

**International Coastal Atlas Network Cookbook:
Understanding Metadata**



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Introduction

This document provides a tutorial for those who wish to understand metadata. It is aimed specifically at members of the International Coastal Atlas Network community and more generally at scientists, data managers, and system developers. Included in this document is a description of metadata and why we need it, metadata standards in use today, description of different metadata hierarchy levels, and a list of some metadata editing tools available. The document also contains an example metadata record aimed at system developers who are familiar with XML.

What is metadata?

Geospatial metadata is “data about data”. It contains information that documents the basic characteristics of a geospatial data resource. It can also document basic characteristics of geospatial applications or services. Metadata falls into broad categories where it answers the “what, why, when, who, where and how” questions about the resource. These questions include¹:

- What: Title and description of the data.
- Why: Abstract detailing reasons for the data collection and its uses.
- When: When the data was created and the update cycles, if any.
- Who: Originator, data supplier, and possibly the intended audience.
- Where: The geographical extent based on latitude and longitude coordinates, geographical names or administrative areas.
- How: How the data was produced and how to access the data.

Why do you need metadata?

Metadata helps a user to find or discover the data that they need and, thereafter, evaluate whether this resource satisfies the user’s requirements. Once a user has chosen the resource, usage metadata is then required to help the user fully understand and interpret the data. Metadata can be used in-house to help locate and use internal data resources. If a staff member leaves an organisation, important knowledge may also leave the organisation too. New staff members may have difficulty in taking up new responsibilities and fully understanding the organisation’s data resources. Such undocumented data resources may lose value or cost time to relearn its value. Metadata can also be used to locate data resources published by other organisations, helping to minimise duplication of data collection and

¹ Wilson, M., 2009, Chapter Three: Metadata -- Describing geospatial data, Spatial Data Infrastructure Cookbook.

enabling more efficient and cost-effective use of this data. Specific examples of business cases for using metadata outlined by Federal Geographic Data Committee (FGDC) include²:

Data Management:

- Preserve data history so that the data resource can be reused or adapted.
- Assess the age and character of data holdings to determine which data should be maintained, updated or deleted.
- Improve data accountability.
- Limit data liability by explicitly stating data limitations of use.

Project Management:

- Plan and document the data resources required for a project.
- Monitor data resource development progress.
- Share data resource development progress with project participants.
- Ability to access data characteristics for outsourced data production by ensuring metadata is a contract deliverable.

Metadata standards and profiles

In order for geospatial metadata to operate effectively between different organisations and data users, metadata must be compliant with international standards. Such standards provide a common structure and format to describe metadata. Standards enable improved metadata interoperability and integration, thus, facilitating more seamless sharing, searching, and discovery of metadata between organisations and users of geospatial data and services. Discovery metadata is the minimum amount of information that needs to be provided to help users find geospatial resources. Prominent metadata standards in use today include:

- ISO 19115 (Geographic information – Metadata)
- ISO 19119 (Geographic information – Services)
- ISO 19139 (Geographic information – Metadata – XML schema implementation)
- Dublin Core (ISO 15836)
- FGDC Content Standard for Digital Geospatial Metadata (CSDGM)

² Business Case for Metadata (www.fgdc.gov/metadata/metadata-business-case)

The Dublin Core Metadata Element Set contains fifteen properties capable of describing a wide range of general web resources. While Dublin Core can be successfully applied to describe geospatial resources, the ISO 19115 standard is more specialised in describing such geospatial resources. In turn, the ISO 19119 standard extends the ISO 19115 to describe geospatial service resources. Therefore, governments and organisations are widely adapting the ISO 19115 and ISO 19119 standards using the ISO 19139 XML implementation. While metadata entities and elements are well defined within the ISO standards, there is an extensive list of optional metadata elements on top of the mandatory metadata element set. It is left up to the system developer to define a specific information model or profile. There is no single metadata profile that fits all users' needs. Therefore, there is a need for metadata profiles to be adapted to support various regions, nations, organisations, and communities' needs.

Within Europe, the INSPIRE Directive has defined a base metadata profile, which builds on the underlying ISO 19115 standard. However, full conformance to the ISO 19115 mandatory elements implies the provision of additional metadata elements which are not required by INSPIRE legislation. However INSPIRE metadata encoding guidelines respects these ISO 19115 mandatory elements. In addition, INSPIRE is defining thematic dataset specifications. Individually these dataset specifications have defined a small additional number of mandatory and optional elements on top of base metadata profile to help data evaluation³.

Within the U.S., the Content Standard for Digital Geospatial Metadata (CSDGM) standard is the U.S. federal standard, while the North American Profile (NAP) of ISO 19115 is the U.S. national standard. The Federal Geographic Data Committee (FGDC) developed CSDGM in the 1990s for federal agencies. CSDGM is often referred as the 'FGDC metadata standard'. This standard preceded the ISO 19115 standard. The American National Standards Institute (ANSI), the U.S. member body of the ISO, adopted ISO 19115 in December of 2003. The U.S. and Canada have aligned national profile development efforts with the cooperative development of the NAP. An initial profile was adopted in 2009. In September 2010, the FGDC formally endorsed the NAP. However, once the NAP profile is fully developed, the FGDC will process it as a federal standard. Therefore, transition from CSDGM to NAP is an on-going process⁴.

Metadata hierarchy levels

Metadata may exist at different levels of granularity. The most common implemented levels are "dataset" and "series". A dataset is defined by ISO 19115 as an: "identifiable collection of data" (e.g. a raster map). A dataset series is defined by ISO 19115 as a: "collection of datasets sharing the same product specification" (e.g. a collection of raster maps captured from a common series of paper maps). Metadata for which no hierarchy is listed are interpreted to be "dataset" metadata by default. Finer levels of granularity include feature and attribute metadata. Examples include: feature type (e.g. a tunnel), feature instance (e.g. the Mont Blanc Tunnel), attribute type (e.g. overhead clearance associated with a tunnel), and attribute instance (e.g. overhead clearance associated with the Mont Blanc Tunnel). These data hierarchical relationships are illustrated in Figure 1.

³ <http://inspire.jrc.ec.europa.eu>

⁴ Preparing for International Metadata, Federal Geographic Data Committee, October 20, 2011

In addition, metadata can also be used to describe geospatial services, which typically includes information on how to access and invoke such services. Service metadata is defined by ISO 19119 as: “a service metadata record describes a service instance, including a description of the services operations and an ‘address’ to access the specific service instance”. An example of a service metadata is a description of a Web Map Service (WMS) that enables viewing of a raster map collection.

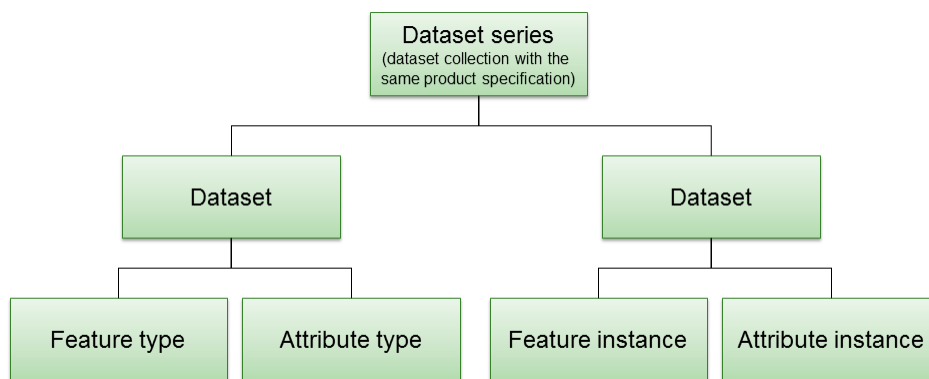


Figure 1: Metadata hierarchy⁵

Metadata editing tools

A metadata editor is a program that is used for creating and editing metadata. It typically uses a graphical user interface, as opposed to direct editing of the XML document. A metadata editing tool may include functionalities such as:

- Creating, editing, deleting and viewing of metadata and metadata templates
- Metadata validation
- Import and export of metadata
- Metadata search
- Automatic metadata generation
- Pre-processing and post-processing of metadata
- Extraction and transformation of metadata to different standards and formats
- Additional functionalities such as automatic selection of bounding box coordinates, thesaurus functions, etc.

Several metadata editing tools have been developed. Commercial metadata editing tools include:

⁵ ISO 19115:2003, Geographic information - Metadata

1. ESRI ArcGIS Desktop (<http://www.esri.com/>)
2. Intergraph GeoMedia (<http://www.intergraph.com/>)
3. MapInfo Manager (<http://www.pbinsight.com/>)

Opensource/freeware metadata editing tools include:

1. CatMDEdit (<http://catmdedit.sourceforge.net/>)
2. GeoNetwork opensource (<http://geonetwork-opensource.org/>)
3. M³Cat (<http://www.intelec.ca/>)

A screenshot of the GeoNetwork opensource metadata editor is shown below:

Figure 2: GeoNetwork opensource metadata editor

Metadata encoding guidance

Metadata can be stored internally within a dataset or in a separate external file. Metadata can also be stored in a database to facilitate more efficient searching. The underlying metadata model (a 19115 profile) is the first important aspect to metadata interoperability. At the physical implementation level, ISO 19139 defines an XML implementation of the ISO 19115 metadata model using XSD (XML Schema Definition) schemas. Therefore, an ISO 19139 XML implementation is the second important aspect to achieve interoperable metadata sharing and exchange between organisations and users of data. The

19139 schemas define the structure of the metadata XML document. The details of the ISO 19139 encoding are not required to be understood by the typical metadata user. Most users typically use graphical based metadata search, view and editing tools. However, for system developers building spatial data infrastructures and who wish to understand more about the ISO 19139 encoding, some useful guidance resources include:

1. UK Gemini Encoding Guidance, version 1.0, September 2010
<http://location.defra.gov.uk/wp-content/uploads/2010/09/UK-GEMINI-Encoding-Guidance-20100930-v1-01.pdf>
2. Guidance notes for the production of discovery metadata for the Marine Environmental Data and Information Network (MEDIN), version 2.3.4
http://www.oceannet.org/marine_data_standards/medin_approved_standards/documents/medin_schema_doc_2_3_4_30nov2010.pdf

Dataset metadata example

For system developers who are familiar with XML, an example of a full dataset metadata instance is shown below. The details of this ISO 19139 XML schema implementation are better described in the MEDIN and UK Gemini documents referenced in the previous section. Also, Figure 2 illustrates part of this same metadata record through the graphical GeoNetwork opensource metadata editor.

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  xmlns:gmx="http://www.isotc211.org/2005/gmx"
  xmlns:gml="http://www.opengis.net/gml/3.2"
  xmlns:xlink="http://www.w3.org/1999/xlink">
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    soundings with interpolation between soundings guided by satellite-derived gravity
    data. Existing gridded bathymetric data sets are included in some areas. The land
    portion of the grid is largely based on the US Geological Survey's SRMT30 data set,
    developed with data from the US National Aeronautics and Space Administration (NASA)
    Shuttle Radar Topographic Mission (SRTM). For the area around Antarctica, the land
    data are taken from the Geoscience Laser Altimeter System (GLAS)/ Ice, Cloud and
    Land Elevation Satellite (ICESat) laser altimetry 500m digital elevation model. The
    grid is accompanied by a Source Identifier (SID) Grid which identifies which cells in
    the GEBCO_08 Grid are based on soundings or existing grids and which have been
    interpolated. The data sets are updated as new bathymetric compilations are made
    available. Both grids are freely available to download, in netCDF form, from the web.
    Free software is available for viewing and accessing data from the grids in netCDF
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        </gmd:CI_Citation>
        </gmd:thesaurusName>
        </gmd:MD_Keywords>
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Environmental Data and Information Network</gmx:Anchor>
        </gmd:keyword>
        <gmd:thesaurusName>
        <gmd:CI_Citation>
        <gmd:title>
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        </gmd:title>
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        <gmd:date>
        <gco>Date>2011-10-04</gco>Date>
        </gmd:date>
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codeList="http://standards.iso.org/ittf/PubliclyAvailableStandards/ISO_19139_Schemas/
resources/Codelist/gmxCodelists.xml#CI_DateTypeCode"
codeListValue="revision">revision</gmd:CI_DateTypeCode>
        </gmd:dateType>
        </gmd:CI_Date>

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        </gmd:date>
    </gmd:CI_Citation>
    </gmd:thesaurusName>
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<gmd:descriptiveKeywords>
    <gmd:MD_Keywords>
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            </gmd:keyword>
            <gmd:keyword>
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xlink:href="vocab.nerc.ac.uk/collection/P22/current/163">Hydrography</gmx:Anchor>
            </gmd:keyword>
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            <gmd:title>
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            </gmd:title>
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                    </gmd:date>
                    <gmd:dateType>
                        <gmd:CI_DateTypeCode
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resources/Codelist/gmxCodelists.xml#CI_DateTypeCode"
codeListValue="revision">revision</gmd:CI_DateTypeCode>
                    </gmd:dateType>
                </gmd:CI_Date>
            </gmd:date>
        </gmd:CI_Citation>
        </gmd:thesaurusName>
    </gmd:MD_Keywords>
</gmd:descriptiveKeywords>
<gmd:resourceConstraints>
    <gmd:MD_LegalConstraints>
        <gmd:useLimitation>
            <gco:CharacterString>Usage restrictions are specified in the terms of the
licence</gco:CharacterString>
        </gmd:useLimitation>
        <gmd:accessConstraints>
            <gmd:MD_RestrictionCode
codeList="http://standards.iso.org/ittf/PubliclyAvailableStandards/ISO_19139_Schemas/
resources/Codelist/gmxCodelists.xml#MD_RestrictionCode"
codeListValue="otherRestrictions">otherRestrictions</gmd:MD_RestrictionCode>
            </gmd:accessConstraints>
            <gmd:otherConstraints>
                <gco:CharacterString>Usage restrictions are specified in the terms of the
licence</gco:CharacterString>
            </gmd:otherConstraints>
        </gmd:MD_LegalConstraints>
    </gmd:resourceConstraints>
    <gmd:spatialResolution>
        <gmd:MD_Resolution>
            <gmd:distance gco:nilReason="inapplicable"/>
        </gmd:MD_Resolution>
    </gmd:spatialResolution>
    <gmd:language>
        <gmd:LanguageCode codeList="http://www.loc.gov/standards/iso639-
2/php/code_list.php" codeListValue="eng">English</gmd:LanguageCode>
    </gmd:language>

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</gmd:language>
<gmd:topicCategory>
  <gmd:MD_TopicCategoryCode>oceans</gmd:MD_TopicCategoryCode>
</gmd:topicCategory>
<gmd:extent>
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      <gmd:EX_GeographicBoundingBox>
        <gmd:westBoundLongitude>
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        </gmd:westBoundLongitude>
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        </gmd:eastBoundLongitude>
        <gmd:southBoundLatitude>
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        <gmd:northBoundLatitude>
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        </gmd:northBoundLatitude>
      </gmd:EX_GeographicBoundingBox>
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    <gmd:geographicElement>
      <gmd:EX_GeographicDescription>
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            <gmd:authority>
              <gmd:CI_Citation>
                <gmd:title>
                  <gco:CharacterString>SeaVoX water
bodies</gco:CharacterString>
                </gmd:title>
              </gmd:CI_Citation>
            </gmd:authority>
            <gmd:code>
              <gco:CharacterString>World</gco:CharacterString>
            </gmd:code>
          </gmd:MD_Identifier>
        </gmd:geographicIdentifier>
      </gmd:EX_GeographicDescription>
    </gmd:geographicElement>
    <gmd:temporalElement>
      <gmd:EX_TemporalExtent>
        <gmd:extent>
          <gml:TimePeriod gml:id="medinMEDIN01">
            <gml:beginPosition>2009</gml:beginPosition>
            <gml:endPosition>2009</gml:endPosition>
          </gml:TimePeriod>
        </gmd:extent>
      </gmd:temporalElement>
    </gmd:EX_Extent>
  </gmd:extent>

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        </gmd:EX_TemporalExtent>
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</gmd:EX_Extent>
</gmd:extent>
<gmd:supplementalInformation>
    <gco:CharacterString>Publication year: 2009-11-20
Publication title: GEBCO_08 Grid
Publication authors: GEBCO
Publication editors: Pauline Weatherall</gco:CharacterString>
    </gmd:supplementalInformation>
</gmd:MD_DataIdentification>
</gmd:identificationInfo>
<gmd:distributionInfo>
    <gmd:MD_Distribution>
        <!--ISO 19115 Constraints require this element!-->
        <gmd:distributionFormat gco:nilReason="inapplicable"/>
        <gmd:distributor>
            <gmd:MD_Distributor>
                <gmd:distributorContact>
                    <gmd:CI_ResponsibleParty>
                        <gmd:organisationName>
                            <gco:CharacterString>British Oceanographic Data
Centre</gco:CharacterString>
                        </gmd:organisationName>
                        <gmd:positionName>
                            <gco:CharacterString>Director</gco:CharacterString>
                        </gmd:positionName>
                        <gmd:contactInfo>
                            <gmd:CI_Contact>
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                                    <gmd:CI_Address>
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Building</gco:CharacterString>
                                        </gmd:deliveryPoint>
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                                            <gco:CharacterString>6 Brownlow Street</gco:CharacterString>
                                        </gmd:deliveryPoint>
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                                        </gmd:postalCode>
                                        <gmd:country>
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                                        </gmd:country>
                                        <gmd:electronicMailAddress>
                                            <gco:CharacterString>enquiries@bodc.ac.uk</gco:CharacterString>
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                                    </gmd:CI_Address>
                                </gmd:address>
                                <gmd:onlineResource>
                                    <gmd:CI_OnlineResource>
                                        <gmd:linkage>
                                            <gmd:URL>http://www.bodc.ac.uk/</gmd:URL>
                                        </gmd:linkage>
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</gmd:distributionInfo>

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        </gmd:CI_Contact>
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    <gmd:role>
        <gmd:CI_RoleCode
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resources/Codelist/gmxCodelists.xml#CI_RoleCode"
codeListValue="distributor">distributor</gmd:CI_RoleCode>
        </gmd:role>
    </gmd:CI_ResponsibleParty>
</gmd:distributorContact>
</gmd:MD_Distributor>
</gmd:distributor>
<gmd:transferOptions>
    <gmd:MD_DigitalTransferOptions>
        <gmd:onLine>
            <gmd:CI_OnlineResource>
                <gmd:linkage>
                    <gmd:URL>https://www.bodc.ac.uk/data/online_delivery/gebco/</gmd:URL>
                </gmd:linkage>
                <gmd:name>
                    <gco:CharacterString>BODC online data delivery
service</gco:CharacterString>
                </gmd:name>
                <gmd:description>
                    <gco:CharacterString>Access the gridded bathymetric (GEBCO) data
delivery service. This allows grid files for a user-defined or global area to be
auto-delivered for each of the GEBCO grids.</gco:CharacterString>
                </gmd:description>
                <gmd:function>
                    <gmd:CI_OnLineFunctionCode
codeList="http://standards.iso.org/ittf/PubliclyAvailableStandards/ISO_19139_Schemas/
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codeListValue="download">download</gmd:CI_OnLineFunctionCode>
                    </gmd:function>
                </gmd:CI_OnlineResource>
            </gmd:onLine>
        </gmd:MD_DigitalTransferOptions>
    </gmd:transferOptions>
<gmd:transferOptions>
    <gmd:MD_DigitalTransferOptions>
        <!--WMS online resource-->
        <gmd:onLine>
            <gmd:CI_OnlineResource>
                <gmd:linkage>
                    <gmd:URL>http://www.gebco.net/data_and_products/gebco_web_services/web_map_service/ma
pserv?</gmd:URL>
                </gmd:linkage>
                <gmd:protocol>
                    <!--The protocol value should be taken from the GeoNetwork controlled
vocabulary-->
                    <gco:CharacterString>OGC:WMS-1.1.1-http-get-map</gco:CharacterString>
                </gmd:protocol>
                <gmd:name>
                    <!--Layer name-->
                    <gco:CharacterString>GEBCO_08_Grid</gco:CharacterString>
                </gmd:name>
                <gmd:description>
                    <!--Description of the layer delivered by the WMS service, etc.-->
                    <gco:CharacterString>Global map of height above sea level (depths
negative) taken from the GEBCO-08 30 arc second grid</gco:CharacterString>
                </gmd:description>
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</gmd:transferOptions>

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    </gmd:onLine>
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</gmd:transferOptions>
</gmd:MD_Distribution>
</gmd:distributionInfo>
<gmd:dataQualityInfo>
  <gmd:DQ_DataQuality>
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    <gmd:scope>
      <gmd:DQ_Scope>
        <gmd:level>
          <gmd:MD_ScopeCode
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resources/Codelist/gmxCodelists.xml#MD_ScopeCode"
codeListValue="dataset">dataset</gmd:MD_ScopeCode>
          </gmd:level>
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      </gmd:scope>
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  </gmd:dataQualityInfo>
</gmd:MD_Metadata>

```

Acknowledgements

This cookbook was written for the International Coastal Atlas community under the auspices of the NETMAR (Open Service Network for Marine Environmental Data) project. NETMAR is partially funded by the European Commission under Theme ICT-2009.6.4 ICT for environmental services and climate change adaptation of the Information & Communication Technologies FP7 Programme.

Thanks to Roy Lowry of the British Oceanographic Data Centre for supplying baseline GEBCO metadata example which has been tuned to the NETMAR project.

This document has been reviewed by, and incorporates comments from, Pete Walker of Plymouth Marine Laboratory. Thanks to the reviewers for their help in making the document clear and readable. Further feedback on this document is welcomed, and may be provided by contacting the author whose details are below.

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Version	1.0
Date	2011 December 23
Revisions	