11th Meeting of the IHO (S-100WG) S-101 Project Team

Use and Modelling of the QualityOfBathymetricData Feature

Agenda Item 08.9

S-101PT11, Lombok, Indonesia, 27-29 September 2023

THE ISSUE

International Hydrographic Organization

- Two methods for the encoding of bathymetric data quality information have been included in the S-101 DCEG since Edition 1.0.1 (March 2021). Intended to provide encoding alternatives for testing and provision of a preferred method to be included in S-101 Edition 2.0.0.
- Very little feedback received.
- A single option needs to be included in Edition 1.2.0 to allow full testing (refer Action S-101PT10-25).

3.7.1 Quality, reliability and uncertainty of bathymetric data (see S-4 – B-297)

[**NOTE:** The modelling of the complex attributre **zone of confidence** and accompanying encoding guidance in this Edition of S-101 Annex A is intended to allow for 2 options for the encoding of degrading bathymetric data quality over time for testing purposes. One of the options described must be used when encoding the quality of bathymetric data for an area. This modelling will be consolidated when the preferred option has been determined. See also clause 24.5.]

Information about quality, reliability and uncertainty of bathymetric data is given using:

- the meta feature **Quality of Bathymetric Data** for an assessment of the quality of bathymetric data;
- the meta feature **Quality of Survey** for additional information about individual surveys (see clause 3.10);
- the attributes **quality of vertical measurement** and **technique of vertical measurement** on groups of soundings or individual features;
- the attributes **horizontal position uncertainty**, **quality of horizontal meas uncertainty** on the spatial types (see clause 2.4.7).

24.5.1 Spatial quality

[**NOTE:** The modelling of the complex attributre **spatial accuracy** and accompanying encoding guidance in this Edition of S-101 Annex A is intended to allow for 2 options for the encoding of degrading bathymetric data quality over time for testing purposes. This modelling will be consolidated when the preferred option has been determined. See also clause 3.7.]

Spatial attribute types must contain a referenced geometry and may be associated with spatial quality attributes. Each spatial attribute instance must be referenced by a feature instance or another spatial attribute instance.

IHO OPTION 1

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- horizontalPositionUncertainty and verticalUncertainty bound to the information type SpatialQuality

3.7 Quality of bathymetric data

IHO Definition: **QUALITY OF BATHYMETRIC DATA**. An area within which a uniform assessment of the quality of the bathymetric data exists. (S-57 Edition 3.1, Appendix A – Chapter 1, Page 1.216, November 2000).

S-101 Metadata Feature: Quality of Bathymetric Data (M_QUAL)

Primitives: Surface

Real World	*Paper Chart Symbol*	*ECDIS Symbol*

S-101 Attribute	S-57 Acronym	Allowable Encoding Value	Type	Multiplicity
category of temporal variation		1: extreme event 2: likely to change and significant shoaling expected 3: likely to change but significant shoaling not expected 5: unlikely to change 6: unassessed	EN	1,1
data assessment		1: assessed 2: assessed (oceanic) 3: unassessed	EN	1,1
depth range maximum value	(DRVAL2)		RE	0,1
depth range minimum value	(DRVAL1)		RE	0,1
features detected			C	1,1
significant features detected			(S) BO	1,1
size of features detected			(S) RE	0,1
full seafloor coverage achieved			BO	1,1
survey date range		See clause 2.4.8	C	1,1
date end	*(SUREND)*		(S) TD	1,1
date start	*(SURSTA)*		(S) TD	0,1
zone of confidence			C	1,*
category of zone of confidence in data	CATZOC	1: zone of confidence A1 2: zone of confidence A2 3: zone of confidence B 4: zone of confidence C 5: zone of confidence D 6: zone of confidence U	EN	1,1
fixed date range		See clause 2.4.8	(S) C	0,1
date end	(DATEND)		(S) TD	0,1
date start	(DATSTA)		(S) TD	0,1
~~horizontal position uncertainty~~			~~(S) C~~	~~0,1~~
~~uncertainty fixed~~	~~(POSACC)~~		~~(S) RE~~	~~1,1~~
~~uncertainty variable factor~~			~~(S) RE~~	~~0,1~~
~~vertical uncertainty~~			~~C~~	~~0,1~~
~~uncertainty fixed~~	~~(SOUACC)~~		~~(S) RE~~	~~1,1~~
~~uncertainty variable factor~~			~~(S) RE~~	~~0,1~~
information		See clause 2.4.6	C	0,*
file locator			(S) TE	0,1
file reference	*(TXTDSC)* *(NTXTDS)*		(S) TE	0,1
headline			(S) TE	0,1
language		ISO 639-2/T	(S) TE	0,1
text	*(INFORM)* *(NINFOM)*		(S) TE	0,1

24.5 Spatial quality

IHO Definition: **SPATIAL QUALITY**. The indication of the quality of the locational information for features in a dataset.

S-101 Information Type: Spatial Quality

Primitives: None

Real World	*Paper Chart Symbol*	*ECDIS Symbol*

S-101 Attribute	S-57 Acronym	Allowable Encoding Value	Type	Multiplicity
~~quality of horizontal measurement~~	~~(QUAPOS)~~	~~4: approximate~~ ~~5: position doubtful~~	~~EN~~	~~0,1~~
~~spatial accuracy~~			~~C~~	~~0,*~~
~~fixed date range~~		~~See clause 2.4.8~~	~~(S) C~~	~~0,1~~
~~date end~~	~~(DATEND)~~		~~(S) TD~~	~~0,1~~
~~date start~~	~~(DATSTA)~~		~~(S) TD~~	~~0,1~~
horizontal position uncertainty			(S) C	0,1
uncertainty fixed	*(POSACC)*		(S) RE	1,1
uncertainty variable factor			(S) RE	0,1
quality of horizontal measurement	(QUAPOS)	4: approximate 5: position doubtful	EN	0,1
vertical uncertainty			C	0,1
uncertainty fixed	*(SOUACC)*		(S) RE	1,1
uncertainty variable factor			(S) RE	0,1

KEY POINTS

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- Separates the horizontal position and vertical uncertainties from the feature intended to provide the overall indication of the quality of bathymetric data. Requires a mandatory feature/information association of instances of SpatialQuality with all instances of QualityOfBathymetricData using the association QualityOfBathymetricDataComposition.
- For the requirement to provide horizontal position and vertical accuracy on all features of depth 30 metres or less, the same procedure is applied regardless of the quality of individual features. The same instance of SpatialQuality associated to the QualityOfBathymetricData can also be associated to all the features for which QualityOfBathymetricData applies; with additional instance(s) of SpatialQuality indicating different quality associated to the features having different horizontal position and vertical accuracies than the underlying QualityOfBathymetricData indicates. Lower quality depth information may be further indicated in the ECDIS by the population of the attribute qualityOfHorizontalPosition on SpatialQuality; however this must not be done for SpatialQuality associated to the QualityOfBathymetricData.

KEY POINTS (2)

- SpatialQuality can play different roles, depending on the association used, with the spatial quality of the QualityOfBathymetricData feature itself able to be encoded using the SpatialAssociation association, while the association to the features is done using QualityOfBathymetricDataComposition.

IHO OPTION 2

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- horizontalPositionUncertainty and verticalUncertainty bound to the meta feature QualityOfBathymetricData

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S-101 Metadata Feature: Quality of Bathymetric Data (M_QUAL)

Primitives: Surface, None

Real World	*Paper Chart Symbol*	*ECDIS Symbol*

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data assessment		1: assessed 2: assessed (oceanic) 3: unassessed	EN	1,1
depth range maximum value	(DRVAL2)		RE	0,1
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least depth of detected features measured			(S) BO	1,1
significant features detected			(S) BO	1,1
size of features detected			(S) RE	0,1
full seafloor coverage achieved			BO	1,1
horizontal position uncertainty			(S) C	1,1
uncertainty fixed	*(POSACC)*		(S) RE	1,1
uncertainty variable factor			(S) RE	0,1
survey date range		See clause 2.4.8	C	1,1
date end	*(SUREND)*		(S) TD	1,1
date start	*(SURSTA)*		(S) TD	0,1
vertical uncertainty			C	1,1
uncertainty fixed	*(SOUACC)*		(S) RE	1,1
uncertainty variable factor			(S) RE	0,1
zone of confidence			C	1,*
category of zone of confidence in data	CATZOC	1: zone of confidence A1 2: zone of confidence A2 3: zone of confidence B 4: zone of confidence C 5: zone of confidence D 6: zone of confidence U	EN	1,1
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date end	(DATEND)		(S) TD	0,1
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~~uncertainty variable factor~~			~~(S) RE~~	~~0,1~~
~~vertical uncertainty~~			~~C~~	~~0,1~~
~~uncertainty fixed~~	~~(SOUACC)~~		~~(S) RE~~	~~1,1~~
~~uncertainty variable factor~~			~~(S) RE~~	~~0,1~~
information		See clause 2.4.6	C	0,*
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~~spatial accuracy~~			~~C~~	~~0,*~~
~~fixed date range~~		~~See clause 2.4.8~~	~~(S) C~~	~~0,1~~
~~date end~~	~~(DATEND)~~		~~(S) TD~~	~~0,1~~
~~date start~~	~~(DATSTA)~~		~~(S) TD~~	~~0,1~~
horizontal position uncertainty			(S) C	0,1
uncertainty fixed	*(POSACC)*		(S) RE	1,1
uncertainty variable factor			(S) RE	0,1
quality of horizontal measurement	(QUAPOS)	4: approximate 5: position doubtful	EN	0,1
vertical uncertainty			C	0,1
uncertainty fixed	*(SOUACC)*		(S) RE	1,1
uncertainty variable factor			(S) RE	0,1

KEY POINTS

- Encoding of all horizontal position and vertical accuracy remains on the QualityOfBathymetricData features, with no requirement for an association to SpatialQuality unless it is required to identify the accuracy of the QualityOfBathymetricData itself through a SpacialAssociation association.
- Because the attributes horizontalPositionUncertainty and verticalUncertainty can be populated for both QualityOfBathymetricData and SpatialQuality, it is important therefore to note in the guidance that SpatialQuality having horizontalPositionUncertainty and verticalUncertainty must not be associated to features having an associated instance of QualityOfBathymetricData.

KEY POINTS (2)

- For the requirement to provide horizontal position and vertical accuracy on all features of depth 30 metres or less, this is done by associating the QualityOfBathymetricData feature to all the features representative of the QualityOfBathymetricData; and through encoding an additional instance(s) of QualityOfBathymetricData having no geometry for other features for which the quality does not correspond to the quality indicated in the QualityOfBathymetricData surface feature. The QualityOfBathymetricData are associated to the features under 30 metres for which the data quality applies using the association QualityOfBathymetricDataAssociation. Optionally, SpatialQuality with attribute qualityOfHorizontalPosition may additionally be encoded and associated to the features using the SpatialAssociation association to indicate lower quality, however this must not be done for any feature having quality equivalent to the underlying QualityOfBathymetricData surface features.

OTHER POINTS OF NOTE

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- Noting the following statement that has been included in the DCEG on request of the DQWG:

"All horizontal positional (2D), vertical (1D), horizontal distance (1D) and orientation (1D) uncertainty attributes concern the 95% confidence level of the variation associated with all sources of measurement, processing and visualization error. Uncertainty due to temporal variation should not be included in these attributes."

the complex attributes horizontalPositionUncertainty and verticalUncertainty have been removed from their current (Edition 1.1.0) nesting as sub-complex attributes for the complex attributes zoneOfConfidence (for QualityOfBathymetricData) and spatialAccuracy (for SpatialQuality) so as to enable temporal changes to the uncertainties to be encoded. The guidance includes a recommendation that, if it is considered important to provide a temporal indication of changes in uncertainty, this is to be done by issuing an ENC Update.

OTHER POINTS OF NOTE (2)

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- S-101 Documentation and FC GitHub Issue #91 has been raised to address ambiguity in encoding depth range values for overlapping QualityOfBathymetricData features. In order to (partially) address this, the guidance has been modified to require the depthRangeMinimum value for the QualityOfBathymetricData defining the next deepest depth range to be 0.1 metres deeper than the depthRangeMaximum value of the QualityOfBathymetricData above.

- **depth range minimum value** must only be used on a **Quality of Bathymetric Data** feature where a swept area occupies the entire **Quality of Bathymetric Data** surface, or **Quality of Bathymetric Data** features overlap. Where these features overlap such that varying bathymetric data qualities exist at different depths in the water column, the **depth range minimum value** for a **Quality of Bathymetric Data** must be set to a value 0.1 metres deeper than ~~equal to~~ the **depth range maximum value** for the **Quality of Bathymetric Data** feature defining the quality for the level above (see Figure 3-2 above).
- **depth range maximum value** must only be used on a **Quality of Bathymetric Data** feature to specify the maximum depth to which all other attributes for the **Quality of Bathymetric Data** feature applies. When **depth range maximum value** is specified, values populated for all other attributes apply only to depths equal to or shoaler than **depth range maximum value**. No quality information is provided for depths deeper than **depth range maximum value**. Where **Quality of Bathymetric Data** features overlap such that varying bathymetric data qualities exist at different depths in the water column, the **depth range maximum value** for a **Quality of Bathymetric Data** must be 0.1 metres shoaler than ~~equal to~~ the **depth range minimum value** for the **Quality of Bathymetric Data** feature defining the quality for the level below (see Figure 3-2 above).

OTHER POINTS OF NOTE (3)

- The revised guidance has been amended to include reference to all features carrying the attribute valueOfSounding (FoulGround, MarineFarmCulture, Obstruction, Sounding, UnderwaterAwashRock and Wreck).

3.7.1.3 Sounding uncertainty

Sounding uncertainty is encoded using ~~the complex attribute **zone of confidence**, sub-complex attribute **vertical uncertainty on Quality of Bathymetric Data**, or alternatively using~~ an associated instance of the information type **Spatial Quality**, complex attribute **vertical uncertainty** ~~**spatial accuracy**~~ (see clause 24.5) and using the association **Quality of Bathymetric Data Composition** (see clause 25.12). If it is required to encode additional sounding uncertainty information, it must be done using the attributes **quality of vertical measurement** and **technique of vertical measurement** on groups of soundings or individual features ~~the complex attribute **vertical uncertainty on individual features where available**~~; or by associating another instance of the information type **Spatial Quality** ~~(see clause 24.5)~~ to the spatial type associated with the individual geo features. Note that this is a mandatory requirement for the features **Sounding** and ~~**Obstruction**~~ **Underwater/Awash Rock**; and **Foul Ground**, **Marine Farm/Culture**, **Obstruction** and **Wreck** of type point, ~~and~~ of depth 30 metres or less.

The vertical and horizontal position uncertainty values populated on the instance of **Spatial Quality** associated to the **Quality of Bathymetric Data** must reflect the most commonly associated values for the **Foul Ground**, **Marine Farm/Culture**, **Obstruction**, **Sounding**, **Underwater/Awash Rock** and **Wreck** features within the area.

RECOMMENDATIONS

- Select one of the modelling options included as scenario's 1 and 2 in the included Annexes to this Paper, for inclusion in S-101 Edition 1.2.0.
- Request the development of test data that implements the preferred option for testing and refinement of the modelling and/or guidance for inclusion in S-101 Edition 2.0.0.

ACTIONS REQUESTED OF S-101PT

- **Discuss** the proposal.
- **Agree** the preferred modelling/encoding guidance for quality of bathymetry information in S-101, for inclusion in Edition 1.2.0.
- **Initiate** the development of associated test data.
- **Initiate** further action as required.

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THANK YOU