Mapping Undersea Feature Names in S-100

UFNPT at SCUFN 31
Wellington, New Zealand
October, 2018
Content

- Update about UFNPT
- Discovery of Undersea Features - excercise
### Work Plan of the UFNPT

<table>
<thead>
<tr>
<th>Action Items (SCUFN30)</th>
<th>Tasking (Lead)</th>
<th>Target Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convene the UFNPT via email correspondence to provide summary of UFNPT kick-off meeting and discuss project team task list and next steps</td>
<td>UFNPT (Canada)</td>
<td>October 20, 2018</td>
</tr>
<tr>
<td>Prepare an information paper for HSSC-9 outlining the results of UFNPT kick-off meeting at SCUFN-30</td>
<td>Canada</td>
<td>October 27, 2018</td>
</tr>
<tr>
<td>Conduct preliminary test case of the current IHO Geo-spatial Information Registry using the current UFN Data Motel (S-57) considering the current concept definitions in B6</td>
<td>UFNPT (Canada), Generic Terms WG</td>
<td>February 2018</td>
</tr>
<tr>
<td>Present results of the test case to UFNPT, obtain their feedback and comments; finalize summary report on results, for submission to SCUFN</td>
<td>Canada, UFNPT</td>
<td>March 31, 2018</td>
</tr>
<tr>
<td>Conduct preliminary testing of Beta Gazetteer in the context of potential S-100 requirements</td>
<td>Canada, Korea, Argentina (SCUFN lead tester)</td>
<td>November 2017</td>
</tr>
<tr>
<td>Evaluate the current list of UFN terms and definitions in relevant IHO publications (B6, S-32) and comparisons/analysis to date</td>
<td>UFNPT, Generic Terms WG</td>
<td></td>
</tr>
</tbody>
</table>
Background

S-57 & S-100

• The cartographic standard for Electronic Navigation Charts (ENC’s)

• S-57 first came out in 1992

• S-100 will replace S-57 once becomes operational
Preliminary test case of an UFN
S-100 compatible
Step 1. What do we need to describe? Review the definitions in B-6

- Some of the definitions for undersea features are descriptive and qualitative.
- But there are quantifiable descriptions:
  - Depth
  - Height difference compared to surroundings
  - Dimension
  - Elevation
Step 2. What do we want to show? Decide on requirements

We came up with a list of required attributes base on:

- Definitions in B-6
- Attributes in the existing S-57
- Fields in the SCUFIN proposal form
- General Bathymetric Chart of the Ocean’s (GEBCO) database

<table>
<thead>
<tr>
<th>Require attribute</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-6 Generic Term</td>
<td>single choice from the list of generic terms in B-6</td>
</tr>
<tr>
<td>Feature Name</td>
<td>basic information</td>
</tr>
<tr>
<td>Display Name</td>
<td>basic information</td>
</tr>
<tr>
<td>Language</td>
<td>basic information</td>
</tr>
<tr>
<td>Name</td>
<td>basic information</td>
</tr>
<tr>
<td>Scale Minimum</td>
<td>basic information</td>
</tr>
<tr>
<td>Depth range minimum value</td>
<td>vertical distance from highest point of the feature to the sea level, in meters.</td>
</tr>
<tr>
<td>Depth range maximum value</td>
<td>vertical distance from lowest point of the feature to the sea level, in meters.</td>
</tr>
<tr>
<td>Vertical length</td>
<td>vertical distance between the highest point and the lowest point of the object.</td>
</tr>
<tr>
<td>Horizontal length</td>
<td>measurement of the longer horizontal linear axis</td>
</tr>
<tr>
<td>Horizontal width</td>
<td>measurement of the shorter horizontal linear axis</td>
</tr>
<tr>
<td>Textual description</td>
<td>additional information such as country of discovery, origin of name, etc.</td>
</tr>
</tbody>
</table>
Step 3. Has it been developed?
Review documentation about S-100

The table shows that the elements and documentation of S-57 are comparable to the elements and documentation of S-100.

<table>
<thead>
<tr>
<th>Organization of S-57</th>
<th>Organization of S-100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Object – can be found in the Object Catalogue</td>
<td>Feature – can be found in the Feature Catalogue</td>
</tr>
<tr>
<td>Object catalogue – Appendix A, Chapter 1 of S-57*</td>
<td>Feature Catalogue – (in development)</td>
</tr>
<tr>
<td>Object acronym – can be found in the Object Catalogue</td>
<td>Feature acronym – n/a in S-100</td>
</tr>
<tr>
<td>Object attribute – can be found in the Attribute Catalogue</td>
<td>Feature attribute – can be found in the Feature Concept Dictionary.</td>
</tr>
<tr>
<td>Attribute catalogue – Appendix A, Chapter 2 of S-57*</td>
<td>Feature concept dictionary – (in development)</td>
</tr>
<tr>
<td>Encoding – can be found in Use of Object Catalogue for ENC</td>
<td>Encoding – can be found in the Data Classification and Encoding Guide</td>
</tr>
<tr>
<td>Use of Object Catalogue for ENC – Appendix B.1, Annex A of S-57*</td>
<td>Data Classification and Encoding Guide – (in development)</td>
</tr>
<tr>
<td>Symbol – can be found in the Symbol library for the use of ECDIS</td>
<td>Symbol – can be found in the Portrayal Register and Portrayal Catalogue</td>
</tr>
<tr>
<td>Symbol library for the use of ECDIS – Annex A of S-52**</td>
<td>Portrayal Register – (in development)</td>
</tr>
<tr>
<td>Product specification – the only one that exists is the ENC Product specification</td>
<td>Portrayal Catalogue – (in development)</td>
</tr>
<tr>
<td>Product specification – various exist or are (in development), depending on the type of product (S-101 ENC, S-102 Bathymetry, S-103 Nautical Publications, etc.)</td>
<td></td>
</tr>
<tr>
<td>ENC Product specification – Appendix B.1 of S-57*</td>
<td>S-101 ENC – (in development)</td>
</tr>
<tr>
<td></td>
<td>S-102 – Bathymetric Surface Product Specification</td>
</tr>
<tr>
<td></td>
<td>S-103 – (in development)</td>
</tr>
<tr>
<td>Domain – n/a</td>
<td>Domain – various exist or are (in development): Hydrography, Sea Ice, Aid to Navigation, etc.</td>
</tr>
</tbody>
</table>
Step 4. Test of Proposed S-101

Brothers Seamount encoded in S-101 standard

<table>
<thead>
<tr>
<th>Feature</th>
<th>Sea Area / Named Water Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feature acronym</td>
<td>n/a</td>
</tr>
<tr>
<td>Feature attributes</td>
<td>Category of Sea Area</td>
</tr>
<tr>
<td></td>
<td>Seamount</td>
</tr>
<tr>
<td>Feature Name</td>
<td>Brothers Seamount</td>
</tr>
<tr>
<td>Display Name</td>
<td>Brothers Seamount</td>
</tr>
<tr>
<td>Language</td>
<td>English</td>
</tr>
<tr>
<td>Symbol</td>
<td>n/a</td>
</tr>
<tr>
<td>Product Specification</td>
<td>S-101 ENC</td>
</tr>
<tr>
<td>Domain</td>
<td>Hydrography</td>
</tr>
</tbody>
</table>

Additional attribute that should be added to Sea Area/Named Water Area (in development)

<table>
<thead>
<tr>
<th>Text</th>
<th>This feature forms a volcano with a central caldera. It lies 15 km north of James Healy Seamount in the Kermadec volcanic arc</th>
</tr>
</thead>
</table>
Comments received from the Generic Term Working Group and the UFN PT

• Create a new feature (object) for Undersea Features with the necessary attributes.

• Consider if we wanted to keep the new feature (object) for Undersea Features under S-101.
Second Test Case
New Geo object
in S-101
Testing a new proposed S-101 Object using the same Seamount

(See Annex 2 for more information about Brothers Seamount)

<table>
<thead>
<tr>
<th>Feature</th>
<th>Undersea Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feature acronym</td>
<td>N/A</td>
</tr>
<tr>
<td>Feature attributes</td>
<td>B6 Generic Term</td>
</tr>
<tr>
<td>Feature Name</td>
<td>Brothers Seamount</td>
</tr>
<tr>
<td>Display Name</td>
<td>Brothers Seamount</td>
</tr>
<tr>
<td>Language</td>
<td>English</td>
</tr>
<tr>
<td>Scale Minimum</td>
<td></td>
</tr>
<tr>
<td>Depth range minimum value</td>
<td>1197</td>
</tr>
<tr>
<td>Depth range maximum value</td>
<td>2250</td>
</tr>
<tr>
<td>Vertical length</td>
<td>1053</td>
</tr>
<tr>
<td>Horizontal length</td>
<td>1500</td>
</tr>
<tr>
<td>Horizontal width</td>
<td>1500</td>
</tr>
<tr>
<td>Textual description</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

This feature forms a volcano with a central caldera. It lies 15 km north of James Healy Seamount in the Kermadec volcanic arc. It is named after Professor RN Brothers (1924-1988), Volcanologist, University of Auckland, 1952-1988, who described the first submarine volcanic rocks from the southern Kermadec arc. Discovered by New Zealand research vessel "Rapuhia", in 1991

Symbol | n/a
Product Specification | S-101 ENC
Result obtained

- Most feature attributes that will meet the requirements for storing descriptive information about UFNs, already exist in the IHO Feature (object) Dictionaries in development.

- Feature (object) attribute B6 Generic term, provides a direct cross-reference to B-6
Round 2 of comments received from the Generic Term Working Group and the UFN PT

Textual description - classification is necessary in textual description

• Associated Features
• Reason for choice of name
• Discovery facts
• Survey Data information
Conclusion

The UFNPT has fulfilled the action items assigned to it at SCUFN 30.

- Neither of the two test case provide all the attributes that the UFN PT desires.
- The UFN PT desires a longer list of attributes than are currently developed for the purpose of safe navigation that is associated with S-101 for ENC.
- However, the S-100 data structure provides flexibility to add more attributes and modify the list of generic terms, as proven.
Next Steps

• Consider further expansion of the UFN standard S101.
  – S101 Not owned by SCUFN

• Or consider the creation of a new S-100 Product Specification for Undersea Feature Names, customized to all data sharing and interoperability requirements of SCUFN and GEBCO.
  – S10? Owned by SCUFN

• Select new Chair of UFNPT

• Confirm membership
# Confirmation of Membership

## UFNPT 2018-2019

<table>
<thead>
<tr>
<th>Member State</th>
<th>Name of Delegate</th>
<th>Email</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>Rocio del Valle Borjas</td>
<td><a href="mailto:borjas@hidro.gov.ar">borjas@hidro.gov.ar</a></td>
<td>SIHN</td>
</tr>
<tr>
<td>Belgium</td>
<td>Paula Oset Garcia</td>
<td><a href="mailto:paula.oset.garcia@vliz.be">paula.oset.garcia@vliz.be</a></td>
<td>Marine Regions</td>
</tr>
<tr>
<td>Canada</td>
<td>Anna Hendi</td>
<td><a href="mailto:anna.hendi@dfo-mpo.gc.ca">anna.hendi@dfo-mpo.gc.ca</a></td>
<td>CHS</td>
</tr>
<tr>
<td>China</td>
<td>Xing Zhe</td>
<td><a href="mailto:Xz_nmdis@163.com">Xz_nmdis@163.com</a></td>
<td>NMDIS</td>
</tr>
<tr>
<td>Korea</td>
<td>Boram Jang</td>
<td><a href="mailto:jangbbo89@korea.kr">jangbbo89@korea.kr</a></td>
<td>KHOA</td>
</tr>
<tr>
<td>SCUFN experts</td>
<td>Generic Term Sub Group</td>
<td></td>
<td>IHO and OIC</td>
</tr>
</tbody>
</table>
# Proposed Work Plan 2018-2019

<table>
<thead>
<tr>
<th>Action Items (SCUFN 31)</th>
<th>Tasking Lead</th>
<th>Target Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explore within existing product specifications in S-100, the expansion of textual description to include - Associated Features - Reason for choice of name - Discovery facts - Survey Data information</td>
<td>Canada and UFNPT</td>
<td>January 2018</td>
</tr>
<tr>
<td>Explore the steps necessary to develop a product specification for UFN</td>
<td>Canada</td>
<td>January 2019</td>
</tr>
<tr>
<td>Prepare and information paper for HSSC 11, with the status of work of the UFNPT and the work plan for the year 2019.</td>
<td>Canada</td>
<td>February 2017</td>
</tr>
<tr>
<td>Hold a video conference call for UFNPT, to discuss if the creation of a product specification is necessary for UFN</td>
<td>Canada and UFNPT</td>
<td>March 2019</td>
</tr>
<tr>
<td>If necessary, hold a Face to Face meeting of the UFNPT or Online workshop, to discuss initial steps to develop the product specification</td>
<td>Canada, UFNPT and Generic Terms WG</td>
<td>June 2019</td>
</tr>
<tr>
<td>Re-evaluate work plan</td>
<td>Canada, UFNPT</td>
<td>August 2019</td>
</tr>
<tr>
<td>Prepare documentation to report progress to SCUFN</td>
<td>Canada, UFNPT</td>
<td>September 2019</td>
</tr>
</tbody>
</table>
Discovery of Undersea Features Using Bathymetric Data

By: Oliver Farwell
Aug 1\textsuperscript{st} 2018
Purpose

- Automate the identification of undersea features
- Using a workflow or script in available GIS software
- Using International Hydrographic Organization [IHO] B-6 definitions of undersea features
Difficulties

- IHO definitions are broad/qualitative
- Definitions are open to interpretation
- Automated identification needs yes/no decisions

Image (right): iho.int
Image (left): https://www.arcgis.com/home/item.html?id=5f3aefe77f6b4f61ad3e4c62f30bff3b
Seamounts

- Undersea mountain

Definition:
- Equidimensional in shape
- Rises 1000 m from deepest isobath surrounding most of the feature

Image: deepreef.org
Area of Interest

Meters From Sea Level:
- Seamount - 4000 m
- - 2000 m
- 0 m
Test Area

- 19 confirmed seamounts off the coast of B.C.
Slope

- Slope tool in ArcGIS
- Gives an image of slope in degrees
- General ocean floor is very flat (>4°)
- Anomalies like seamounts range from 5° to 25°
- Produce doughnut shaped rings, outlining seamounts
- Good for visual check
Hydrology Tools

- Hydrology tools within ArcMap for Raster datasets
- Model the flow of water on impermeable surface
- Basins tool (right) divides the elevation model into separate basins that collect water
- Each colour represents a separate basin on a topographical model of a river system

Inverting Bathymetry

- If the bathymetry is inverted it resembles a DEM.
- Peaks become troughs to collect water.
- Large basins delineate seamount locations.
Basins

- Invert the bathymetry (multiplied by -1)
- Seamount peaks became troughs (deep points)
- Use basins tool to derive basins of seafloor

Each unique colour is a different basin
Testing Basins

- Basins encase the footprint of the seamounts
- Extract max/mini depth from original un-inverted bathymetry
- Difference >1000 m depth flagged
Python Script

- Python script used to automate process of extracting basin and checking min/max
Results

- Tested method on subset of 75 basins, encasing 5 seamounts
Results

- Successfully ID 4/5 seamounts

- 5th seamount was actually below 1000m threshold

- Method also flagged continental shelf

- Also split seamounts into sections
Fill Tool

- Used to fill troughs in raster before using hydrology toolset
- Can specify maximum depth to fill
- Can be used to extend footprint of basins outward
- Also can fix splitting of a seamount into multiple basins

Profile view of a sink before and after running Fill

Image:
Fill Tool on Basins

- Fill tool removes small basins
- Previously 2,250 now 1700 basins
- Extends seamount basins outward
Fill Tool Results

- Similar results with same area flagged
- Combine basins of two seamounts into one
- Continues to flag continental shelf
Hills

- A distinct elevation generally of irregular shape, less than 1000m above the surrounding relief as measured from the deepest isobath that surrounds most of the feature.

- Script was adapted to work with a second undersea feature, Hills
Hill Results

- Redefined the threshold needed for the script to flag the basin being tested
- Tested for a height difference between 500 m and 999 m
- 25 out of 134 basins flagged as possible hills
Next Steps

- Applications of slope to identify other types of undersea features
- Using slope to automate the identification of a seamount
- Application of fuzzy logic on different seamount thresholds
- Refining workflow to prevent ID errors (flagging the continental shelf)
Next Steps

- Process could be used in Canadian Arctic
- Help identify seamounts as more complete high resolution data is collected
Automation of Undersea Feature Detection – Basin

Using Spatial Analysis with ArcMap 10.6

By Shenghao Shi
(Project in progress)
Area of Interest
B-6 Definition of Basin

- **BASIN:**
  - A depression more or less equidimensional in plan and of variable extent

- **Key points:**
  - Depression: center lower than edge (depth)
  - Depression: center flatter than edge (slope)
  - Equidimensional: overall shape
General method Summary

1. Use hydrology-basin tool to **identify basins** base on flow direction analysis
2. Check each basin with three factors:
   1. **Slope** value difference between edge and center
   2. **Depth** value difference between edge and center
   3. Overall **shape**
3. Using fuzzy logic to combine the result of step 2 (in progress)
Step 1. Hydrology Analysis

- **Flow direction:**
  - Creates a raster of flow direction from each cell to its downslope neighbor, or neighbors.

- **Basin:**
  - Creates a raster delineating all drainage basins.
Step 3. Bathymetry and Slope Data
Step 4. Identify the center of each basin

- Use calculate geometry - X coordinate of centroid & Y coordinate of centroid to get the center coordinate for each basin
- Export value as table
- Use Table-Display XY data to generate the central points
- Use buffer tool to create central area for each basin
Step 5. Import Bathymetry and Slope Data into Center Area and Edge Area

- Use raster to point function to convert Bathymetry and Slope Data into point layers
- Use Analysis Tools -> Overlay - Spatial Join tool to import value into the center area and rings of edge respectively
- Joining the attribute tables
Step 6. Compare the Differences
Step 6. Compare the Differences
Step 7. Shape Check using Minimum Bounding Geometry Tool (in progress)
Step 7. Shape Check using Minimum Bounding Geometry Tool (in progress)
This project is still in progress and we look forward to sending the result of the analysis when it is completed.

Next Step

- Continue to work on the shape check using minimum bounding geometry tool
- Experiment with different setting, such as difference basin size, use difference constant for calculations, etc.
- Use fuzzy logic to combine the result of three results.
- Check coordinates in real life to evaluate the effectiveness of the tool
- Automatic the procedure using module builder or script.
Thank You / Merci

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+1 613 355 8909
Questions