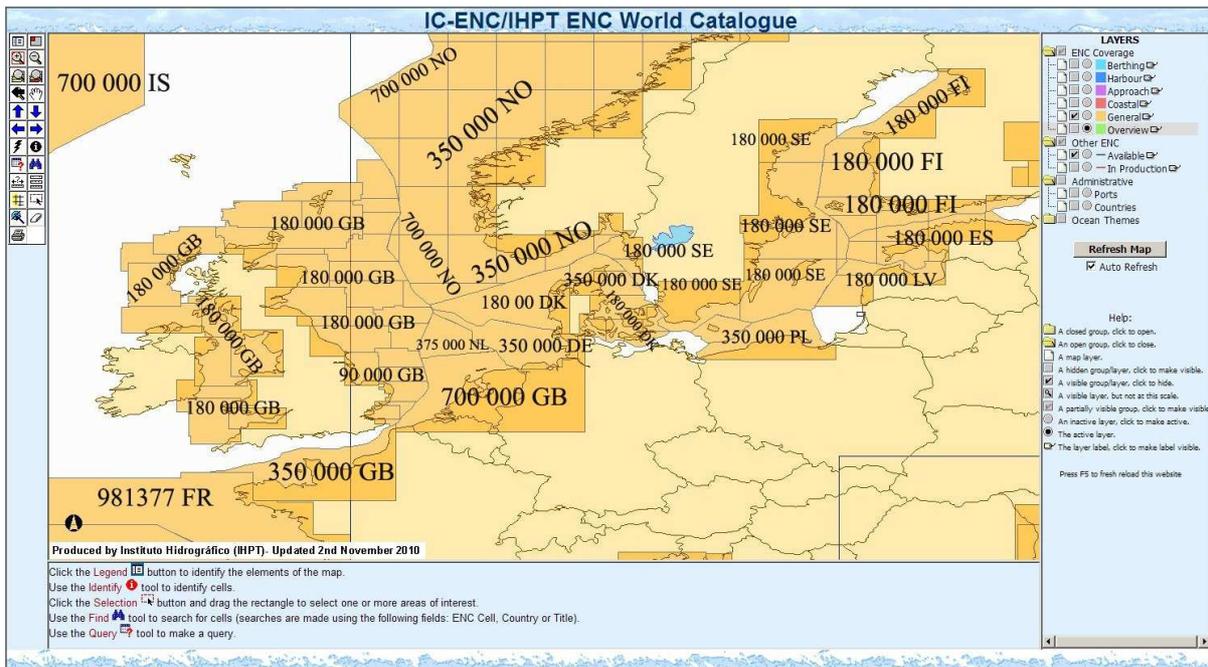


Figure 4. The state of general ENCs for the North Sea and the Baltic Sea

4.2. Description and review of the current state of MBSHC

None of the cells of Overview ENC navigational purpose for the MBSHC are consistent with the borders of the nation's jurisdiction at sea, so that certain countries publish ENCs for the areas under other countries' jurisdiction although there is an established hydrographic service for such areas. In some areas there is also inconsistency of compilation scale of the neighbouring cells (Figure 5) and (Table 3).

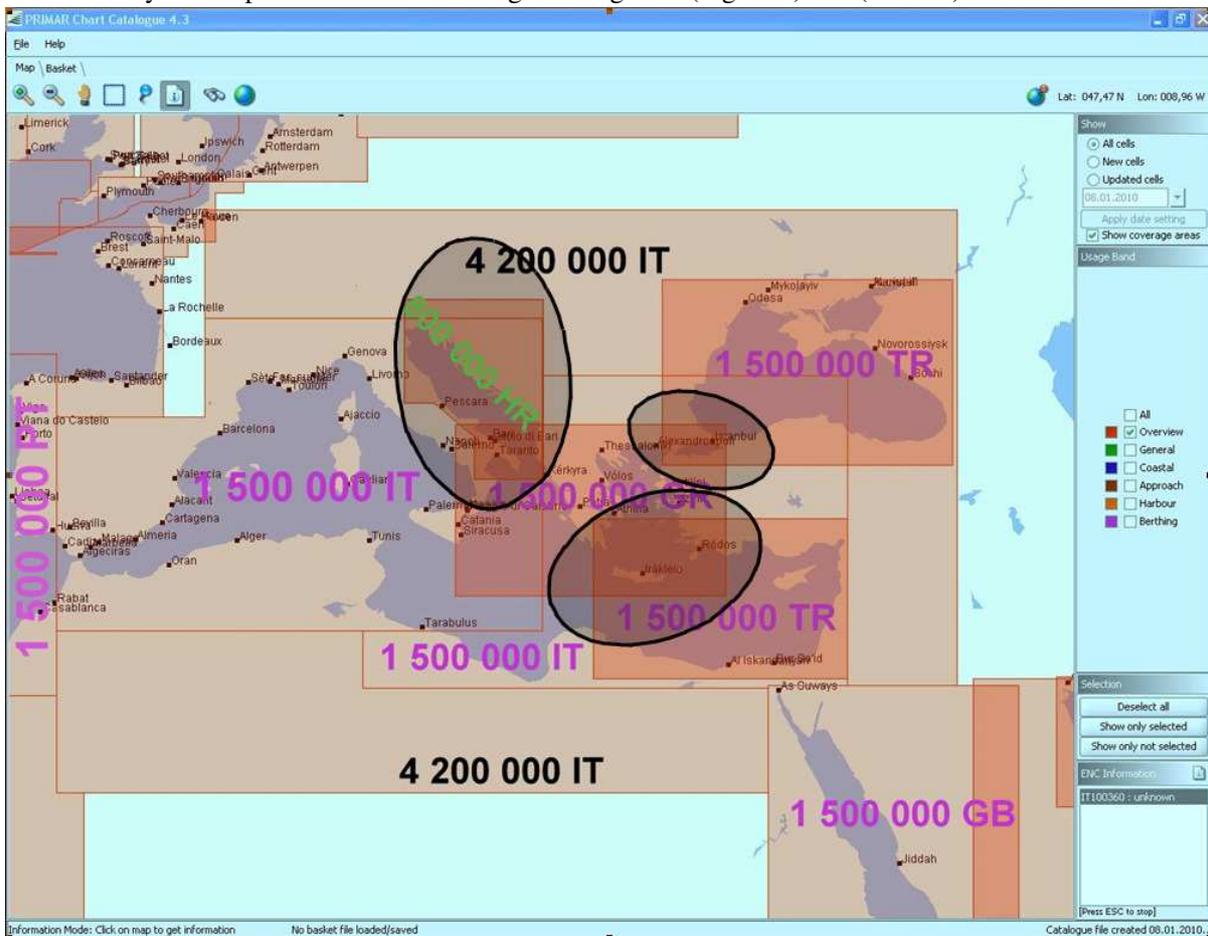


Figure 5. Overlap of ENC data within Overview navigational purpose band for MBSHC

Table 3. Different use of compilation scales in the Overview navigational purpose usage band for MBSHC

Compilation scale	IHO Recommendations	Croatia	Italy	Greece	Turkey
Overview	3 000 000 1 500 000	800 000	1 500 000 4 200 000	1 500 000	1 500 000

Cell borders within the General navigational purpose in the area of MBSHC are not consistent to the countries' jurisdiction at sea, so that certain countries publish ENC's for the areas under other countries' jurisdiction although there is an established hydrographic service for such areas. Inconsistencies in compilation scale at the border in some other areas can be seen (Figure 6) and (Table 4).

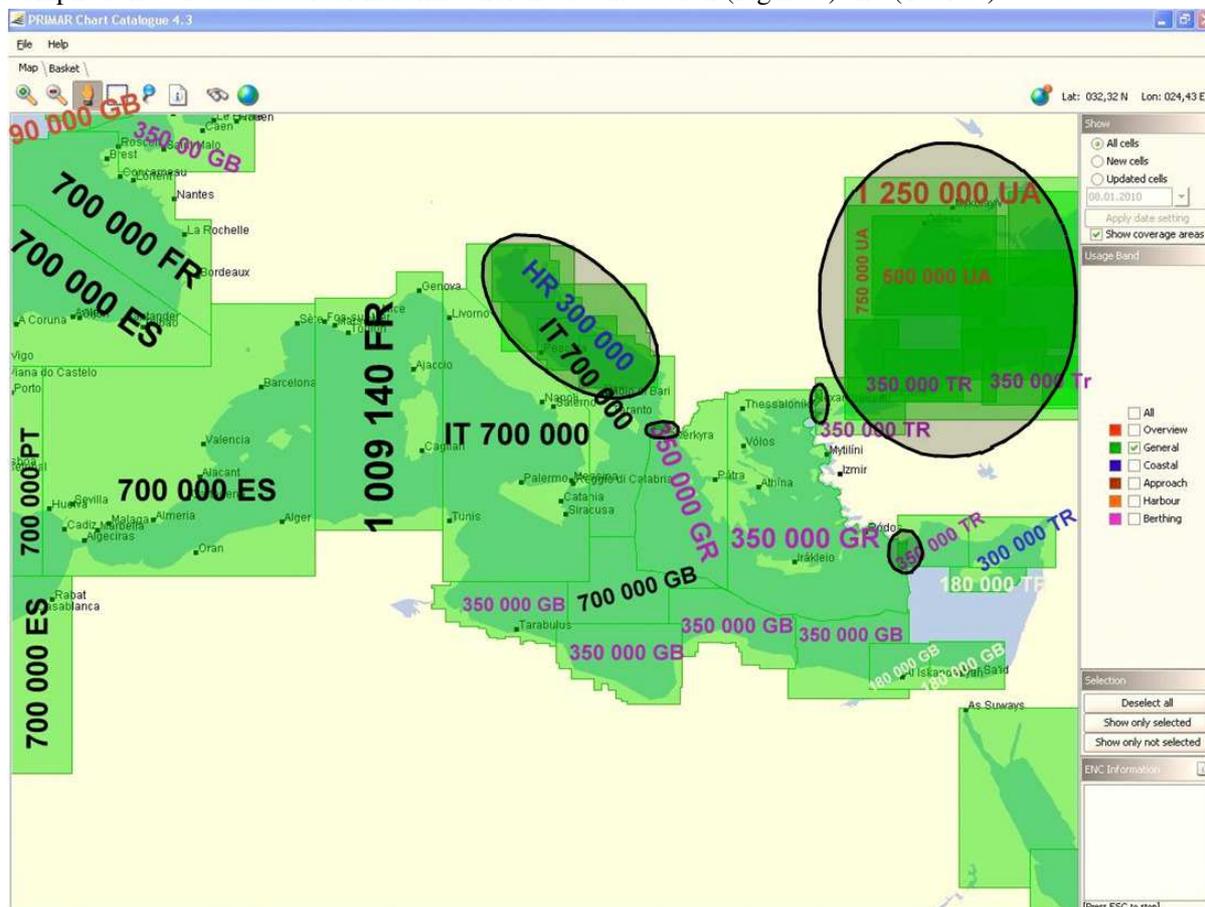


Figure 6. Overlap of ENC data within General navigational purpose band for MBSHC

Table 4. Different use of compilation scales in General navigational purpose band for MBSHC

Compilation scale	IHO Recommendations	Croatia	Italy	Greece	Turkey	France	Spain
General	700 000 350 000	300 000	700 000	350 000	350 000	1 009 140	700 000

4.3. Description and review of the current state for the Adriatic Sea

The problem of overlap for the Adriatic Sea has been identified at the ENC cells published by three official publishers in both usage bands (Overview and General). This leads to the conclusion that the principle of “no data limits” has not been observed and that the majority of such cells have been produced according to the range of the existing paper charts, not taking into account or being unaware of production plans of the member states of the region. Also, there is inconsistency in compilation scale. According to the authors' information, there are no mutual agreements between the three member states. Such untenable situation has been present for some time and there no indications for the solution in the near future.

According to the above paragraph, in the Overview navigational purpose band, there is overlap between ENC data of the three producers and inconsistency of the scale at the cell borders. GR and IT published cells in the scale 1:1 500 000 and HR published the cells in the scale 1: 800 000 (Figure 7). Double overlap of ENC data of IT and HR exists in the greater part of the Adriatic, while the triple overlap of cells is in

the southern part of the Adriatic and in the northern part of the Ionian Sea. The triple overlap includes also the Strait of Otranto that is an important and congested navigation area.

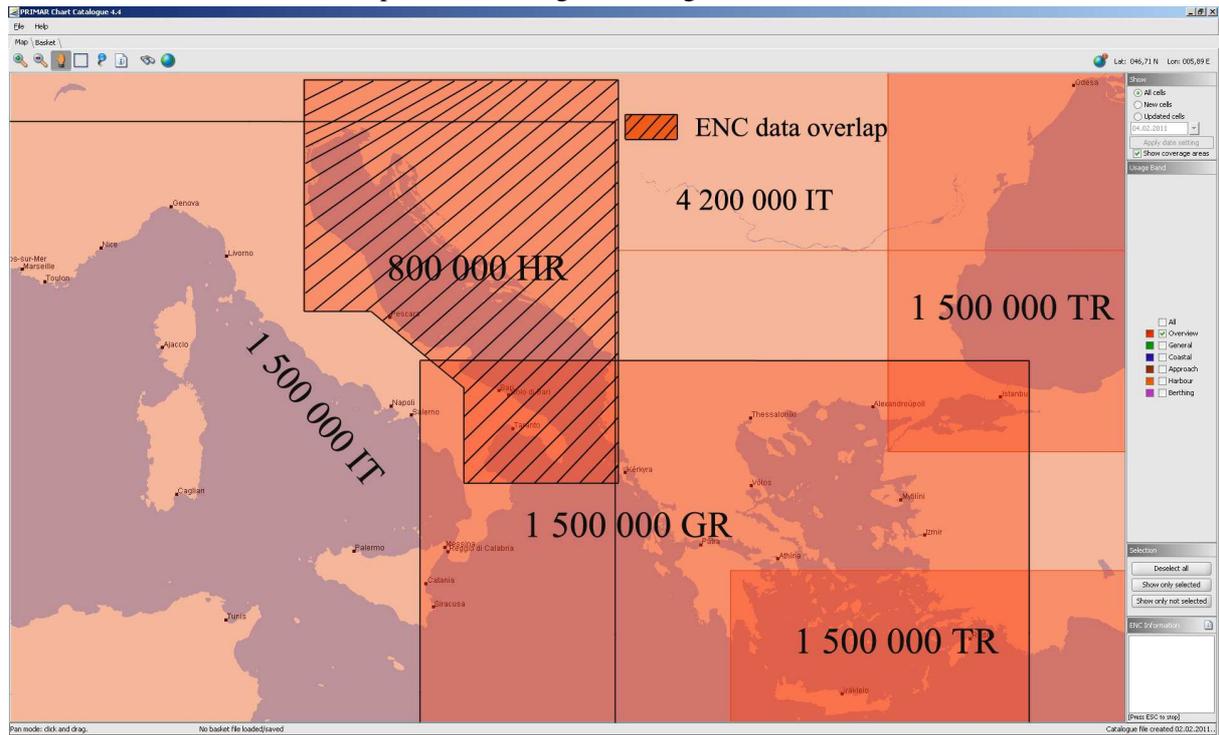


Figure 7. *Overlap of ENC data within Overview navigational purpose band for the Adriatic Sea*

In General navigational purpose band there is the overlap of ENC data between IT and HR. Croatia has published four ENC cells in the scale of 1:300 000, while IT has published one ENC cell in the scale of 1:700 000. There is a small overlap in two cells in the Ionian Sea between producers IT and GR. As for General ENC, the cell borders do not correspond to the borders of the states' jurisdiction at sea, hence, it can be concluded that the principle of “no data limits” is not applied, since there is not agreement relating to it (Figure 8).

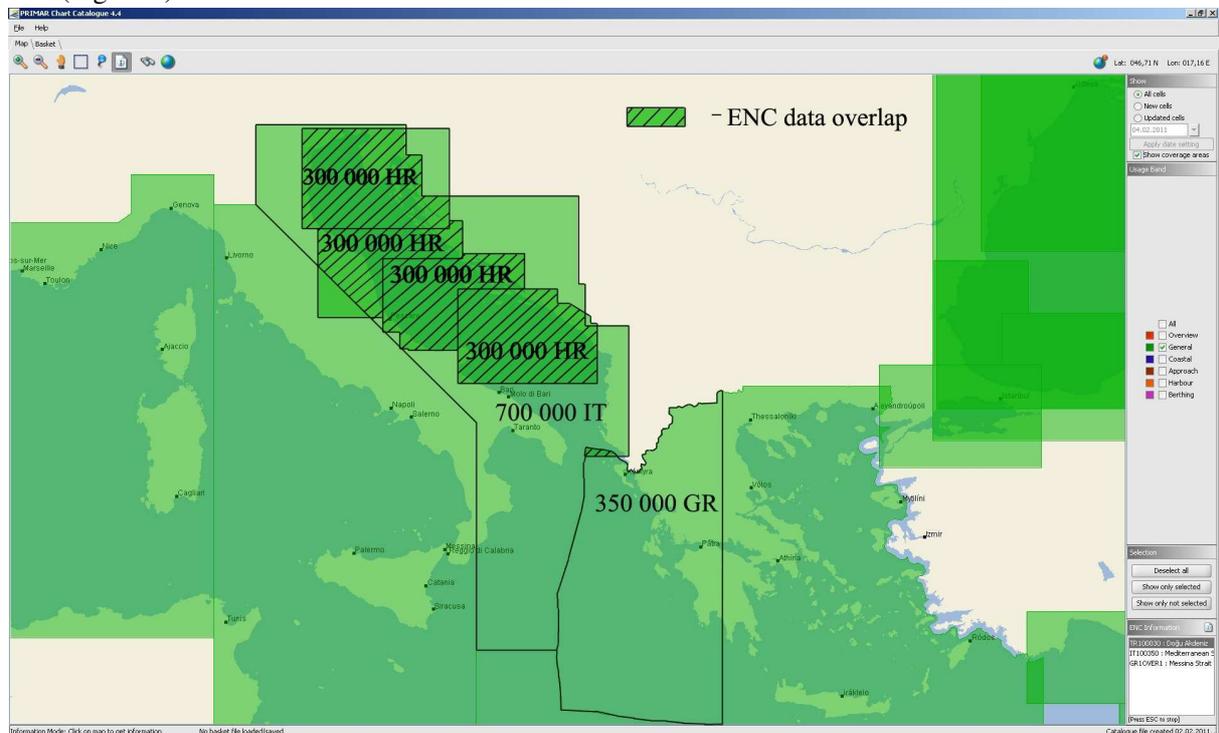


Figure 8. *Overlap of ENC data within the General navigational purpose band for the Adriatic Sea*

5. RESULTS

After completing an analysis of the current state of the areas with corresponding overlap solutions for the broader area of the Mediterranean and the Black Sea and the area of the Adriatic Sea for which the solution of overlap is being studied by applying the described methodology, the authors have designed a general proposal for the solution and proposal for each navigational purpose band.

5.1. General proposal for the solution

In conformity with the stated methodology, a general proposal for the solution has been developed, according to which it is proposed to map the borders of ENC cells (IT, HR) in compliance to the border determination of the epicontinental shelf's in the Adriatic. In the southernmost area of the Adriatic, where there is a triple overlap of the Overview ENCs IT, HR and GR, it is proposed to follow the middle line of border determination of coastal cells IT and sea border between AL and GR. The cells for user bands 1 and 2 HR and IT will be produced by each of the states for the area under its jurisdiction. For the areas under the jurisdiction on the east coast of the Adriatic which do not have an established hydrographic service or did not (will not) produce ENCs for the area under their jurisdiction by the mandatory terms, it is proposed to initiate the process of agreement. The agreement will stipulate that a state would allow the other state, in compliance to WEND principles, to produce and maintain the cells within the proposed borders. The agreement would remain effective until the states are ready to produce their own ENCs for the area under their jurisdiction.

5.2. Proposal for the solution of Overview navigational purpose band

The realisation of the proposed matter in the above paragraph related to the review cells would refer to implementing the following activities of the competent hydrographic offices:

- Croatian Hydrographic Institute should produce a new cell in the production scale of 1:1 500 000 for the area within its competence;
- New cell would also contain data from the territory of jurisdiction of the Republic of Albania, Montenegro, Federation of Bosnia and Herzegovina and Slovenia, with the prior approval of the stated countries;
- Croatian Hydrographic Institute would publish new cell not later than the date of mandatory implementation of ECDIS;
- By the same date, the Italian HO should be ready to publish a new cell that would leave out the content of the new cell published by the Croatian Hydrographic Institute.
- By the same date, GR should be ready to publish a new cell that would leave out the content of the new cell published by the Croatian Hydrographic Institute.

Production of new cell in the scale of 1:1 500 000 will meet the requirement pursuant to which a particular purpose of use will be assigned the corresponding compilation scale. Also, the requirement of cross-border consistency will be fulfilled (Figure 9).

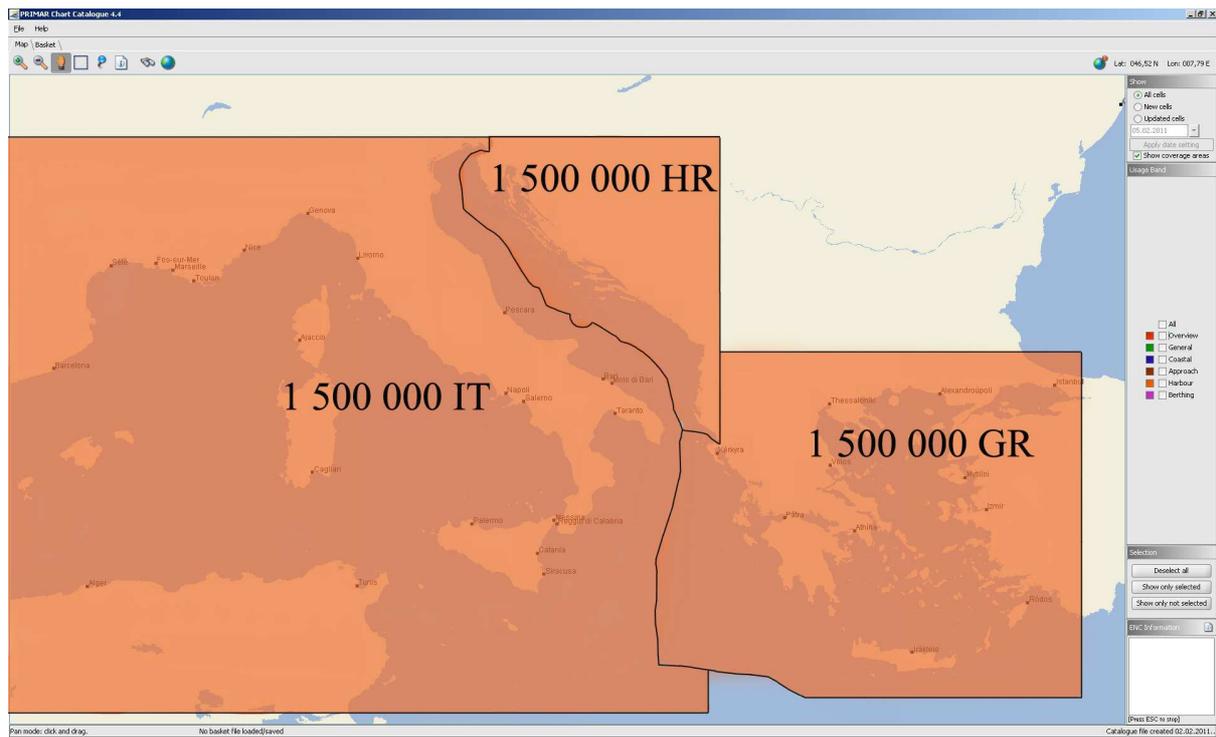


Figure 9. Proposal for the solution of overlap of ENC data in Overview navigational purpose band

5.3. Proposal for the solution of General navigational purpose band

The realisation of the proposed matter in the above paragraph related to the General cells would refer to implementing the following activities of the competent hydrographic offices:

- Croatian Hydrographic Institute should produce 4 new cells in the production scale of 1:350 000 for the area of its competence and for the area of jurisdiction of the Republic of Slovenia, Federation of Bosnia and Herzegovina and Montenegro, with the prior approval of the stated countries;
- Croatian Hydrographic Institute would produce an additional new cell in the production scale of 1:350 000 from the current cells which would contain data from the territory of jurisdiction of the Republic of Albania, with the prior approval of the stated country;
- Croatian Hydrographic Institute would publish new cells not later than the date of mandatory implementation of ECDIS;
- By the same date, the Italian HO should be ready to publish a new cell that would leave out the content of the new cells published by the Croatian Hydrographic Institute.
- Optionally, what would be the best solution, IT HO might consider the production of a new cell in the larger scale of 1:350 000.

Production of new cells in the scale of 1:350 000 will meet the requirement according to which a particular purpose of use should be assigned the corresponding compilation scale. In view of the configuration of the eastern coast of the Adriatic it is more convenient to produce the cells for that area in a larger scale, i.e. the scale of 1:350 000. Also, since GR HO has published the ENC cell to the AL border in the scale of 1:350 000, the consistency in scale will be provided for the whole eastern coast of the Adriatic Sea and the Ionian Sea (Figure 10). However, the proposed solution has a minor drawback because of the inconsistency between the scale of the proposed cells that would cover the eastern coast of the Adriatic Sea and the Ionian Sea (all of the same scale of 1:350 000) and the scale of the cells that would cover the western coast of the Adriatic Sea and the Ionian Sea (scale 1:700 000). Should IT consider the issue and accept the production of a new cell in the scale of 1:350 000, the drawback would be eliminated. Nevertheless, the proposed solution would still be a significant improvement of the current situation.

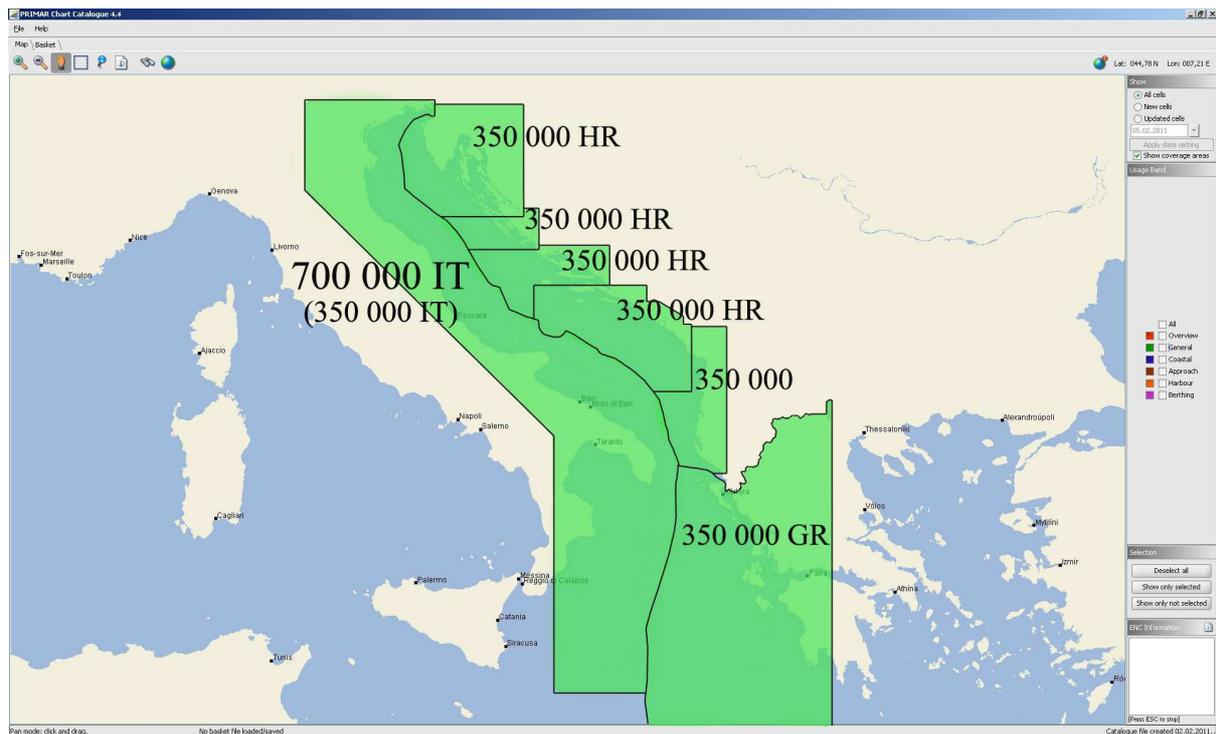


Figure 10. Proposal of the solution for overlap of ENC data for General navigational purpose band

6. CONCLUSION

International Hydrographic Organisation and its members, i.e. national hydrographic offices, are faced with new challenges in providing quality, reliable and easily accessible official ENCs. Since most of the available ENCs have been produced on the basis of the existing paper charts the following problems appeared: overlap of ENC data and cross border consistency of the compilation scale. The problem of overlap of ENC data is significant as it may cause unforeseen work of ECDIS system. For the responsible hydrographic offices will cause organisational and technical problems that need to be solved not later than 1st July 2012, when the mandatory implementation of ECDIS and ENCs will be enforced. The area of the MBSHC, which includes the member states of the Adriatic Sea as well, and which is competent for the issue, demonstrates the overlap of ENC data within the usage band 1 (Overview navigational purpose) and usage band 2 (General navigational purpose). In view of the demanding aspect of the problem, and of the fact that, so far, the attempts of MBSHC and other official forums have not given results, the authors of this paper propose a compromise solution for the transition period. By adopting and implementing the concrete measures as presented herein, in accordance to WEND principles, the major problem of overlap of ENC data within usage bands 1 and 2 in the Adriatic Sea would be completely solved. In view of the fact that, in the proposed solution, the problem of inconsistent cross-border scale (IT 1:700 000 and HR 1:350 000) between ENC cells in usage band 2 would still remain, the solution could be characterised as conditionally temporary. It would be temporary because the presence of inconsistency of the scale is contrary to the standards of S-57, and it would be conditionally temporary because it could be a permanent solution if taking into account the fact that eastern and western part of the Adriatic are completely different in terms of the coast indentedness and the number and size of the islands. The authors therefore think that the eastern part of the Adriatic could be shown in ENC cells of general navigational purpose in larger scale (1:350 000), and the western part of the Adriatic in the current scale (1:700 000) or better, in the scale of 1:350 000. In the period after the implementation of the proposed solution, the six countries of the Adriatic Sea region and one country bordering the Ionian Sea should continue their cooperation and develop the formal agreement that would initiate a new joint project. One of the aims would be a new joint hydrographic survey of critical navigational areas and of other areas that have many outdated data. The new data could be used for an agreed design of a new ENC production plan according to previously agreed borders of ENC cells and the production would not be based on the existing paper charts. New approach and new data would lead to a complete coverage of the area with ENCs of the adequate navigational usage band, without overlap and cross-border inconsistency and with reliable hydrographic data. Mutual agreements would be the basis for the exchange of data necessary for the production of new cells or the update of the existing cells for the areas or states which do not have sufficient or adequate capacities for

producing and updating ENC's. The agreement would also guarantee adherence to other rights and obligations that are related to complex and demanding tasks in providing to end users quality and reliable ENC's. Such approach could be a model that could be implemented in other regions of MBSHC, particularly for the Black Sea, but also beyond the area of MBSHC.

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