Issue 1

Spatial units and ecosystem classification for ocean accounts

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Objective

Recommend a standard approach to delineating ocean and coastal spatial units and classifying ecosystem types coherent with international methods and SEEA System of Environmental-Economic Accounting (SEEA) Experimental Ecosystem Accounting

Spatial units for oceans

Spatial units (SU) > Ecosystem assets (EA) > Ecosystem type / classification (ET)

• Spatial units (SUs) are basic building blocks in SEEA-EEA accounting framework
  • information attributed to a specific geographic location over time
  • biotic and abiotic
  • grid - cell based

• SUs can be thought of as collection units
  • information on extent, condition and ecosystem services can be gathered, derived, compared and reported on
• Currently in SEEA-EEA concept of BSU used to compile land accounts

Basic Spatial Unit (BSU) - based primarily on surface characteristics / activities
integral part of SEEA land cover classification (16)
  • land cover/use, elevation, soil type, water resources and climate

• No standard marine BSUs in SEEA-EEA but revision on spatial units
looking at guidelines for classifications and delineation of marine areas

• BSU smallest unit in ecosystem hierarchy
  for which data are collected or to which
  information is attributed

• Aggregated based on their components and
  similarities of ecological and non-ecological
  characteristics
  • Ecosystem Assets (EAs – stocks)
  • Identifies ecosystem services (flows) they provide
  • Ecosystem Types / Classifications (reporting area)
    • Global classifications (EMU, Longhurst, drainage, admin areas (EEZ, FAO fishing areas)
Ecosystem Assets (stock) / Classifications

- Ecosystem Assets spatial areas – abiotic (non living) and biotic (living) components and other characteristics that function together
  
  UNSEEA

- Ecosystem assets provide services that are spatially significant and in some instances relevant to other ecosystems
  
  Eigenraam et al 2016

- Ecosystem assets part of hierarchy and the services they provide can be classified
  
  - Provisioning /regulating /cultural /supporting

- After UNESCAP review and issue brief many global marine classifications exist (habitat / benthic / coastal)
  
  - ensures all marine habitat, communities and ecosystems and their ecological attributes are represented
  
  - a structured approach used to consider biodiversity at various spatial extents
  
  Fisheries and Oceans Canada Canadian Science Advisory Secretariat report 2016/003
Spatial units and classifications identified

Spatial units
- USGS - Ecosystem Marine Units
- Large Marine Ecosystems (LMEs)
- Biogeographical Provinces
- Ecologically or Biologically Significant Marine Areas (EBSAs)
- Vulnerable Marine Ecosystem (VMEs)
- Longhurst provinces

Ecosystem classifications
- Coastal and Marine Ecological Classification Standard (CMECS)
- Marine Ecoregions of the World (MEOW): A Bioregionalization of Coastal and Shelf Areas
- The Marine Habitat Classification for Britain and Ireland Version 04.05
- Global Open Oceans and Deep Seabed (GOODS) Biogeographic Classification
- Seamap Australia the development of a national benthic marine classification scheme for the Australian continental shelf
- Great Lakes Aquatic Habitat Framework
- IUCN Habitat Classification Scheme 9-13
- Review of Marine Habitat Classification Systems
- Marine Spatial Data Infrastructure (MSDI)
- South African National Biodiversity Index
# Existing maps of ocean regions (Sayre et al 2017)

<table>
<thead>
<tr>
<th>NAME</th>
<th>GEOGRAPHIC SCOPE</th>
<th>BASIS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Countries’ Exclusive Economic Zones (EEZs) (United Nations, 1982)</td>
<td>Global, Coastal</td>
<td>Political</td>
</tr>
<tr>
<td>Large Marine Ecosystems (LMEs) (Sherman et al., 2005)</td>
<td>Global, Coastal</td>
<td>Management areas</td>
</tr>
<tr>
<td>Marine Ecoregions of the World (MEOWs) (Spalding et al., 2007)</td>
<td>Global, Coastal</td>
<td>Expert-derived biogeography (realms, provinces) and management units (ecoregions)</td>
</tr>
<tr>
<td>Fisheries and Agricultural Organization (FAO) Major Fishing Areas (FAO, 2016)</td>
<td>Global</td>
<td>Rectangular fishery statistical assessment regions</td>
</tr>
<tr>
<td>International Council for the Exploration of the Sea Ecoregions (ICES, 2004)</td>
<td>Regional (Northeast Atlantic)</td>
<td>Large ecosystem and fishery management areas</td>
</tr>
<tr>
<td>International Hydrographic Organization Seas and Oceans (IHO, 2002)</td>
<td>Global</td>
<td>Geographically named areas</td>
</tr>
<tr>
<td>Ecoregions of the Oceans and Continents (Bailey, 2014)</td>
<td>Global</td>
<td>Expert recommended regions</td>
</tr>
<tr>
<td>Deep-Sea Provinces (Watling et al., 2013)</td>
<td>Global</td>
<td>Expert-derived revision of GOODS based on literature review</td>
</tr>
<tr>
<td>Biogeochemical Provinces (Longhurst, 2007)</td>
<td>Global</td>
<td>Satellite ocean color</td>
</tr>
<tr>
<td>Seafloor Map (GSFM) (Harris et al., 2014)</td>
<td>Global</td>
<td>Expert geomorphological feature extraction using 30 arc-second bathymetry data</td>
</tr>
<tr>
<td>Deep-Sea Seascapes Map (Harris and Whiteway, 2009)</td>
<td>Global</td>
<td>Multivariate analysis of seabed morphology and sediments</td>
</tr>
</tbody>
</table>
Issues and challenges identified

• All surface is water (fluid) and characteristics are different and should be captured
  • at different depths and distances (littoral, neritic, oceanic)
  • temperature, geology, species, currents, salinity, currents population, economic activity, upwell, fish catches, etc

• Define clearly between - Marine Basic Spatial Unit (MBSU) (collection) and Ecosystem Asset (EA) and Marine Ecosystem Classification / Type (MEC) (reporting) and their roles in Ocean Accounts
  • Important to understand the extent of ecosystem assets because this, with condition, determines the flow of ecosystem services
  • Capturing ecosystem function / interdependencies across spatial units (and national boundaries)

• Proliferation of ecosystem classifications
  • Ecosystem assets must be classified so they can be consistently organized within the environmental-economic accounting framework over time

• Determine what data is required from other briefs to ensure spatial unit data quality and completeness
Issues and challenges identified

• Need standard comprehensive shoreline for spatial units

• Data infrastructure (gdb) and management requirements

• Marine SDI could provide an appropriate structure for managing spatial unit of ocean account
  • range of applications from coastal/marine resource management to disaster risk management

• Coastal shoreline analysis, analyze historical shoreline change

• Combined Biotope Classification Scheme (CBiCS)
  • unified scheme for classifying all marine habitats and biotopes
  • hierarchical incorporates disparate information and levels of resolution (Edmunds et al 2015).

• Impacts to marine ecosystems due to climate change
  • Risk and hazard analysis and potential loss due to cyclone

• Mapping of temperatures sea, fish habitat and fishery management plans
The CBiCs Hierarchy and the Proposed SEEA Units

**CBiCS**

**Level 1: Environment**
Marine, coastal, freshwater and terrestrial.

**Level 2: Broad habitat type**
Defined by zone (littoral, infralittoral, circalittoral, sub-littoral, deep-sea bed, pelagic water column, ice-associated marine) and by substrate hardness (sediment, rock).

**Level 3: Habitat complexes**
Sediment groups are differentiated by grain size and/or the presence of macrophytes or biogenic reefs. Habitat complexes for rocky substrata are differentiated as having high, medium or low energy (based on both wave and tidal exposure).

**Level 4: Biotope complexes**
Biotope complexes are groups of community-level biotopes with similar physical and biological character that occur together.

**Level 5: Biotopes**
Biotopes are typically distinguished by the dominant species or suites of conspicuous species.

**UN SEEA**

**Ecological Domains**

**Ecosystem Classes**

**Level 1**
Ecosystems

**Level 2**
Ecosystems
Coastal example – from CBiCs
Port Philip Bay, Australia

<table>
<thead>
<tr>
<th>Broad habitat</th>
<th>Habitat complex</th>
<th>Centra l</th>
<th>Corio</th>
<th>Exchange</th>
<th>Hobson s</th>
<th>Intertid al</th>
<th>Total</th>
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<tr>
<td>Littoral sediment</td>
<td>Mangrove</td>
<td>87</td>
<td>475</td>
<td>5</td>
<td>1,868</td>
<td>2,435</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mud</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>274/275</td>
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<tr>
<td></td>
<td>Saltmarsh coastal vegetation</td>
<td>87</td>
<td>475</td>
<td>5</td>
<td>1,868</td>
<td>2,435</td>
<td></td>
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<tr>
<td>Littoral sediment total</td>
<td></td>
<td>87</td>
<td>475</td>
<td>5</td>
<td>2,147</td>
<td>2,714</td>
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<td>Sublittoral rock</td>
<td>Ravine</td>
<td>798</td>
<td></td>
<td></td>
<td>11</td>
<td>809</td>
<td></td>
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<td></td>
<td>Rock (unclassed)</td>
<td>299</td>
<td>471</td>
<td>760</td>
<td>902</td>
<td>48</td>
<td>2,481</td>
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<tr>
<td></td>
<td>Seagrass</td>
<td>209</td>
<td></td>
<td></td>
<td></td>
<td>209</td>
<td></td>
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<tr>
<td></td>
<td>Seaweed</td>
<td>298</td>
<td>64</td>
<td>3</td>
<td>5</td>
<td>369</td>
<td></td>
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<tr>
<td>Sublittoral rock total</td>
<td></td>
<td>299</td>
<td>769</td>
<td>1,832</td>
<td>904</td>
<td>63</td>
<td>3,868</td>
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<td>Sublittoral sediment</td>
<td>Mud</td>
<td>69,923</td>
<td>3,391</td>
<td>7,393</td>
<td>3,922</td>
<td>234</td>
<td>84,863</td>
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<tr>
<td></td>
<td>Muddy sand</td>
<td>8,935</td>
<td>5,898</td>
<td>10,656</td>
<td>3,872</td>
<td>8</td>
<td>29,369</td>
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<tr>
<td></td>
<td>Sand</td>
<td>5,800</td>
<td>11,064</td>
<td>23,458</td>
<td>6,921</td>
<td>312</td>
<td>47,555</td>
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<td></td>
<td>Seagrass</td>
<td>1</td>
<td>3,280</td>
<td>3,524</td>
<td>123</td>
<td>209</td>
<td>7,138</td>
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<tr>
<td></td>
<td>Seaweed</td>
<td>7,087</td>
<td>352</td>
<td>431</td>
<td>14</td>
<td>7,884</td>
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<tr>
<td></td>
<td>Silty mud</td>
<td>141</td>
<td>9,737</td>
<td>2,113</td>
<td>905</td>
<td>28</td>
<td>12,925</td>
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<tr>
<td>Sublittoral sediment total</td>
<td></td>
<td>84,800</td>
<td>40,457</td>
<td>47,498</td>
<td>16,175</td>
<td>804</td>
<td>196,734</td>
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<tr>
<td>Total</td>
<td></td>
<td>85,099</td>
<td>41,313</td>
<td>49,804</td>
<td>17,085</td>
<td>3,014</td>
<td>196,315</td>
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</tbody>
</table>
Alternative approaches to address issues and challenges

Marine Basic Spatial Unit (MBSU)

• On surface all water, environment and ecosystem vary
  • Depth / distances - benthic / pelagic/ intertidal / oceanic
  • USGS Ecosystem Marine Unit based on 3D point data for six physical land
    chemical environment parameters 37 distinct volumetric region units
    from sea surface to seafloor

• A collection unit should be at the smallest possible spatial extent that can be delineated based on criteria
  • different resolution for coastal to EEZ and oceanic zone
  • water column like EMU for x,y,z data, geometric shape, grid, hexagon, point
  • components of MBSU include, physical characteristics (depth, slope, distance - coastline, etc.)
  • biological / climatic (temperature, salinity, currents, oxygen levels, species, ambient climate, etc)
  • socio-economic (population, economic activity, mineral exploration, pollution, governance, etc).

The Ocean Accounts
Marine Ecosystem Classifications

• Many global and regional Marine classifications exist
  • combination of key components (depth, temperature, geology, chemical composition, other biotic/abiotic parameters, etc).

• Review of MECs should be done to determine if a comprehensive MEC exists that would best serve Ocean Accounts

• Analysis of the principles and components of MECs could identify commonalities that could serve as a base for a new international standard marine classification.

• MECs should follow SEEA principles recent SEEA experts forum

Credible - The classification must be scientifically sound
Salient - The classification must be relevant for policy needs
Legitimate - The process must be respectful of stakeholders’ divergent values and beliefs

Sjoerd Schenau, Patrick Bogaart, Edwin Horlings UNSD export forum; New York; 18 June 2018MECs
• Review of marine units and classification done by UNECSAP
  spatial resolution and components for classifications vary

• Coastal areas important (human /economic activity) and many
  classifications exist CMECS SANBI MEOW

• How to integrate and manage spatial and non-spatial data with
  different spatial resolutions and extents

• Marine classifications not easy
  • Large spatial extent
  • Complex habitats
  • Oceans process and patterns fluid and 3D
  • Many scales geographic and temporal
Recommendations for inclusion in ocean accounting guidance

- Assess data and user needs from other issue briefs, particularly global spatial datasets
- Spatial geodatabase key and all data should have spatial component
- Research and develop a Marine Basic Spatial Unit and associated marine ecosystem hierarchy and classification
- Adopt 3D water column for MBSU concept (depth and distance)
- Have different sets of scale for coastal and open ocean MBSU
- Use hexagonal approach for better area representation and modelling
- Flexibility to aggregate up to whatever geographic area or classifications
- Develop links to the SEEA EEA working group revising spatial units to contribute and learn from the development of an international standard classification for marine areas and contribute to the activities underway
• Chose a standardized spatial foundation layers
  • shoreline that meets needs (30m Landsat)
  • bathymetric – depth and slope calculation
• Marine Spatial Data Infrastructure (MSDI) as a potential framework
• Integration with terrestrial through use of Marine Basin Catchment Area concept
  • Nutrient load
  • Pollution
  • Climatic effect
  • Catchment
  • Human activities

Climate - precip, land cover, population, economic activity, etc
Recommendations for inclusion in ocean accounting guidance

• Ideally two points in time for data in MBSU to allow temporal analysis and to monitor change for accounts

• Focus on coastal areas
  • Link to watersheds that drain into coastal pour points
  • Nutrient loads, tidal mixing, river runoff, inputs from land

• Include socio-economic data into MBSU

• Strive for global datasets that meet data quality standards and are temporal to allow to track changes to ecosystems

• Develop prototype ocean account for Asia-Pacific region

Thank you.
Acknowledgements

Issue brief participants

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Thank you:

UNESCAP
https://www.unescap.org/events/asia-and-pacific-regional-expert-workshop-ocean-accounts

Contact: bordt@un.org
Who is using MSDI currently

Australia
Australian Marine Spatial Information System[3]

Canada: MSDI as part of Canadian SDI[6]
Marine User Requirements for Geospatial Data[7]

Malaysia: Marine Cadastre[8]

U.S.: Coastal and Marine Spatial Planning[9]

ENC Direct[10]

Coastal and Marine Spatial Planning Data Registry[11]