7th Meeting of the Data Quality Working Group (DQWG)
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Discussion paper for 7th meeting of IHO-DQWG:
Unified population of Zones Of Confidence for sea areas with a mobile seafloor
submitted by Leendert Dorst (NLHO), 7 June 2013

Comments (in red colour) from Jeff WOOTTON, Australian Hydrographic Service

Introduction:

According to Action item DQWG4-5A, the DQWG Chair submitted clarifications for the Use of Object Catalogue section 2.2 to HSSC4, which proposes a way to populate the CATZOC element of M_QUAL in case of mobile seafloors [1]. The proposal was:
"It is recommended that, for any survey conducted over an area of likely mobile seafloor, i.e. where, due to the moving seafloor, the seafloor can be expected not to agree with the chart based on data as gathered during the survey, the CATZOC of this area is artificially degraded to CATZOC value of 4 (Zone of Confidence C). Examples of likely mobile seafloors include some areas covered by the SNDWAV object, and areas with a note about mobile seafloor."

HSSC4 did not accept this part of the DQWG submission [2], the relevant section of the minutes is also available in Appendix 1. The strongest opposition to the DQWG submission was expressed by Australia:
"*Australia reported that it might be unwise to implement CATZOC C in mobile seafloor areas as it could restrict shipping unduly."*

Subsequent discussions between the DQWG Chair and Vice-chair resulted in (a) a suggestion to put together a list of the types of mobile seafloors so these can be looked at individually; (b) a paper and presentation at the 4th conference on Marine sandwaves and River dune Dynamics (MARID) to exchange views with experts in mobile seafloor behaviour [3]. The paper presents two different arguments for migrating sandwaves, a common type of seafloor mobility that is defined by shifting patterns of constant sand wave height:
"On one hand, one may argue that depth anomalies cannot be expected, as the charted depth values remain constant. Such an argument ignores the changes in surveyed depth values, which it justifies by pointing out that CATZOC applies to the charted product, not to the observed data set. Advocates of this argument even fear that degradation of such a "safe" sand wave area to a CATZOC of C could tempt mariners to enter other CATZOC C areas with insufficient care.

On the other hand, one may argue that the mariner should be informed about the mobile character of the sea floor, especially if human activities may change the hydrodynamics that drive the sea floor dynamics. Hydrographic offices may not have the resources to resurvey the area with a sufficiently high frequency to detect changes in the behaviour of the pattern in time, or may otherwise not be willing to accept the risk of assigning the area with a CATZOC value of A or B. This argument would satisfy the desire to indicate the potential danger of mobile areas, rather than give a potentially false indication of a highly accurate depiction of the seafloor.

Given the challenges that the example provides, we are inclined to, at least, allow hydrographic offices to artificially degrade CATZOC to a category C for areas with dynamic patterns. Perhaps the ideal of an internationally fully consistent assignment procedure is not feasible for CATZOC, and the specifics of each sea area, as known at the national hydrographic office, have to be taken account."

Analysis:

A key point seems to be whether the shallowest likely depth values in a mobile area change. If it is likely that the positions of the shallowest depth values gradually change, but unlikely that those shallowest values themselves change, the risks involved for surface navigation remain more or less constant. This idea was further elaborated by [4], calculating an "overall shoaling rate" of an area and a "maximum shoaling rate" of any location within this area. In an area with an overall shoaling rate of zero or less the risk increase for surface navigation is limited. If, in addition, the maximum shoaling rate of the area also is zero or less, there is no risk increase due to a mobile seafloor.

I observe two important conditions to this line of reasoning:

The first condition is that the character of the mobility needs to be known:

- repeated surveys and/or a reliable morphological model need to be available;
- it is necessary that there is confidence that the observed or modelled mobility is still valid in the present and the future, even in the presence of human interventions like windfarm construction, dredging and land reclamation in other parts of the basin;
- and it is paramount that a policy is formulated and followed to monitor whether the character of the mobility changes.

The second condition is that the character of surface navigation needs to be known:

- a position change of the shallowest likely value may not be relevant to the navigator in open seas or coastal waters, but very relevant during high-precision navigation in an enclosed area (an international straight or a busy port approach) [5];
- ships with a critical under keel clearance at any water level do not enter a mobile area. This type of ship could either be absent, as proven by e.g. AIS data [6,7], or such ships are led around mobile areas by pilots;
- in areas with intense shipping, ships should be expected to incidentally deviate from their intended route to avoid traffic. Critical under keel clearances should even be expected if deep draught ships do not regularly enter a mobile area, but do regularly navigate in its proximity.

An example highlighting the complexities of these conditions is given in [3], for the Port of Rotterdam approach in the Dutch part of the North Sea.

There could also be a sense of pride among hydrographic offices: a product with lower CATZOC values could incorrectly be interpreted as a product with an inferior quality, especially if there have been heavy investments in survey equipment or commercial services. Nobody likes to see a lower CATZOC values in its domestic waters than in the bordering foreign waters. Hydrographic offices should be protested against such an inflation of CATZOC values by providing explicit guidance from the IHO. Inflation could lead to unlikely CATZOC values, which in turn may lead to overconfidence in the data by mariners, potentially followed by accidents and legal claims. The good quality of the survey should be given by populating other S-57 attributes, so that the detoriorating quality of the data could be described using CATZOC. The Admiralty Guide to the Practical Use of ENCs puts it as follows: "*Whilst CATZOC provides useful information, it should not be relied upon in isolation, and mariners should use the ECDIS pick report function to interrogate any further information that may have been provided by the ENC producer within M_QUAL/M_SREL/M_ACCY objects to build a full picture of the accuracy of the ENC data that is available, and so establish the appropriate safety tolerances when determining the best voyage plan* (see below)."

Proposals:

(1) I propose to use a detailed list of mobile seafloor types, and to assign allowed CATZOC values to each type of mobile seafloor. An initial list is given in Appendix 2.

(2) I propose to supply a series of notes for the choice between the allowed CATZOC values, to guide the assignment procedure in case of special nautical circumstances and in case of incomplete knowledge of the present or future mobility. The initial notes are also given in Appendix 2.

(3) I propose to support the list and the notes with a few realistic examples. I invite the WG to draft these examples once the list and notes have been agreed upon in the meeting.

(4) I propose to strongly encourage the use of the other S-57 quality attributes, especially the ones that describe survey quality rather than data quality ("M_SREL"). Hydrographic offices could use these attributes to illustrate their high survey capacity and the reasons why this does not lead to a high CATZOC value (like "SNDWAV").

Requested actions:

1. to evaluate the initial list of potentially mobile seafloor types;
2. to discuss the above proposal to assign CATZOC values to these seafloor types;
3. to submit a new set of draft clarifications to HSSC, using the ideas and references mentioned above;
4. to explain the result to HSSC representatives in order to build support, especially on a national level.

References:

[1] DQWG: Paper for Consideration by HSSC, Clarifications for Use of Object Catalogue section 2.2, document HSSC4-05.6B.
[2] HSSC: Final minutes of the 4th Meeting of the Hydrographic Services and Standards Committee (HSSC4)
[3] L. Dorst, T. Dehling, and C. Howlett: Developments in North Sea wide resurveying and charting of dynamic sand wave areas. In: Proceedings of MARID IV, Bruges (Belgium), 15-16 April 2013.
[4] L. Dorst, P. Roos, and S. Hulscher: Improving a bathymtric resurvey policy with observed sea floor dynamics. In: Journal of Applied Geodesy, Vol. 7 (2013), pp. 51-64.
[5] L. Dorst: Report of visit to CSMART Almere. Document discussed during DQWG6.
[6] K. Ward, and B. Gallagher: Utilizing Vessel Traffic and Historical Bathymetric Data to Prioritize Hydrographic Surveys. In: Proceedings of USHydro2011, Tampa Bay (USA), 25-28 April 2011.
[7] T. van Dijk, C. van der Tak, W. de Boer, M. Kleuskens, P. Doornenbal, R. Noorlandt, and V. Marges: The scientific validation of the hydrographic survey policy of the Netherlands Hydrographic Office, Royal Netherlands Navy. Deltares report, Utrecht (NL), 2011.

Appendix 1: section 5.6.2 of HSSC4 minutes

Mobile areas and areas affected by extreme events

DQWG Chair proposed that TSMAD be tasked to modify the "Use of the Object Catalogue for ENC" (UOC) to take into account the two issues associated with mobile seabed and extreme events such as tsunami. Australia reported that it might be unwise to implement CATZOC C in mobile seafloor areas as it could restrict shipping unduly. Brazil noted that CATZOC C was used in areas where there was mobile bottom in the Amazon. Netherlands also expressed reservations about this proposal. Australia further noted that CATZOC was not meant to be a measure of survey quality but was intended to provide a quality indicator for the mariner: general sea bed variability would be just one parameter to consider.

USA concurred that the purpose of CATZOC was to provide an indication that the mariner should be able to understand — where he could go, and where he should not go. In view of the lack of consensus about the proposal, USA recommended that it should not be accepted and the DQWG should be requested to reconsider the proposal.

TSMAD Chair recommended that mobile areas should be referred back to DQWG — but that the proposal concerning extreme events should be forwarded to TSMAD for applying the changes to the UOC. Taking the comments into account, DQWG Chair recommended that the publication "Use of the Object Catalogue for ENC" (UOC) be modified to include the proposals in section 8 of HSSC4-05.6B.

Outcome:
- The committee noted the paper (HSSC4-05.6B).
- The Committee did not endorse the proposal in section 6 of HSSC4-05.6B to artificially degrade to 4 (Zone of Confidence C) the CATZOC value for mobile seafloors.
- The Committee endorsed the proposal in section 8 of HSSC4-05.6B to artificially degrade to 5 (Zone of Confidence D) the CATZOC value for areas affected by extreme events.
- Action HSSC4/29: TSMAD to apply to S-57 Appendix B.1 Annex A (Use of the Object Catalogue for ENC), the changes identified in section 8 of HSSC4-05.6B and dealing with reflecting the impact of extreme events through CATZOC.

Appendix 2: Initial list of CATZOC values for common types of potentially mobile seafloors and some notes for their use

1. insignificant changes to the seafloor of any type	A,B,C,D
2. changes with an unlikely impact on the shallowest depth values in an area of any type	A,B,C,D
3. field of dynamic sediment patterns	C,D
4. dynamic sediment feature	C,D
5. general sediment transport	C,D
6. sediment extractions	B,C,D
7. sediment dumping	C,D
8. nearby depth maintenance activities	B,C,D
9. nearby coastline changes	B,C,D
10. nearby present or recent construction of offshore installation parks	B,C,D
11. substantial risk of undetected objects on the seafloor	C,D
12. frequent iceberg scouring	B,C,D
13. frequent bottom trawling	B,C,D
14. oil or gas extraction	B,C,D
15. siltation	C,D
16. changing nautical depth in area with fluid sediments	C,D
17. biology induced changes (coral growth; weed growth; work of benthic organisms)	C,D
18. frequent landslides	B,C,D
19. frequent or continuous vulcanic activity	C,D
20. any type of event with a potentially significant impact on the shallowest depth values	D

notes:

- The term "insignificant" is to be understood in relation to the specifications of the CATZOC categories. If the sum of all uncertainties plus the expected change between two consecutively charted surveys is less than specified in the columns depth accuracy and position acucracy, a change can be understood as insignificant.
- Terms like "nearby", "substantial", and "frequent" are not defined. Interpretation of these terms is up to the local circumstances and therefore should be done by the national hydrographic office.
- In case of high-precision navigation through narrow sea areas, and in case of low under keel clearances in or near the area, a lower category has to be considered. It is safer to chart an area with a CATZOC value that is too careful than a CATZOC area that is too ambitious.
- If the dynamic character of the seafloor is not known or could change, the largest motions that could be possible should be used. These can for instance be determined using literature, or series of surveys from similar areas.
- Large-scale human activities (nearby coastline changes, nearby construction of offshore installation parks) could change the hydrodynamic conditions, which in turn could affect the morphology of the seafloor over a large area. The removal of sediments (sand extractions, nearby depth maintenance activities) could start the formation of a sediment pattern, with an influence on the shallowest likely depth values.
- It is highly recommended to formulate a resurvey policy for any area that is potentially dynamic. If no resurvey policy is in place for potentially dynamic areas, extra care has to be taken before the higher CATZOC categories are assigned to such areas.

DQWG should note the following:

There is already guidance in the S-57 UOC:

5.7 Areas of continual change (see S-4 – B-416)

If it is required to encode an area of continually changing depth, it must be done using the object class **CTNARE** (see clause 6.6). Caution notes in such areas must be encoded using the attributes INFORM or TXTDSC.

Such areas must always overlap **DEPARE** objects.

An area on the source with the indication "Less water" should be encoded using this method.

If it is required to encode sandwaves, this must be done using the object class **SNDWAV** (see clause 7.2.1).

Note that this is additional to **M_QUAL** or **M_SREL**. Additional to the above guidance regarding use of a **CTNARE** (which I consider is appropriate as at least this will result in an ECDIS alarm which hopefully would prompt the mariner to further interrogate the SENC, which would include associated information in the **CTNARE** as well as the existence of other objects such as **SNDWAV**), new guidance has been proposed for discontinuity between surveys due (in most cases) to mobile seabed, for the next version (4.0.0) of the UOC:

5.8.4 Depth discontinuities between surveys (see S-4 – B-416.1)

Depth discontinuities between adjoining or overlapping source bathymetric surveys may be caused by:

- Surveys in areas of continually changing depth (see clause 5.7) conducted with a significant time gap between the surveys; or
- Adjoining areas having significant differences in the quality of bathymetric data (see clause 2.2.3.1).

It may not be possible to safely resolve significant depth discontinuity by interpolating approximate depth contours, which may compromise the ability for the compiler to adequately encode complete, non-overlapping Group 1 coverage of the area of the ENC cell covered by data. Where it is required to indicate these significant depth discontinuities, it should be done by encoding a “very narrow” **UNSARE** object (see clause 5.8.1).

The “very narrow area” should be about 0.2mm in width at ENC Compilation Scale (see clause 2.2.6).

Remarks:

- An indication of the purpose of the **UNSARE** may be done by population of the attribute INFORM, e.g. *Discontinuity between surveys*.
- In order to provide an indication to the mariner of the more reliable encoded bathymetry in an area of continually changing depth, the attribute CATZOC should be downgraded for the **M_QUAL** object (see clause 2.2.3.1) corresponding to the less reliable (or older) data.

This new clause is a result from work done over the past 12 months by the CSPCWG to better indicate the reason for a depth discontinuity between surveys on the paper chart. I would consider this to be sufficient indication to the mariner of the existence of an area of constantly changing bottom (and possible reasons for inconsistency in the representation of depth in these areas).

Additional consideration may be given to including an indication of the date of the survey in at least one of DATSTA or DATEND on the associated **M_QUAL**, but this would necessitate the mariner doing an “unprompted” ECDIS pick report in the area, which is not optimal.

I find it interesting in terms of my comments on the previous Paper that Australia argued against a downgrading of CATZOC in changeable areas, but there is an argument (within our office) that CATZOC should be downgraded as a result of the impact of the nautical cartography on the data.

The HSSC action regarding areas affected by extreme events should hopefully be covered in another Paper (I have sent the relevant text to Eivind).