ENC and ECDIS

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Electronic Navigational Charts (ENC) and Electronic Chart Display and Information Systems (ECDIS) are typically created at different places: ENCs by various hydrographic offices, ECDIS by various industrial ECDIS manufacturers. When in use, ENCs and ECDIS form a closely interconnected »community« with its members strongly dependent on each other when creating results which aim to support the navigator as efficiently as possible. Recognising the complexity of the standardisation task a great deal of success has been achieved in creating a worldwide community of producers and users of ECDIS and ENCs providing a global coverage for the international maritime community. However, gaps exist between worlds of ENCs and ECDIS with regard to the standards and methods applied when producing and using ENCs and ECDIS. Some of these discrepancies between the worlds of ENCs and ECDIS have the potential to mislead the navigator and other users.

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ENC | ECDIS | bathymetry | zooming in | S-57

1 ENC

ENC is the actual chart data prepared by hydrographic authorities for use with appropriate systems to support safe navigation.

ENC is neither software nor hardware – quite like a text file is neither software nor hardware, but »just« the actual user data.

The content, structure and format of ENC is standardised by the International Hydrographic Organization with their Special Publication No. 57 *IHO Transfer Standard for Digital Hydrographic Data* and its components (IHO 2000; IHO 2014).

ENC is »… issued for use with ECDIS on the authority of government-authorized hydrographic offices« (IMO 1995).

ENCs are object-oriented vector charts, hence providing not only pixel-information allowing to produce chart images (like raster charts such as ARCS do), but machine-readable real-world information such as depth values and light-sectors.

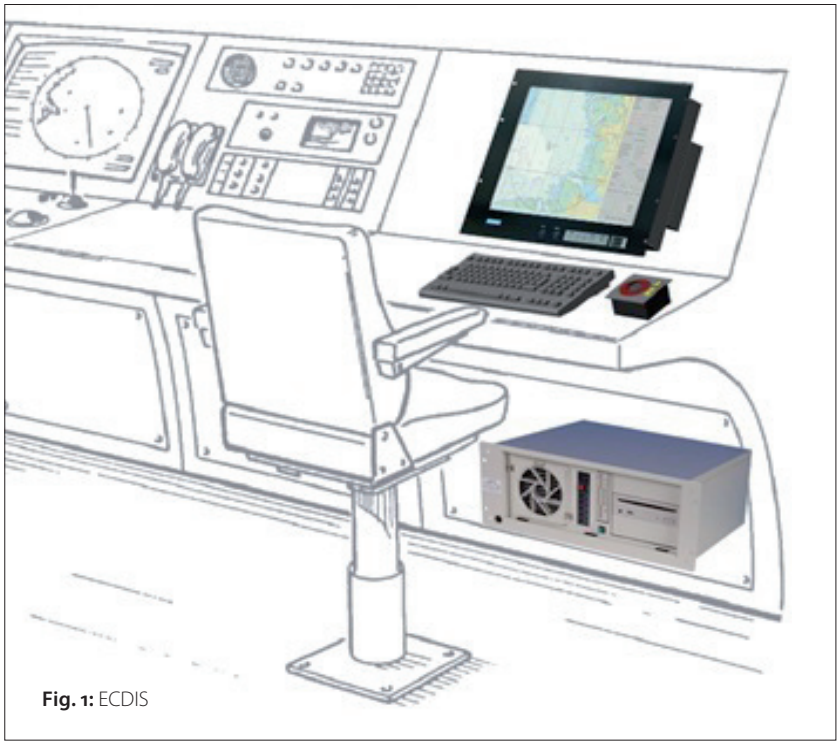

Fig. 1: ECDIS

2 ECDIS

Together with appropriate ENCs ECDIS is a tool to support safe navigation at sea (Hecht et al. 2006; IMO 1995).

Generally ECDIS is understood to be a system consisting of »just« hardware and software but no chart data – quite like a computer with just a word processor is just hardware and software but does not contain any user data.

When the development of an ECDIS is finalised, it is thoroughly checked against tests stated in IEC 61174 *Operational and performance requirements, methods of testing and required test results* (IEC 2015) which – after successful tests – is the basis for the official type-approval of an ECDIS and its use for navigation on-board of seagoing ships (Hecht et al. 2006).

ECDIS is developed and produced mainly by commercial ECDIS manufacturers.An ECDIS typically consists of a computer with interfaces for navigation sensors, a monitor and a keyboard (Fig. 1).

ECDIS is not just a »display« system just creating chart images with a symbol on top showing own ship's position, but also provides »information« functions such as automatic route checks against charted depths.

3 ENC and ECDIS

Based on the understanding stated in chapters 1 and 2, ENCs issued by or on behalf of hydrographic offices and ECDIS developed and produced by manufacturers form together a »Real-Time Geographic Information System« consisting of data, hardware and software – like all geographic information systems do (Bill and Fritsch 1994, p 5).

The fact, that in this sense neither ENCs nor ECDIS alone provide any real use, is reflected by the following definitions in the *IMO Performance Standards for ECDIS* (IMO 1995):

- ENC »means the database (…) issued for use with ECDIS«;
- ECDIS »means a navigation information system (…) displaying (…) information« from a SENC, with SENC being the ENC imported into the ECDIS.

It is quite obvious that the data and the hardware and software must fit well together in order to provide a tool useful to the navigator.

With ENC and ECDIS this is achieved by following a set of rules carefully adjusted to each other and constantly maintained based on the feedback of hydrographic offices, ECDIS manufacturers and navigators. This set of rules consists of:

- mainly S-57 and its components for the data (IHO 2002; IHO 2016)
- and IEC 61174 for the hardware and software (IEC 2015).

With the purpose of ENC and ECDIS being civil sea surface navigation and therefore ENCs providing worldwide coverage, ECDIS with ENCs is the only GIS known to the author with worldwide coverage of up-to-date, quality controlled, object-oriented vector charts commercially accessible for a clearly defined purpose, and with public standards allowing production and update for data and hardware and software independently from each other.

Other chart product specifications than those for ENCs regularly applied to provide for worldwide chart coverage are either used with raster charts (such as ARCS), used with gridded data (such as DTED used to exchange elevation data), proprietary formats (such as Shape from ESRI), used for products largely accessible to the military only (such as DNC, MGCP and AML), used with largely outdated information (such as VMap), or used with crowd-sourced information which is not quality-controlled by an authority (OpenStreetMap, OpenSeaMap).

Consequently, official sea charts are also used for applications other than civil navigation – e.g. the military (Dugge 2016; Offenborn 2016). It is actually its unique combination of features which makes ENCs attractive for users other than navigation, too, but only, if the related standards are carefully

- obeyed when actually producing ENCs and developing and producing ECDIS and other GIS using ENCs,
- maintained to meet anticipations of users.

If this is not the case, the appearance of ENCs on an ECDIS or other GIS has the potential to deviate from the expectations of the user as being detailed with the following examples.

4 Medium scale bathymetry

Some hydrographic offices have decided to show bathymetry for some areas only on the more detailed charts – no medium scale bathymetry is provided for these areas.

As an example, this is shown with some electronic charts for the German Bight. The German Bight is a sea area situated north-west of Germany in the North Sea with a size of roughly 100 nm × 100 nm.

Fig. 2 shows the General ENC covering the German Exclusive Economic Zone on an ECDIS at a display range of 96 nm (with the »display range« being the range from the centre of the display to its top). It can be clearly seen that the entire coastal waters are covered by a greenish area. Greenish stands for »intertidal areas«, sea areas that fall dry at low water.

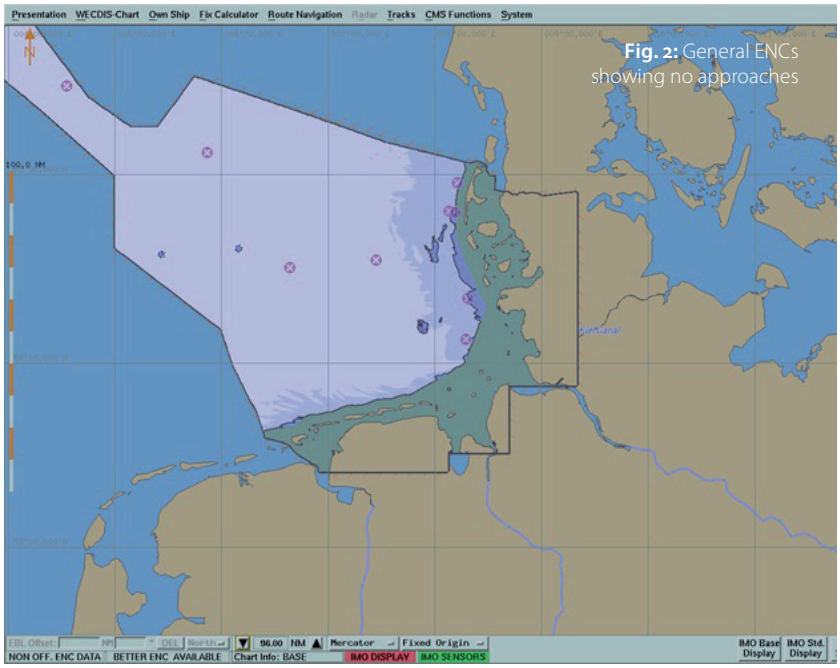

Fig. 2: General ENCs showing no approaches

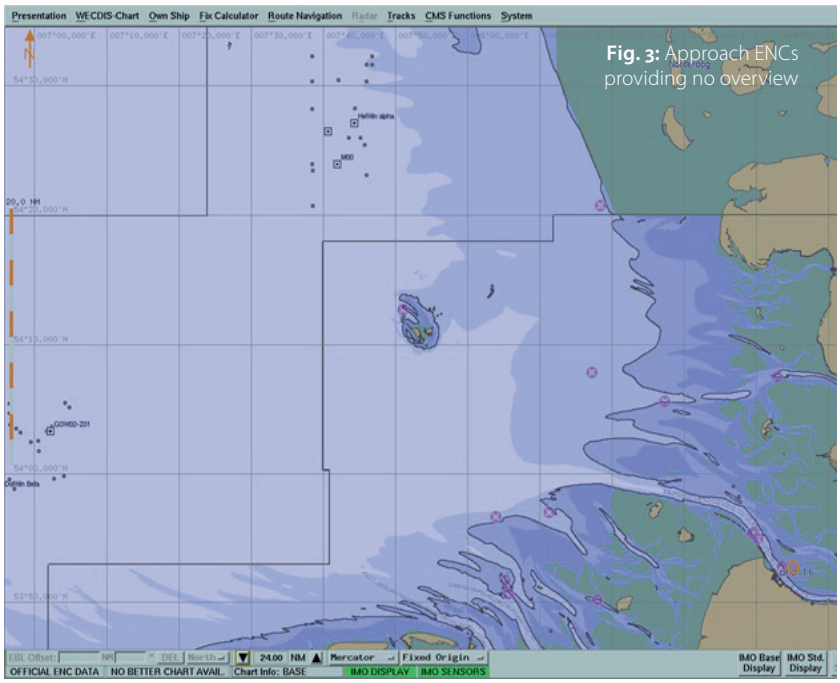

Fig. 3: Approach ENCs providing no overview

In this chart no approaches leading to any harbour such as Hamburg or Bremen are indicated.

When using this chart on an ECDIS a Caution Area is shown warning the mariner to use a more detailed chart to navigate these areas.

When zooming in, charts carrying more detail – so-called »Coastal« ENCs – will appear. These, too, do not indicate any approaches to harbours.

Only when zooming in further, »Approach« ENCs showing major approaches eventually appear (Fig. 3).

However – as the sea area being displayed

Abbreviations

ARCS – Admiralty Raster Chart Service
AML – Additional Military Layers
DNC – Digital Nautical Chart
DTED – Digital Terrain Elevation Data
IEC – International Electrotechnical Commission
MGCP – Multinational Geospatial Coproduction Program
SENC – System Electronic Navigational Chart
VMap – Vector Map

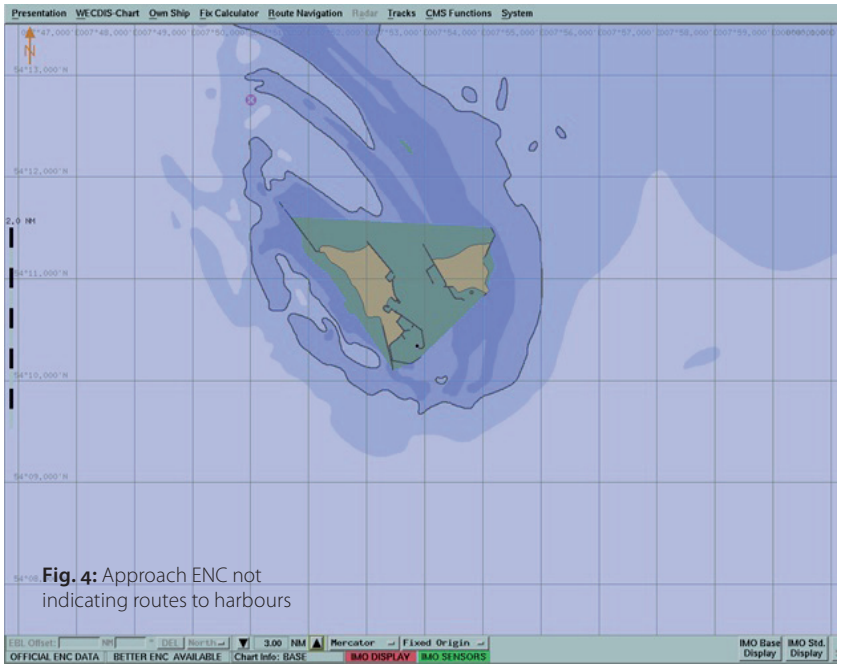

Fig. 4: Approach ENC not indicating routes to harbours

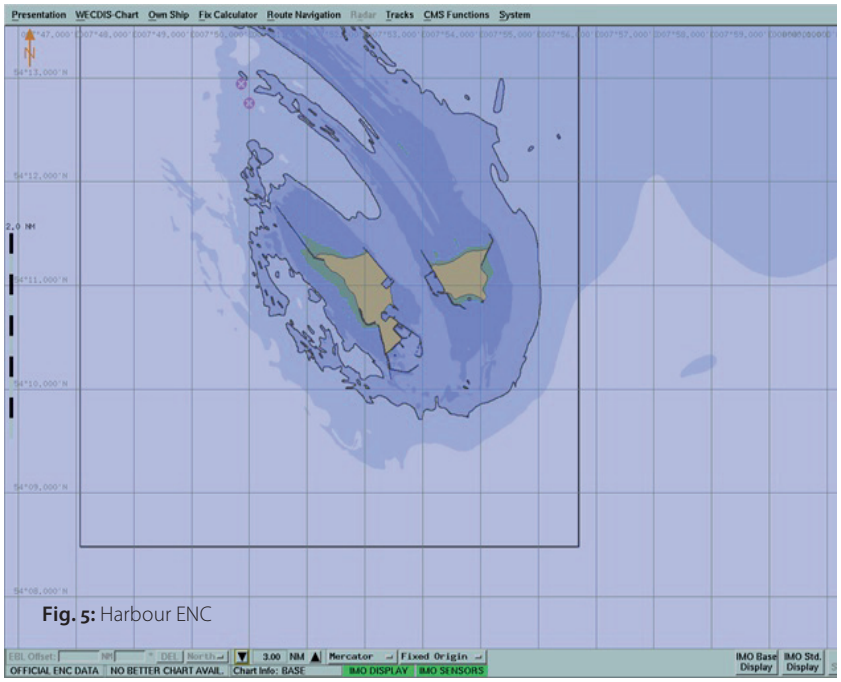

Fig. 5: Harbour ENC

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Hecht, Horst; Bernhard Berking; Gert Büttgenbach; Mathias Jonas; Lee Alexander (2006): The Electronic Chart – Functions, Potential and Limitations of a New Marine Navigation System; GITC, Lemmer

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shrinks – the overview gets lost. It does not become clear immediately which of the approaches shown must be taken to travel from one particular harbour to another one.

Zooming in further shows – e.g. at Heligoland (Fig. 4) – that even now no indications are given with the Approach ENC on how to reach a harbour, as the area of Heligoland is covered by an artificial »cartographic« intertidal area not representing the actual feature.

Only when switching to the harbour chart (which is the most detailed chart for this area), this oversized intertidal area is resolved and the mariner can see from which direction the harbour entrance can be approached (Fig. 5).

With these effects of showing no bathymetry at medium-scale displays in some areas the question arises:

What does this method of using »cartographic« intertidal areas mean to the mariner using ECDIS and to other users of ENCs?

Based on a background of uses of ENCs in ECDIS and other GIS the following can be stated:

- The overview gets lost with showing no indications of approaches on charts covering large areas.
- When executing route checks on an ECDIS, many ECDIS will individually check all charts available from coastal usage to the most detailed usage and will provide all alarms to the user. This means that all route checks in these navigable waters covered with »cartographic« intertidal areas will result in a false check results.
- For many other uses of ENCs the last decimetre of depth is not relevant. This applies e.g. to sonar propagation predictions, tactical SAR planning or simulation of currents. Hence, medium-scale charts are used. However, if these are wrong by many metres and virtually close existing waterways, they cannot be used for such applications.

To summarise it can be concluded: The geographic information provided for and loaded into a GIS should not be distorted due to mere cartographic reasons.

5 Vanishing details when zooming in

When zooming in it is the user's expectation that more details appear in the chart window than was visible before.

However, in many areas the charts provided are designed in such a way that details vanish when zooming in on an ECDIS.

As an example, charts for the sea area of Bab el Mandeb are chosen (Fig. 6). Bab el Mandeb is a busy Sea Line of Communication situated between Djibouti and Yemen forming the southern entrance of the Red Sea. ENCs for this area are issued by the hydrographic offices of the UK and France.

Fig. 7 shows a chart picture with no surprises which is generated by the ECDIS at a display range of 256 nm. It is somewhat cluttered, but a good overview is given showing e.g. cables running to and from Bab el Mandeb. General ENCs are used for this image.

When zooming in to a range of 128 nm, Coastal ENCs (bordered by grey solid lines) are drawn on top of the General ENCs (Fig. 8). However, rather than showing more details, fewer details are shown: where the Coastal ENCs are drawn, no cables can be seen anymore – they are visible only in the area which is not covered by the Coastal ENCs.

Route planning along a cable becomes virtually impossible at this scale. Only when zooming in to a range of 36 nm the cables are shown again (Fig. 9).

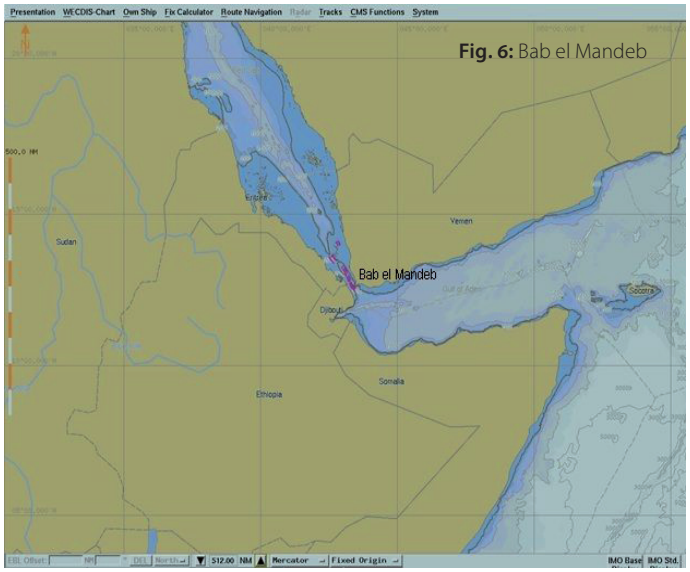

Fig. 6: Bab el Mandeb

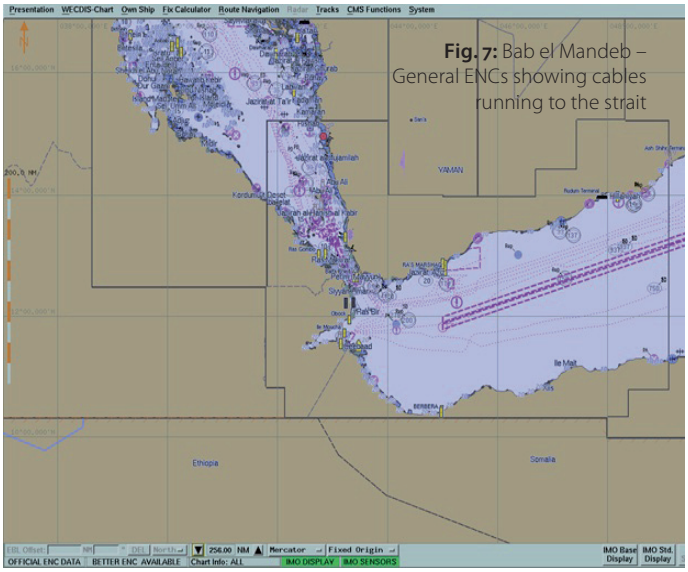

Fig. 7: Bab el Mandeb – General ENCs showing cables running to the strait

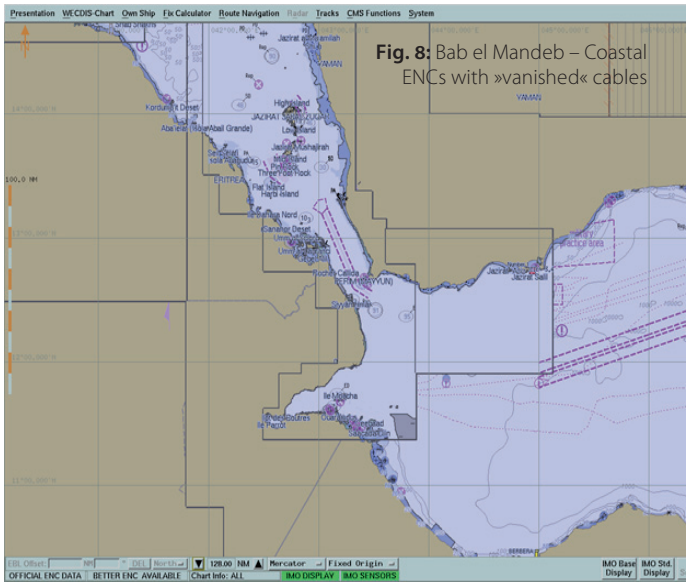

Fig. 8: Bab el Mandeb – Coastal ENCs with »vanished« cables

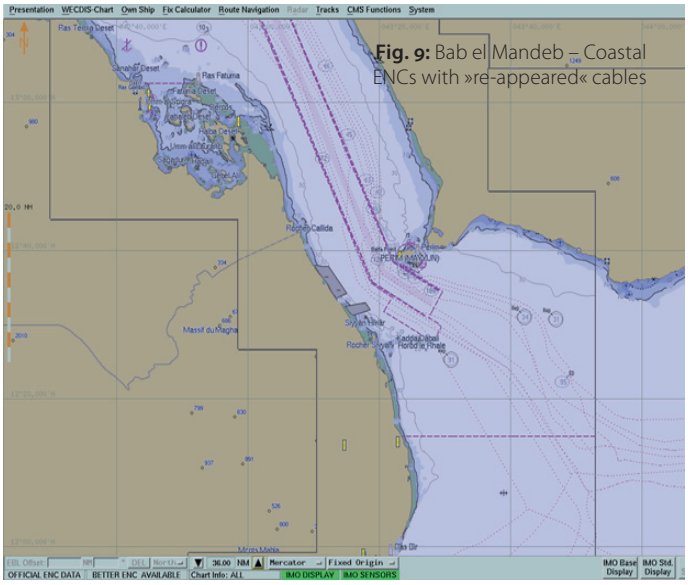

Fig. 9: Bab el Mandeb – Coastal ENCs with »re-appeared« cables

However, only a small area is shown now – an overview of where the cables come from and run to is not provided at this display scale.

The same effect can be observed when zooming in further: Approach ENCs appear and the cables vanish in the areas of the Approach charts which are expected to show more details than the Coastal charts.

And – once again – only when zooming in further do the cables »re-appear«.

For many users the examples with the »vanishing« cables shown here may not be of great relevance. But the same effect has been observed with other objects such as anchorage areas. Their picture, too, vanishes in parts when zooming in in some areas and only re-appears when zooming in further – hence not given an overview of the complete set of anchorage areas.

To summarise what it means when details vanish when zooming in:

- The anticipations of the user are not met – hence he or she gets lost.
- No tactical – in other words medium-scale – planning is possible.

As a conclusion it is preferred to have no vanishing details when zooming in using ENCs.

6 Recommendations

ENC and ECDIS together form a real-time GIS based on a common set of carefully adjusted and maintained rules.

The following is recommended to be considered when producing ENCs in order to increase acceptance by meeting anticipations of users of ECDIS and to promote usages of ENC other than navigation:

- No distortion of geographic information to achieve cartographic effects;
- No vanishing details when zooming in.

It is hoped that these recommendations contribute to the harmonisation efforts of the maritime community to lessen the gaps between the worlds of ENC and ECDIS. Furthermore, this explanation aims at contributing to the usability of ENCs not only with ECDIS but also in other environments such as tactical displays, hence contributing to a common maritime picture of various stakeholders creating commercial benefits for the production of ENCs. ⚓

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