



# Marine Spatial Data Infrastructures

## Fundamentals

Produced by IIC TECHNOLOGIES

1

# Marine Spatial Data Infrastructures

Concepts and Definitions

2

# Why are you here?

Data engineering for reuse is really hard!

I'm lost in the buzzwords

Too much information

MSDI?
What is it?
What do I do next?

What are the hurdles?

National Commitment

What is data-centric?

Regional Coordination

It's Not My Job!

3

# Definitions

A **"Spatial Data infrastructure (SDI)"** is:

**"the relevant base collection of technologies, policies and institutional arrangements that facilitate the availability of and access to spatial data."**

A **"Marine Spatial Data Infrastructure (MSDI)"** is:

**"that element of an SDI that focuses on the marine input [to an SDI] in terms of governance, standards, ICT and content"**

4

# Definitions

Technology

Policy Governance

Technical Standards

Data and Metadata

"The relevant base collection of
technologies
policies
institutional arrangements

that

facilitate the availability of and access to

spatial data"

Users

"Marine Spatial Data Infrastructure (MSDI)":

MSDI – The focus on marine elements in any SDI
Governance, Standards, ICT and Content


5

# The Four Elements of MSDI

MSDI is how these elements work together within an SDI to connect end users to marine geospatial data.


Users

Technical Standards

Policy Governance

Technology

Data and Metadata

6

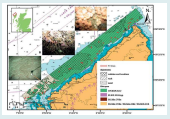
# Benefits of MSDI

Leisure and Tourism

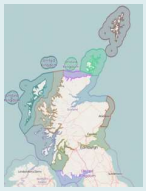
Emergency Planning and Response

Fisheries Regulation

- Unlock the economic and environmental power of marine geospatial data
- Provide reusable data to a broader audience for diverse uses
- Break out of a single tightly defined customer group
- Improve marine geospatial data quality and working practices



Coastal Zone Management



Maritime Boundaries
Marine Protected Areas

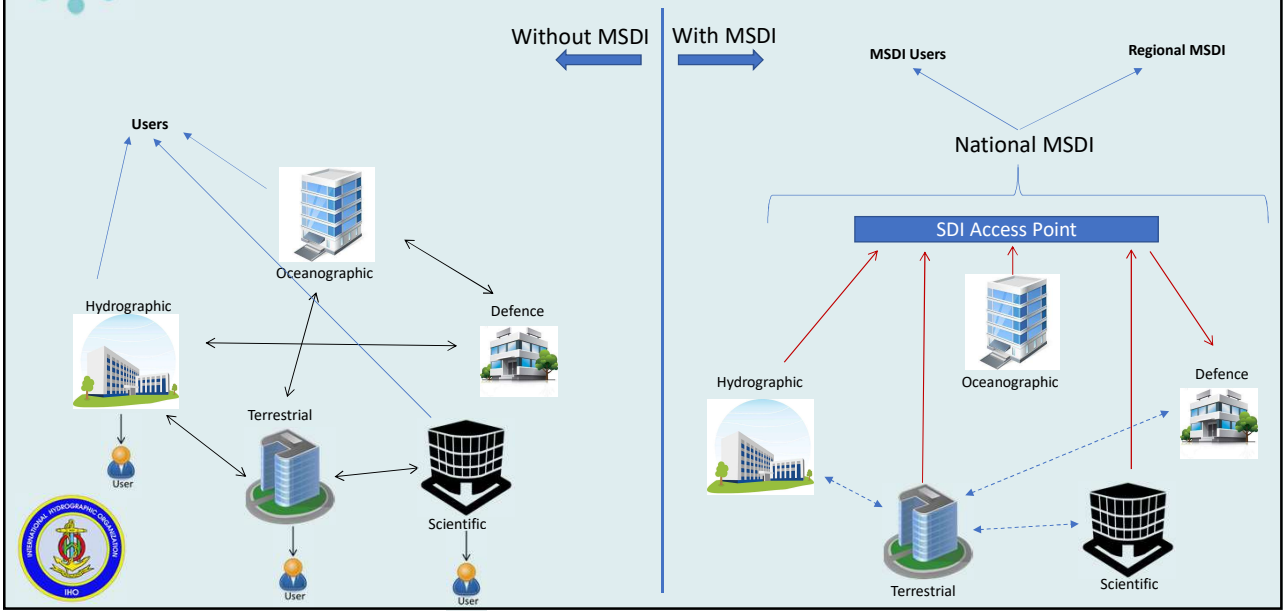
Dredging planning and beneficial reuse

Marine Spatial Planning

Site Selection

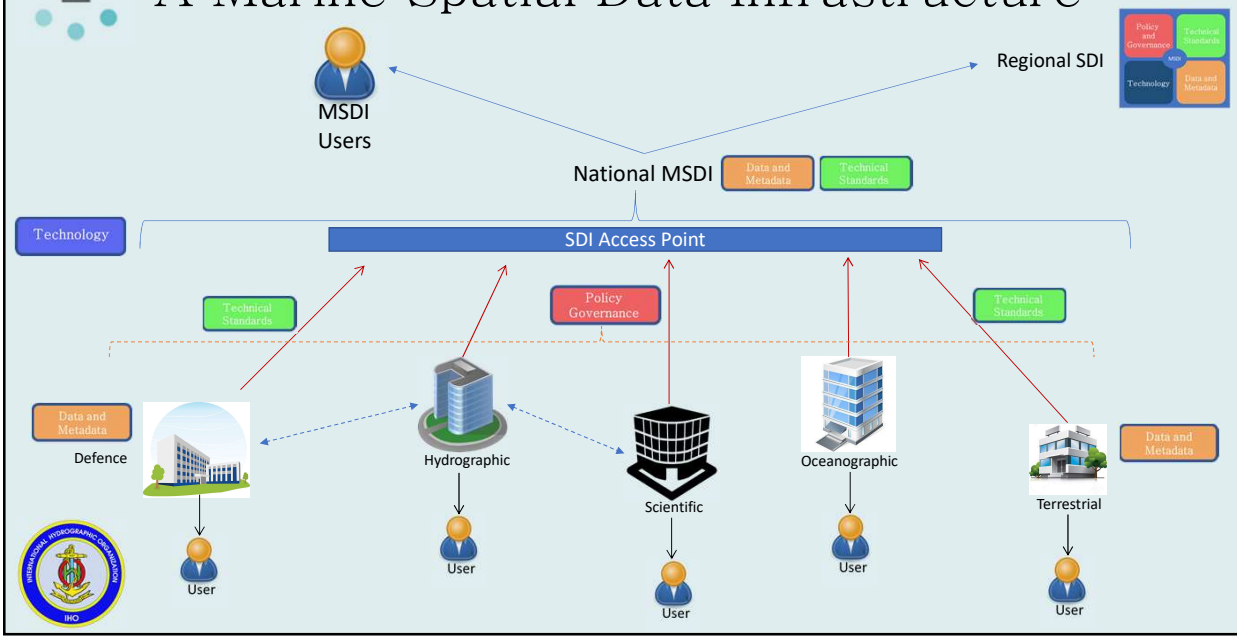
7

# What is MSDI?



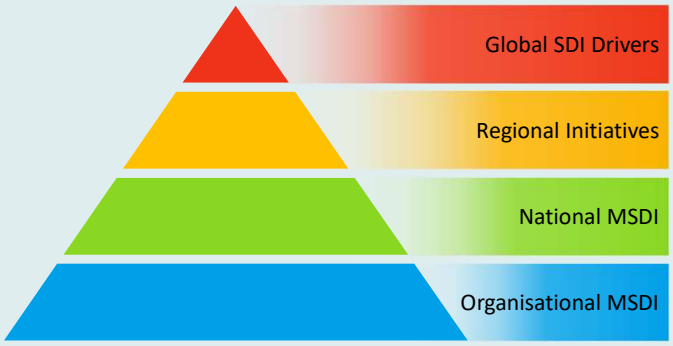

8

# A Marine Spatial Data Infrastructure




9

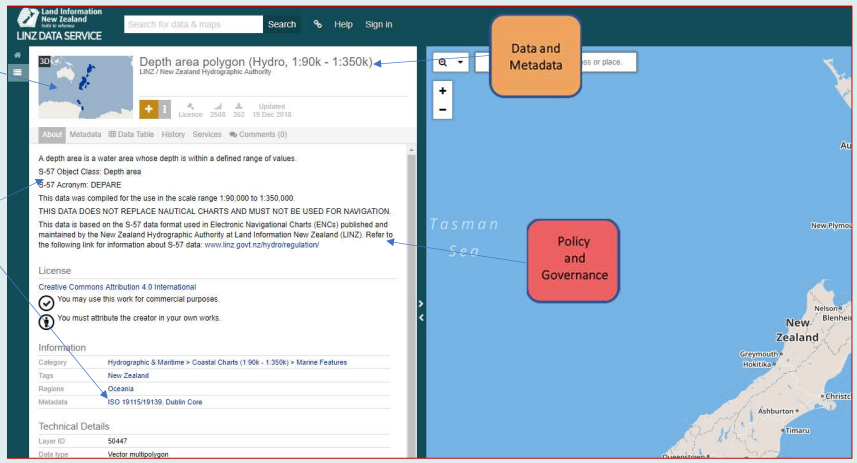
# The MSDI Hierarchy




MSDI can be seen at different levels.

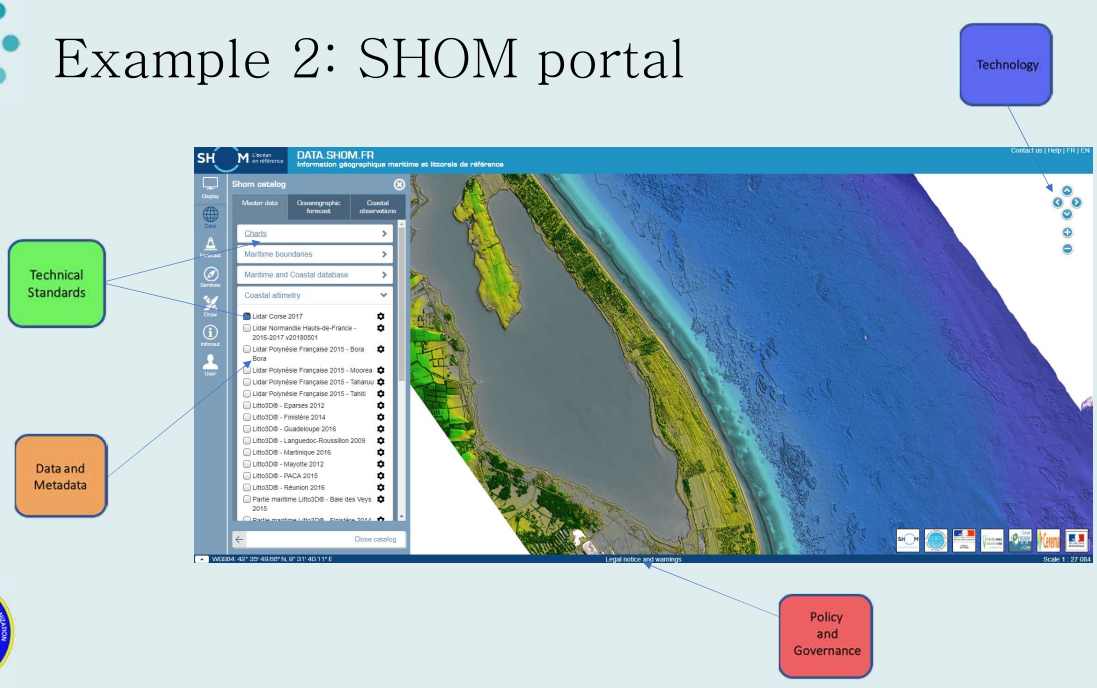
10

# Example: New Zealand Geoportal




11

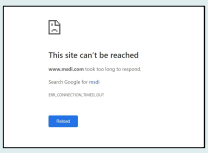
# Example 2: SHOM portal



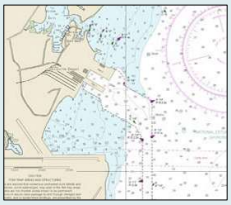

12

# What SDI and MSDI "isn't"

Not an IHO initiative




Not a website



Not a "product"

Not a Format

13

# MSDI policy development

Policy and Governance

- To establish MSDI a policy and governance framework should define the need to create information that is interoperable
- Policy and Governance should:
  - Sets the vision and goals of the MSDI and
  - Define the responsibilities of participating institutions
  - Resource the work necessary to establish and maintain the MSDI
  - Define which institution is authoritative for each domain
- Policy is often linked to a regional, national or organizational strategies
- Policies can very significantly between different states
  - Often the most difficult hurdle to establishing MSDI
  - No fixed format, standard or process for policy development
  - IHO publication C-17 contains best practice guidelines for Hydrographic Offices

Areas considered within policy

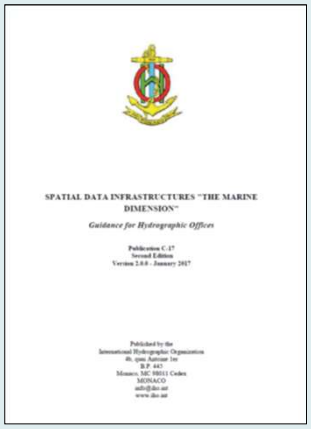
- Privacy
- Licensing
- Intellectual Property
- Authenticity
- Data Security
- Data quality
- Data integration
- Data Archiving
- Open Data
- Copyright and Licencing

14

# IHO MSDIWG

Policy and Governance

- MSDIWG - The IHO's working group with the objective of supporting activities relating to SDI and MSDI.
- Also links to OGC Marine domain working group (MDWG)
- Publishes IHO C-17, "a guide to establishing the role of the national hydrographic authority in MSDI"
- Contains much advice on formulating policy, governance and implementation of MSDI
- IHO C-17 also contains much information on the other MSDI elements


SPATIAL DATA INFRASTRUCTURES "THE MARINE DIMENSION"

*Guidance for Hydrographic Offices*

Technical Standards | Data and Metadata | Technology

**"Hydrography** is the branch of applied sciences which deals with the measurement and description of the physical features of oceans, seas, coastal areas, lakes and rivers, as well as with the prediction of their change over time, for the primary purpose of safety of navigation and in support of all other marine activities, including economic development, security and defence, scientific research, and environmental protection "

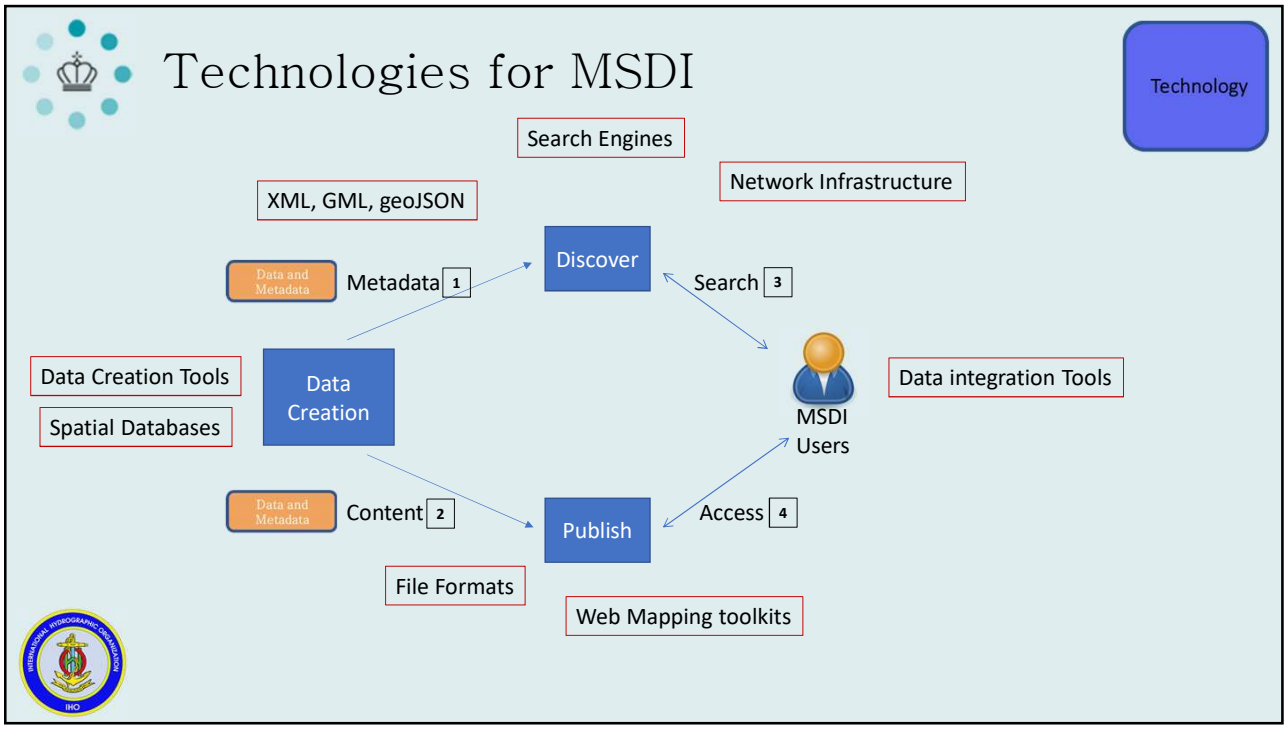
15

# Business models for delivery of MSDI

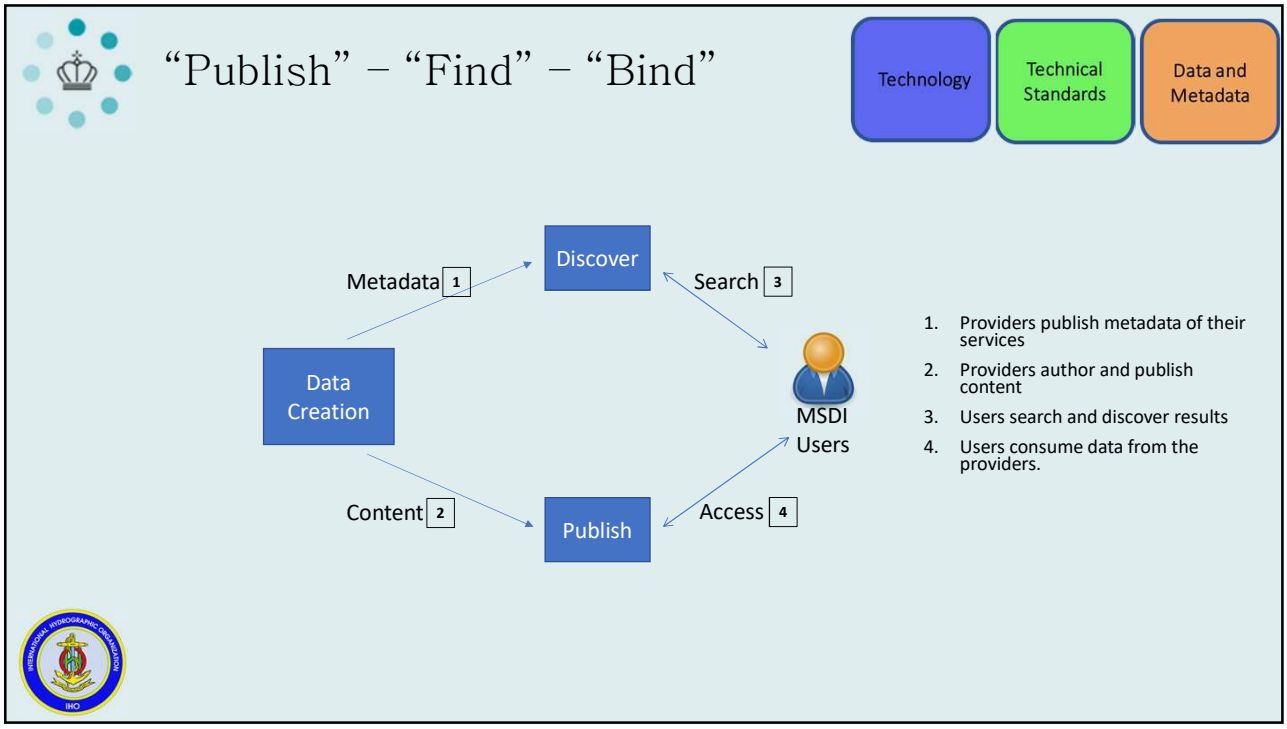
Policy and Governance

- MSDI can be costly to implement at a national scale
- MSDI Funding models vary
  - Funded publicly funds, nationally or regionally
  - Funded by revenue from products and services
  - Private sector or hybrid vehicles
- MSDI Policy and Governance
  - Should put in place a sustainable business model
  - Provide a remit for creation of reusable data
- Long-term planning for MSDI is a frequent challenge.
- Education and engagement with stakeholders is key

16


Technologies for MSDI
Technology
Search Engines
Network Infrastructure
XML, GML, geoJSON
Discover
Data and Metadata
Metadata 1
Search 3
Data Creation Tools
Data Creation
Data integration Tools
Spatial Databases
MSDI Users
Data and Metadata
Content 2
Publish
Access 4
File Formats
Web Mapping toolkits

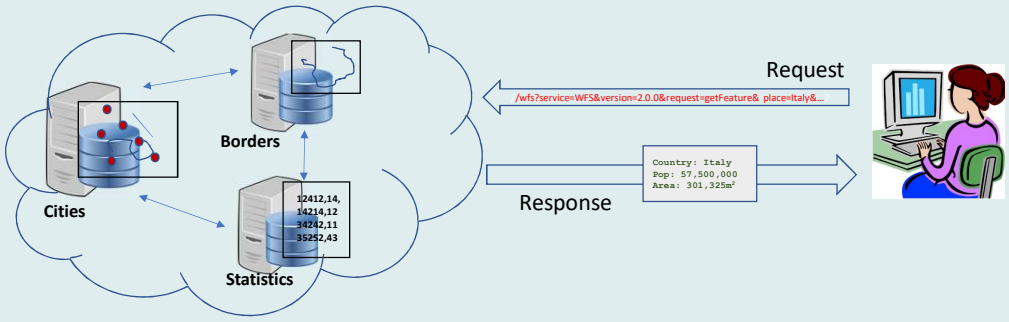
17


"Publish" – "Find" – "Bind"
Technology
Technical Standards
Data and Metadata
Discover
Metadata 1
Search 3
Data Creation
MSDI Users
Content 2
Publish
Access 4
1. Providers publish metadata of their services
2. Providers author and publish content
3. Users search and discover results
4. Users consume data from the providers.

18

# Web Services for MSDI

Technology




Data and Metadata

Technical Standards

19

# Marine Technology Advances

Technology

**Sensors:**
- Increase in power, decrease in price
- Scale of sensors for marine survey
- LIDAR, AIS, Satellite imagery
- Handheld positioning

**Crowdsourcing:**
- Volunteered geographic information now realistic, reliable and usable by many agencies
- Changes role of some agencies.
- Tools have revolutionised the concept. OpenStreetmap, Waze, Google Maps

Marine Geospatial Technology

**Big Data, Data Science and Machine Learning:**
- Emerging in geospatial technologies
- Could have tremendous impact on data manipulation, compilation and search/retrieval
- Data science will enable "information" exchange rather than just data.

**Computing Power:**
- Computing Power and connectivity have dramatically increased
- Cheap access to high powered, cloud based databases and mainstream geospatial technology
- Convergence of hydrography with GIS

20

# Technical Standards

Technical Standards

- Definitions
- The Standards world
- MSDI and standards
- Important Standards for:
  - Content
  - Encoding / Format
  - Exchange
  - Validation
  - Quality
  - Metadata

Data and Metadata

21

Technical Standards

Standards are technical documents that detail interfaces or encodings (OGC).

Software developers, cartographers and data engineers use these documents to build their products and services.

Standards span the collection, management, publication and use of geospatial data

Key to MSDI are <u>open</u> standards and standards <u>interoperability</u>

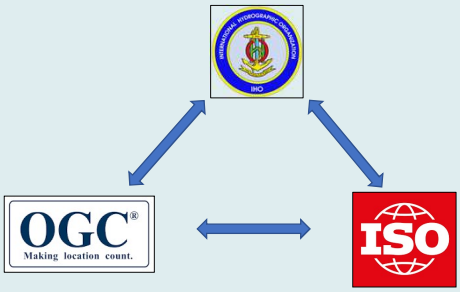
Open Standards can be used by anyone at little or no cost

Interoperability is being able to combine data and services from different sources without requiring specific efforts of humans or machines

22

Technical Standards

**IHO** – a detailed set of standards for content and distribution of marine geospatial data




**OGC** – a leading organisation developing open geospatial standards

**ISO** – define overarching global standards for all geospatial data

# Global Standards Organisations for MSDI

23

Technical Standards

# Why are standards key to MSDI success?

- Standards are agreements that make it easier for systems to publish, access, share and use data
- MSDI exists to connect end users to many diverse sources of marine content
- MSDI success at a technical level needs:
  - A way of communicating content to many users as efficiently as possible [Web Services and Open Standards]
  - A way of ensuring MSDI users can use data from many sources without building bespoke systems [Interoperability]

24

# MSDI and the role of IHO S-100

Technical Standards

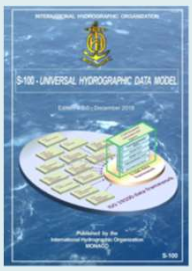
S-100 is a <u>fundamental</u> standard for MSDI:

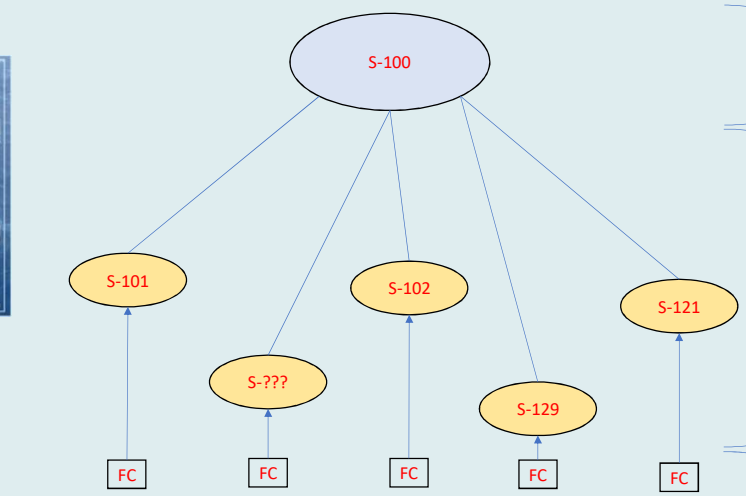
- A universal standard for encoding marine geospatial data
- Derived from ISO19100 standards – for interoperability
- Open – free for all to use and implement
- Extensible – all marine domains (including MSDI) can represent their data
- IHO Geospatial Registry of defined features

25

# The structure of S-100

Technical Standards




S-100 - Overall Standard

S-100 Product Specifications
- Use parts of S-100 within a particular domain
- Define data model, features and attributes
- Metadata, geometry and identifiers

Feature Catalogues

IHO GI Registry

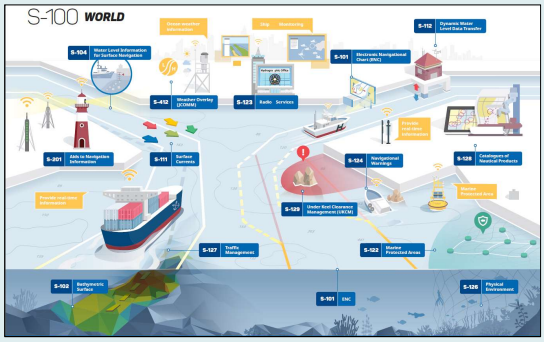
26

# S-100 product specifications for MSDI

Technical Standards

Example Product Specifications useful for MSDI

- Electronic Navigational Charts (S-101)
- Maritime Limits and Boundaries (S-121)
- Maritime Protected Areas (S-122)




27

# Marine standards evolution

Technical Standards

- Global standards for marine data continue to evolve:
  - S-100 and its product specifications
  - OGC standards for web services
- OGC Web Services APIs show how institutions can implement MSDI
- Using existing open standards and technologies means institutions can focus on engineering content to facilitate reuse

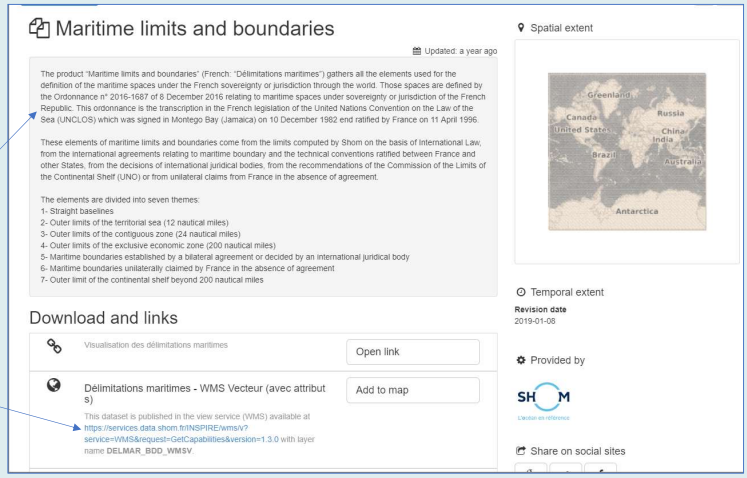
28

# Example: Using OGC standards

Technical Standards

Data and Metadata

Technical Standards

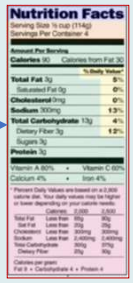



29

# What is "Data"?

Data and Metadata

- Data is the "Content"
  - Regardless of container or format
- Metadata – is data about data
- Information is the "useful" part of data
- Data is not the same as "Products"


30

# Marine geospatial data content

Data and Metadata

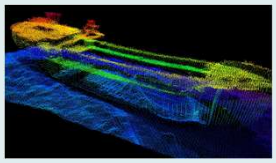
Vector Data: "Things"

```
LIGHTS:
{
  CATLIT = 6
  COLOUR = 3
  INFORM = More than one
  SCAMIN = 59999
}
geometry:
{
  id = 6E42010000 [-40.5,36.2]
  ornt = null
}
```

A collection of features with attributes and geometry.

Raster Data and Imagery

Bathymetry: Point Clouds and Surveys



Technical Standards

Standards for data format
Vector: IHO S-57, S-100
Raster: geoTIFF, PNG, HCRF
Bathymetry: LAS, IHO S-102

31

# Example content: IHO S-57

Data and Metadata

- Very common MSDI dataset
- IHO S-57 product specification for Electronic Navigational Charts primarily designed for SOLAS navigation
- Features are collected into logical groups
- Also specifies important metadata

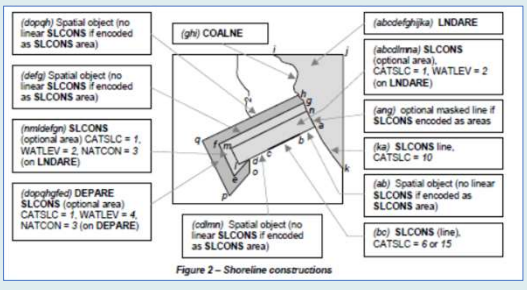


Figure 2 – Shoreline constructions

Standards provide detailed guidance on defining content

Technical Standards

32

# Metadata and MSDI

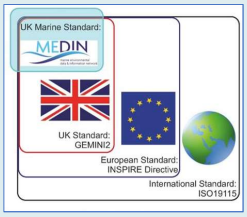
Data and Metadata

- Metadata is Information about datasets
- Published "discovery" metadata is how MSDI users "find" the data they are searching for and establish its authenticity
- For the MSDI community standardized, populated, comprehensive metadata is crucial to success.
- Collection of metadata facilitates good data management and has benefits beyond MSDI applications

Technical Standards

Metadata content is Standardised

Standards exist at different levels, e.g.
- International
- Regional
- National




33

# Different kinds of metadata

Data and Metadata

- Metadata provides information about data holdings in catalogue form
- Key to MSDI user searches
- Reporting descriptive metadata is essential to promote geospatial data beyond traditional boundaries
  - Discovery metadata - What data sets hold the data I want?
  - Exploration metadata - Do the datasets contain information for my purposes?
  - Exploitation metadata – How do I obtain and use the data?

34

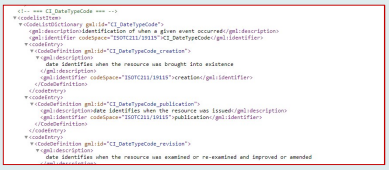
# Standards for Metadata

Data and Metadata

Technical Standards

- ISO19115 : a popular industry standard for metadata
  - " [ISO19115] provides information about the identification, the extent, the quality, the spatial and temporal aspects, the content, the spatial reference, the portrayal, distribution, and other properties of digital geographic data and services." ISO/TC211
- Dublin Core Metadata Initiative - open organization supporting innovation in metadata design and best practices across the metadata community
- FGDC (US) enables access to national SDI data through Content Standard for Digital Geospatial Metadata (CSDGM).

NOAA ISO19115 metadata



35

# Broader Use of Marine Geospatial data

"Just like statistics, every country must have authoritative, trusted, maintained, definitive mapping data" - Professor Paul Cheung, Director, United Nations Statistics Division, Geospatial World Forum Amsterdam, May 2013

36

## Part 2 – Broader Use of marine geospatial data

Contents:

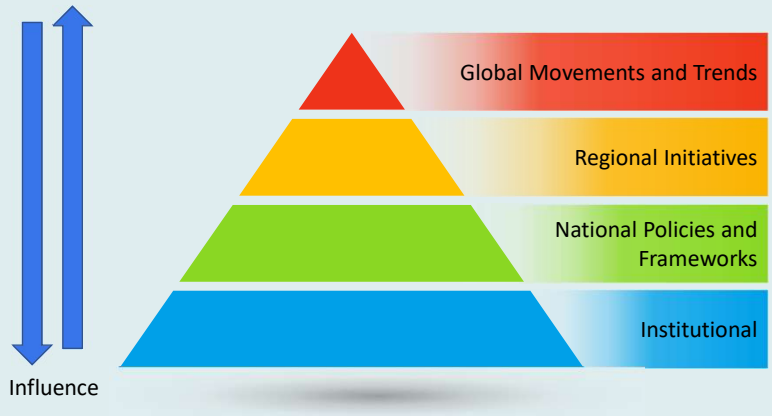
- The MSDI ecosystem:
  - The global, regional and national drivers which support MSDI development
- What MSDI means for end users
  - Broader use of marine geospatial data by MSDI user
- What MSDI means for participants
  - Transforming marine geospatial data agencies into MSDI participant

37

# The MSDI ecosystem.

38

# MSDI doesn't happen in isolation




UN-GGIM
GSDI Global Spatial Data Infrastructure Association
INSPIRE: Infrastructure for Spatial Information in Europe
ARCTIC SDI Arctic Spatial Data Infrastructure
MEIP
GOV.UK
NSDI
SG SPACE

39

# UN-GGIM

Data and Metadata

Technical Standards

Policy and Governance

SDGIO

SUSTAINABLE DEVELOPMENT GOALS

**14 LIFE BELOW WATER**

**SDG 14 TARGETS:**

**14.1** By 2025, prevent and significantly reduce marine pollution of all kinds

**14.2** By 2020, sustainably manage and protect marine and coastal ecosystems to avoid significant adverse impacts

**14.3** Minimize and address the impacts of ocean acidification, including through enhanced scientific cooperation at all levels

**14.4:** By 2020, effectively regulate harvesting and end overfishing, illegal, unreported and unregulated fishing and destructive fishing practices

**14.5:** By 2020, conserve at least 10 per cent of coastal and marine areas

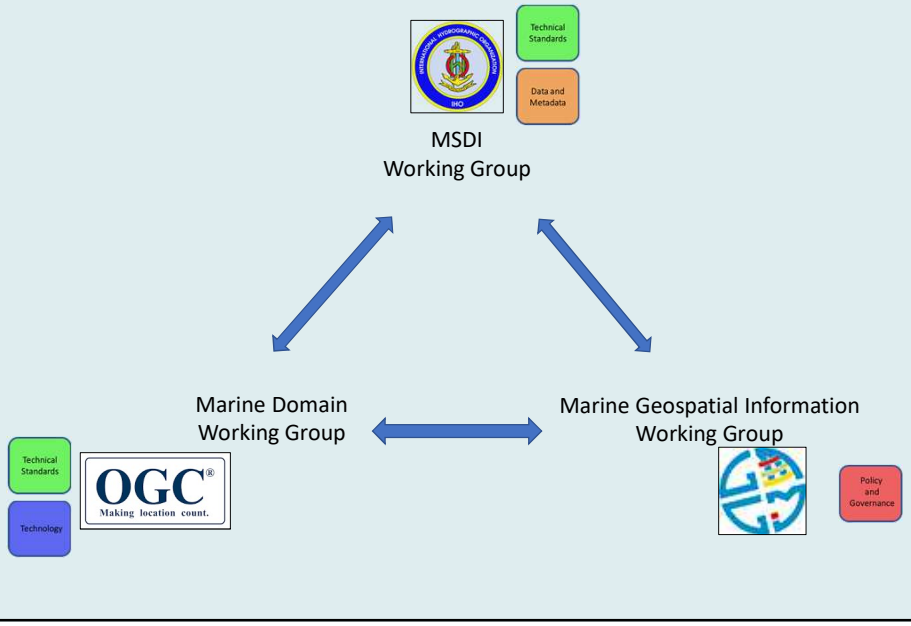
**14.6** By 2020, prohibit certain forms of fisheries subsidies which contribute to overcapacity and overfishing, eliminate subsidies that contribute to illegal, unreported and unregulated fishing

**14.7** By 2030, increase the economic benefits to Small Island developing States and least developed countries from the sustainable use of marine resources

SUSTAINABLE DEVELOPMENT GOALS
NEREUS PROGRAM

40

# IHO, OGC, UN-GGIM and MSDI




41

# UN-GGIM MGIWG

- In 2017 UN-GGIM, established the Working Group on Marine Geospatial Information
- Objectives:
  - Play a leading role at the policy level
  - Encourage the use of internationally agreed-upon information frameworks, systems and established standards
  - Support the UN Committee of Experts in development of principles, guides and standards to increase the availability of high-quality, timely and reliable geospatial information

42

# What does MSDI mean for end users.

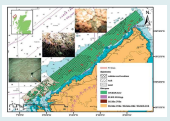
43

## User Benefits of MSDI

Fisheries Regulation

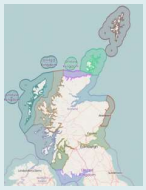
Leisure and Tourism

Emergency Planning and Response



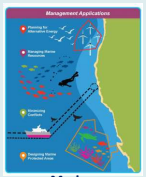
Coastal Zone Management

- Unlock the economic and environmental power of marine geospatial data
- MSDI provides reusable data to a broader audience for diverse uses



Maritime Boundaries Marine Protected Areas

Dredging planning and beneficial reuse



Marine Spatial Planning

Site Selection

44

# Case Studies (EU EMODnet)

https://bit.ly/2LlD63i


New sea cage designs for fish farming
Requires:
- Hydrographic
- Geological
- Water column
- Meteorological
- Biological


Coastal Erosion across Europe.
Requires:
- Detailed historical meteorological data
- Tide and current flows
- Water temperature
- Detailed coastal bathymetry

Siting and protection of offshore wind cables:
Protection from recreational craft, sand waves, rocks, dredging
Requires:
- Seabed type
- Bathymetry
- Historical installations
- Ambient temperature conditions

Technical Standards

Data and Metadata

45

# Marine Spatial Planning

"The process of analyzing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic, and social objectives"

Brings together users to make informed and coordinated decisions about how to use marine resources sustainably.

SDGS
14. LIFE BELOW WATER
17. PARTNERSHIPS FOR THE GOALS

46

# What does MSDI mean for participants.

47

## Being part of an MSDI

- Being a data supplier
  - Creating data suitable for reuse by many participants
- Supplying data
  - Ensuring policy is in place for reuse
  - Cataloguing
  - Creating metadata
  - Using open standards
- "Facilitating Access"
  - Through geo-portals

48

# Licencing and Reuse

Policy and Governance

- Vital to define a policy for reuse of data by MSDI users
- Policy and Governance
  - Defines how data can be re-used for various purposes, responsibilities, pricing, coverage and content
- Many differences between individual institutions, states and regions
- Must support business model

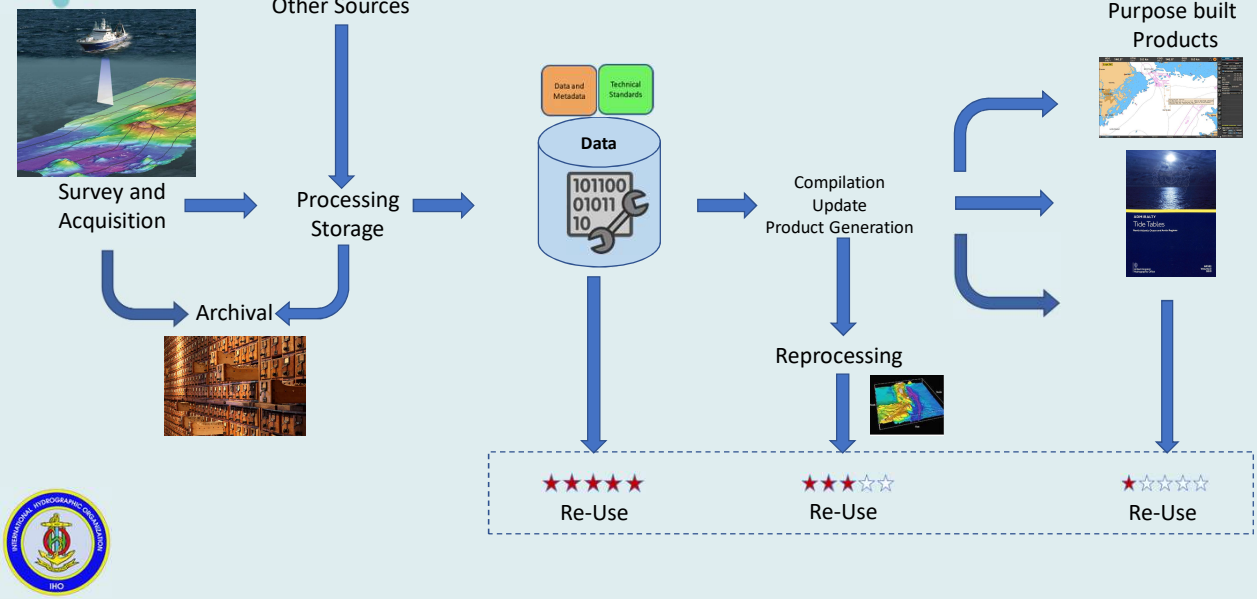
**2.3.3 Policy and legislation on access to and re-use of public sector information (PSI)**

The legal basis for access to public information is the Government Information Public Access Act of 31 October 1991. This act replaced the Act on Public Access to Information of 9 November 1978. It creates a presumption that documents created by a public agency should be available to everyone. The law provides for access to information that is crucial in the decision making process of the administration. The price to be paid for this information is based on dissemination cost. It is reasoned however that the electronic geographic data cannot be obtained through a request based on this Act. Government agencies can claim copyright or database right on their data and most of them do so. Moreover, citizens or businesses cannot access entire databases because - according to current interpretation- the Government Information Act does not apply to complete databases.

Example: Dutch framework

49

# Transforming a Marine Geospatial Agency

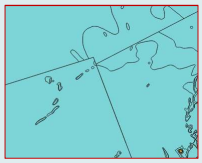



50

# "Products-centric" features in data

Data and Metadata

- Examples from Hydrographic ENC data
- "Product-centric" features found:
  - Sparse shoal-biased bathymetry
  - Paper chart specific encodings
  - Borders between features at chart boundaries
  - Non integrated vertical datums
  - Cartographic judgement e.g. "obstructions", "dangerous" wrecks
  - "INFORM" – text recording of unclassifiable data and attribution.
  - Non-uniform compilation scales – aimed at defined paper sizes.
  - Inconsistent generalisation rules.
- These features affect the reuse of the data by MSDI participants



If I pick data within a point of 1km are the borders included?

If I do get borders do the edges match?

51

# Data-Centric working

Data and Metadata

Data for MSDI must be as reusable as possible
- Multi-purpose
- Interoperable

Creating data for re-use is a challenge.
- Can take a long time
- Can be a fundamental shift for agencies

Data-Centric working is a central focus on data within an organisation.

Transformation into a data-centric organisation requires
- Cultural change
- Technology development
- Planned data engineering and transformation

52

# Implementing MSDI: Benefits

MSDI can benefit non-MSDI goals too:

- Data quality
  - Seamless data matches features across product boundaries
  - Improved vertical and horizontal consistency of data, better generalisation rules
  - Consistency of attribution across datasets
- Metadata focus
  - Focus on comprehensive catalogues and well documented data definitions
  - Metadata collection helps improve data management and increases efficiency of update processes
- Data-Centric working
  - Data-centric methodologies are at the centre of emerging Big Data, Machine Learning and Data Science technologies
- Encourages cooperation between agencies
  - Reduces duplication of effort in data collection

53

# What now? An example plan for MSDI

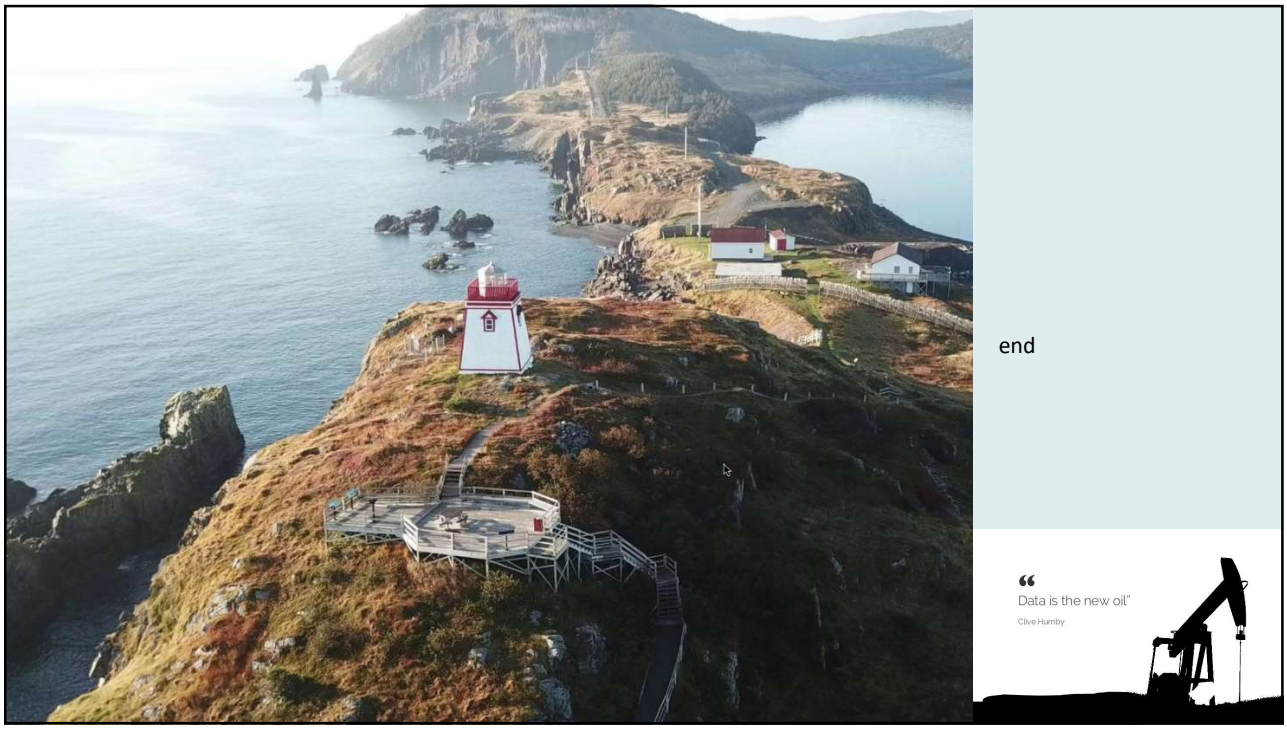
**Policy and Governance**
- Define policies for technology, standards and content to promote interoperability and reuse.
- Ensure the right team are in place to deliver MSDI
- Define business model so that MSDI can be delivered as part of organisation's mission
- Define and promote the organisation's part in the national, regional and global infrastructure.

**Technical Standards**
- Audit current standards in use
- Assess standards within the technical infrastructure
- Assessment of standards with closest partners and likely MSDI users
- Define a roadmap for interoperability and reuse using best practice standards.
- Define upgrade plan where required

**Technology**
- Define a technical architecture for the delivery of data to all users
- Make sure MSDI best practices are followed. Use national and regional best practices
- Design infrastructure that can be updated and upgraded as the MSDI evolves

**Data**
- Data Audit - What data is held? Evaluate completeness, consistency and metadata.
- Overlaps/duplication with other stakeholders?
- How ready for re-use is the data? What needs to be done. Compile action plan for data content.
- Is the organisation data-centric? What steps should be taken?

54




55

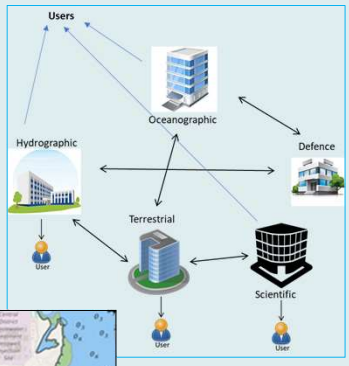
# Selected Exercises

- Institutional Responsibilities for the Coastal Zone
- Analysis of a marine plan and its sources
- Labelling of MSDI access points
- of participant’s MSDI

56

# Institutional Responsibilities for the Coastal Zone

- Construct a map of national institutions responsible for the coastal zone.
- Who is responsible for Data collection? Processing? Dissemination? Who are the primary customers?
- Are there duplicate responsibilities? Could the network be improved?
- Is there an existing MSDI?
- How does MSDI help?




57

**Challenge – think about the coast!**
**e.g.**
- **Environmental protection**
- **Maritime Efficiency**
- **Emergency response**

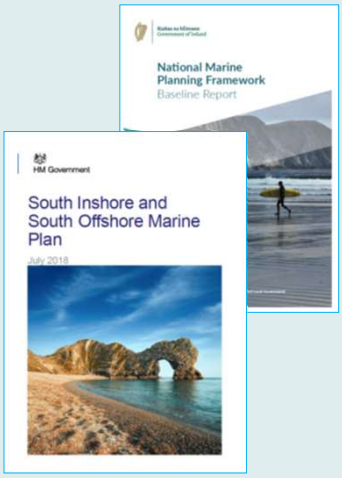
| | Issues | Challenges |
|---|---|---|
| Coast | • Complex physical and institutional relationships<br>• Hazardous regions<br>• Conflicting uses, activities and interests<br>• Contributions to socio-economic development<br>• Integration with coast/marine<br>• Data Gaps over coastal zone | • Harmonised, universal access<br>• Capacity building and funding<br>• Security and privacy issues<br>• Encouraging cooperation and culture for spatial data reuse |
| Land | • Interoperability<br>• Institutional arrangements | • Copyright, ownership, privacy and licencing<br>• Pricing and cost recovery |
| Marine | • Dynamic, temporal data<br>• Lack of framework for accessing and sharing<br>• Different level of accuracy, precision and consistency<br>• No description for legislative boundaries<br>• Inconsistent metadata<br>• Institutional arrangements | • Building partnerships<br>• Privacy and sensitivity |

- Presents many good examples of issues
- Frequently an interface between national agencies
- Data models likely to differ significantly
- Metadata representations
- Temporal nature of data

58

# Marine Plan Analysis

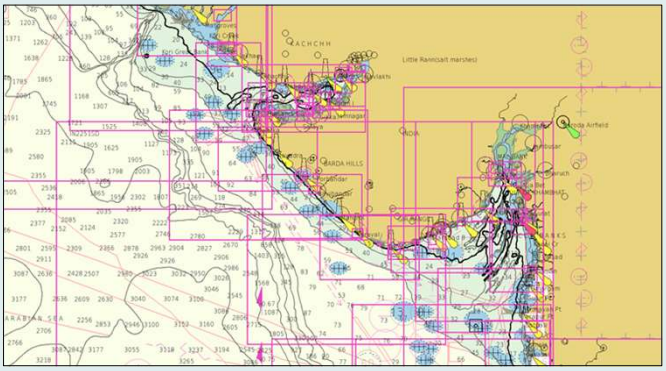
- Take a published Marine plan (or similar)
- Locate and analyse the geospatial data it uses
- Make a list detailing
  - What data is used?
  - Where it came from?
  - Was it compiled for the purpose of the plan?
  - Is it suitable?




59

# Exercise: Data design for reuse

What aspects of content (data and metadata) might affect reuse but don't affect primary use?

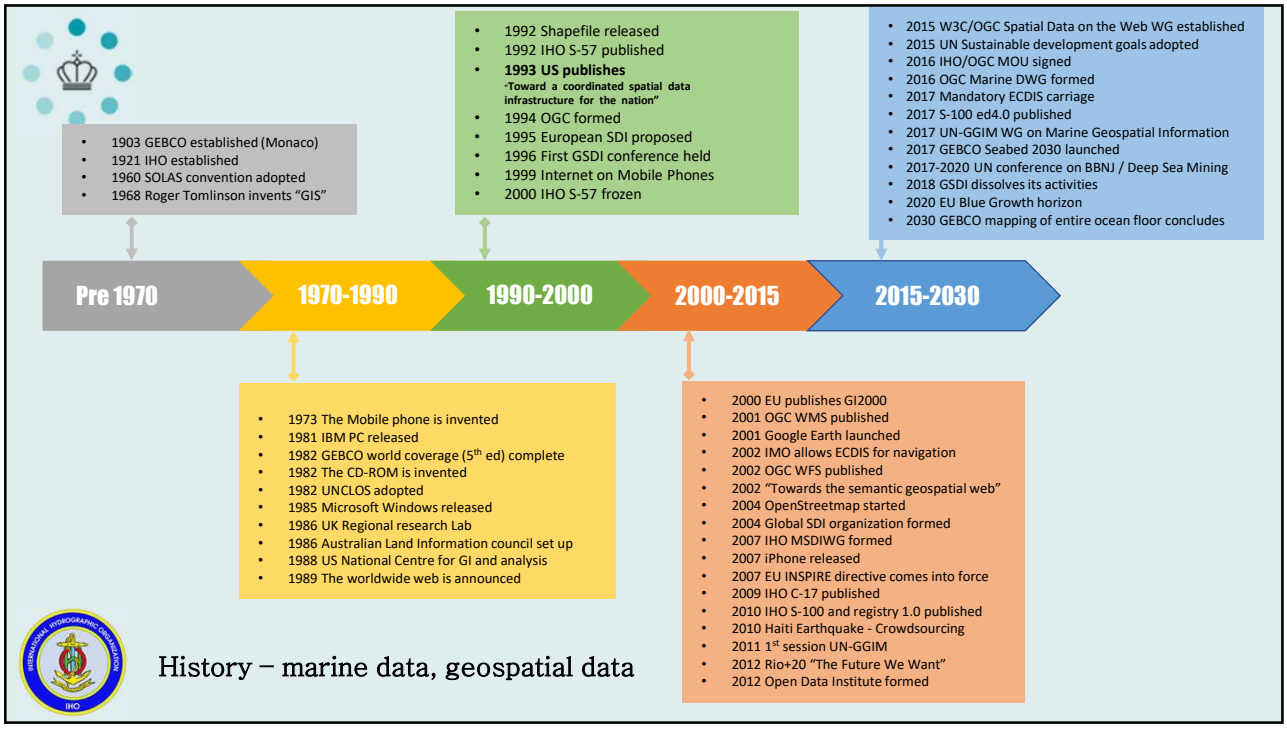


60

# Useful Annexes

Extra detail on selected topics

61




62

# Good Practices1 : Data Design for reuse

Data and Metadata

- Borderless, seamless data is best
- The importance of populated, consistent metadata
- Consistent content – catalogued and classified
- Store once – use many times
- Interoperable implies open standards for distribution
- Identified (persistent, unique identifiers)
- Data integrity – how does your end user know data is unchanged and complete?
- Remember technology comes and goes. Build in the ability to update as standards and infrastructure advance
- Thematic grouping of features

63

# Good practice2: Identifiers

INSPIRE:

- The creation of persistent identifiers for the spatial objects is one of the most crucial challenges in the implementation of INSPIRE and they are essential for the reuse of INSPIRE data by other communities.
- Implementers have to guarantee that the identifiers refer unambiguously to the same resources over time.
- Best practices need to be shared among different actors, aiming to the definition of commonly agreed encoding rules.

https://bit.ly/2CjXgrw Data Usability beyond conformance 2017

**Identifiers**

Identifiers are crucial to the process of sharing information. They are fundamentally important in being able to make connections between data, which puts them at the heart of how we create value from structured data.[108]

Geospatial identifiers provide unambiguous labels or reference numbers for the things described in a geospatial dataset, such as lamp-posts, roads, houses, or administrative areas.

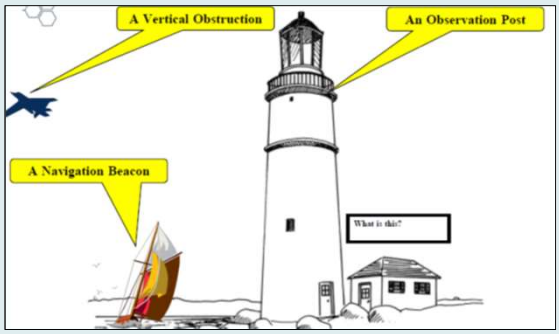
Heavily domain specific:

- IHO S-57 uses "FOID" but persistence is not mandatory
- Little interoperability with other domains
- Must be considered when constructing MSDI architecture
- IHO S-100 is looking at MRN (https://bit.ly/2R3KK7Q )
- There can be legal implications with Maritime Limits and IDs
- INSPIRE shows regional influences can help define issues

64

# Themes: groupings of data for re-use

- Many (M)SDI components group data into "themes" which are designed to enable use of data in a wider context
- Themes use the definition of features to group them by common characteristics
- Theme – a high level categorisation of subject matter (UN-GGIM)
- This can be highly subjective and domain specific however!




65

# Themes example 1 - EU

INSPIRE
- Themes grouped into three numbered annexes

ANNEX I
2. Geographical grid systems
4. Administrative units
8. Hydrography
9. Protected sites

ANNEX II
1. Elevation (includes bathymetry)
4. Geology (includes seabed sediments & coastal)

ANNEX III
7) Environmental monitoring facilities
9) Agricultural and aquaculture facilities
11) Area management / restriction / regulation zones (+ CZM)
12) Natural risk zones
15) Oceanographic geographical features
16) Sea regions
18) Habitats and biotopes
19) Species distribution
20) Energy resources
21) Mineral resources

EMODnet

Bathymetry | Geology | Seabed | Chemistry | Biology | Physics | Human activities

66

# Themes Example 2 – UN-GGIM

1. Global Geodetic Reference Framework
2. Addresses
3. Buildings and Settlements
4. Elevation and Depth
5. Functional Areas
6. Geographical Names
7. Geology and Soils
8. Land Cover and Land Use
9. Land Parcels
10. Orthoimagery
11. Physical infrastructure
12. Population Distribution
13. Transport Network
14. Water

UN-GGIM – July 2018


67

# Example: Reuse of hydrographic data

Hydrographic Data for reuse:

- Bathymetry
- Coastline
- Tidal data (heights and streams)
- Oceanographic data (e.g. sound velocity, salinity, temperature, currents)
- Aids to Navigation (e.g. lights, landmarks, buoys)
- Maritime information and regulations (e.g. administrative limits, traffic separation schemes)
- Obstructions and wrecks
- Geographical names (e.g. sea names, undersea feature names, charted coastal names)
- Seafloor type (e.g. sand, rocks, mud)
- Constructions/infrastructure at sea (e.g. wind farms, oil platforms, submarine cables, pipelines)
- Shoreline constructions/infrastructures (e.g. tide gauges, jetties)
- Practice, Exercise and Restricted areas.

68

# Focusing on Product elements of data

- Generalisation
- Quality and accuracy
- Subjective qualities – “Obstruction”, “Conspicuous”
- Duplication between providers around the coastline
- Reduction of clutter
- Product boundaries
- Names
- Encoding conventions
- Attribute Detail

69

# EU Maritime Spatial Planning (MSP)

Maritime Spatial Planning Framework Directive (2014)

- Promotes:
  - sustainable growth of maritime economies
  - sustainable development of marine area
  - sustainable use of marine resources
  - coexistence of relevant uses and activities
- Takes into account land-sea interactions
- Places obligations on member states to establish maritime spatial plans before 31 March 2021

Ecosystem based approach:
Aims for cross-sectoral and sustainable management of human activities to achieve an ecosystem in good condition - a healthy, productive and resilient condition so that it can provide the services humans want and need.

https://bit.ly/2Btoc6R Guideline for the implementation of ecosystem-based approach in Maritime Spatial Planning (MSP) in the Baltic Sea area

European MSP Platform

70

# EU MSP – a vision for a maritime space

European MSP Platform

Planning for various reasons
- Environmental protection
- Efficient maritime operations
- Managing activities within and across established limits and boundaries
- Facilitating Blue Growth

MSP cooperation at:
1. International Level – UNCLOS, OSPAR, Aarhus
2. EU Level – Legal and Policy Instruments
3. National / Bilateral level
4. Sub-Regional – stakeholder partnerships
5. Local Level – MSP partnerships and coastal Fora

Identifies 9 maritime sectors for focus
- Offshore wind energy
- Tidal and wave
- Coastal and maritime tourism
- Marine aggregates and marine mining
- Shipping and ports
- Oil and gas
- Cables and pipelines
- Fishing
- Marine aquaculture.

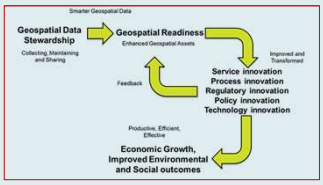
Maritime Spatial Planning (MSP) for Blue Growth https://bit.ly/2AdPfDp

Exercise: what kinds of data are required to enable ecosystem-based MSP?

71

# Marine data management

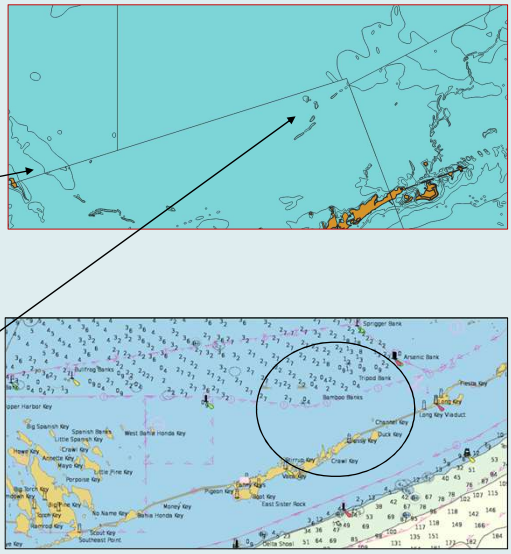
- Data management – how you manage, control, edit, and transform data before publishing is crucial.
- Integrates SDI elements into working practices
- Often the hardest part of getting data into a form suitable for multiple stakeholders, the "wider use" of MSDI.
- There is no single "formula" or fixed set of principles - a wide range of methodologies, processes and good practices apply. These are adapted into particular domains
- There are also "maturity models" which assess data management practices
- There are common themes




72

# Marine data – example data management issues

- Scale
  - Rarely uniform in marine data
  - Age of collection are often very broad
  - What happens at the borders of different scales
  - Vertical consistency
- Seamless-ness
  - Key differentiator between product-centric and data-centric.
  - If I pick data within a point of 1km are there borders included?
  - If I do get borders, do the edges match



73

# Example S-57 INFORM

Unstructured attribute encoding

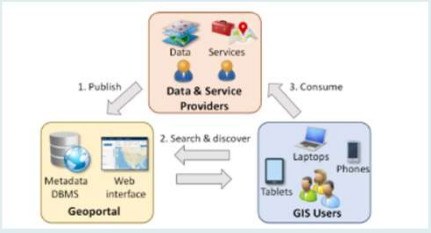
- BUISGL | Octagonal
- BUISGL | Small house
- LNDMRK | House
- LNDMRK | Towers
- LNDMRK | Old Tower
- LNDMRK | Lighted
- LNDMRK | House
- LNDMRK | Conical, lower half white, upper half black
- LNDMRK | House
- LNDMRK | Aband light house
- CTNARE | Most features, including bathymetry, are omitted in this area. The minimal depiction of detail in this area does not support safe navigation, mariners should use a more appropriate navigational purpose.
- CTNARE | Unexploded ordnance
- CTNARE | Numerous Platforms

- OBSTRN | Marine Protected Area
- CTNARE | Drilling rigs and pipeline construction in this area.
- OBSTRN | Reported
- OBSTRN | Shoal reported
- OBSTRN | Position approximate
- CTNARE | 27.4 to 31 meters/15 to 17 fathoms reported in 1960
- CTNARE | Unexploded ordnance reported in 1968
- CTNARE | Shoaling
- CTNARE | Unexploded ordnance reported in 1985
- CTNARE | Recommended routing to reduce the likehood of ship strikes of endangered whales are in effect within this area. See larger scale charts.
- CTNARE | Reported in 1947
- CTNARE | Dangerous shoal

74

# Metadata

- Metadata provides information about data holdings in catalogue form
- Organises and maintains an organisation's investment in data acquisition and production
- Coordinated metadata development avoids duplication of effort by making SDI users aware of the existence of data sets
- Metadata is the key to search functionality
- Collection of metadata facilitates good data management
- Reporting descriptive metadata is essential to promote geospatial data beyond traditional boundaries



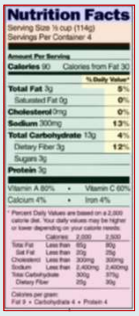

- Discovery metadata - What data sets hold the sort of data I am interested in
- Exploration metadata - Do the identified data sets contain sufficient information to enable a sensible analysis to be made for my purposes?
- Exploitation metadata – What is the process of obtaining and using the data that are required?

- Metadata drives the most popular SDI usage architecture
- "Publish" – "Find" – "Bind" pattern
  1. Providers publish metadata of their services through a geoportal
  2. Users search and discover results
  3. Users consume data from the providers.

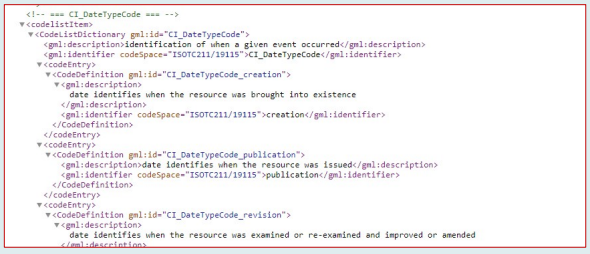
75

# Metadata：ISO19115

- ISO19115 : a popular industry standard for metadata
  - " [ISO19115] provides information about the identification, the extent, the quality, the spatial and temporal aspects, the content, the spatial reference, the portrayal, distribution, and other properties of digital geographic data and services." ISO/TC211
- Dublin Core Metadata Initiative - open organization supporting innovation in metadata design and best practices across the metadata community
- FGDC (US) enables access to national SDI data through Content Standard for Digital Geospatial Metadata (CSDGM).




FGDC.GOV
FEDERAL GEOGRAPHIC DATA COMMITTEE




NOAA ISO19115 metadata

76

# A case study – establishing MSDI

- From National Spatial Data Infrastructure: The Case of the Republic of Korea (https://bit.ly/2GofIn8 ) which documents the Korean development of a national SDI.

| SDI component | Lessons learned | Recommendation |
|---|---|---|
| Data | In South Korea, an over-emphasis on data accuracy has retarded the development of SDI. Harmonizing a concept of data quality in users' perspective with suppliers' perspective is important for data production, usages and various applications<br><br>Harmonization of cost with quality is important.<br><br>The strategies for data updating must be considered during initial data-building to prevent duplicated investment for revision and data updating. | Efforts to bridge gaps between assessing formal institutional data quality and informal real usage for business<br><br>For example, using digital ortho-photo, satellite image or new surveying technology can be preferable to using traditional surveying methods.<br><br>For rapid return on investment, the selection of maps at proper scale and decision on data building method will need to be reviewed.<br><br>Tools such as UFID for efficient and real-time updating will be useful. |

77

# Example: obstacles and mitigations

| Category | Lessons Learned | Mitigation |
|---|---|---|
| Data | Harmonising cost with quality is important and an over-emphasis on data accuracy can impact project timescales. Updating must be considered during initial phases | Ensure realistic goals for data quality levels are reached at outset and appropriate source methods are identified. Use of appropriate tools for updating att an early stage |
| Standards | Standards take time to develop and delays can impact projects and interoperability | More strategic standardisation efforts and use of external resources like USGS bluebook as "guidance resources" |
| Technology | Development of appropriate GIS technologies is a high priority | Educational programs for GIS are crucial. Strategic use of open-source technology. Strategic and rapid development of selected technologiers for developing countries' SDI is recommended. |
| Policy | Balancing Administrators and GIS experts as decision makers. Similarly between GIS and survey community resulting in accuracy prevailing over fitness for use which holds GIS development back. | Legislation at national and local levels is required for SDI defining clear roles and responsibilities. Participation by GIS experts in policy-making is required. Strategic and sustainable master plans for SDI required |
| Access and Metadata | online and offline distribution networks are essential for successful SDI. | Standards for metadata and data catalogue are required. Encourage adoption of VGI by spreading knowledge of data availability and access. |
| Applications | Users are making their own GIS applications using Open API services | Master plan should prioritise GIS applications and provide interoperability for them through geoWeb platform |
| Partnerships | Lack of organisational partnerships | Institutional reorganisation and regulations are required to promote powerful organisational partnerships. |

From National Spatial Data Infrastructure: The Case of the Republic of Korea (https://bit.ly/2GofIn8 ) which documents the Korean development of a national SDI.

78

# Next Steps – An MSDI involvement plan

Develop a step by step approach for MSDI involvement (from IHO C-17)

- Prepare and define policy (IHO example)
- Identify MSDI "champions" at senior level
- Identify key HO stakeholders and their requirements and build support.
- Identify national and regional initiatives and legislation
- Profile other data providers to the MSDI in detail
- Plan engagement and reach out to other stakeholders and data providers
- Promote the MSDI benefits and opportunities via "white paper"
- Promote benefits internally.
- Develop a work plan to move to data-centric operations. Plan how to address each of the MSDI components

- Organisations which can assist
  - Standards Development Organisations
  - Global working groups
- Testbed projects
- Stakeholders
  - Standards experts
  - National mapping agencies
  - Govt Contacts
  - End Users
  - IHO – working groups and RHC
  - Regional SDI
  - GSDI organisation
  - Scientific
  - Marine/maritime organisations

79

# Where am I? – SDI readiness model

- How does an organisation measure SDI readiness?
  - Of itself
  - Of the state or region in which it is located
- There are several models developed
- SDI development / maturity can be measured against a number of factors:

**SDI Readiness**
A basic seven tier classification system is used — from Extremely High to Extremely Low.
The SDI index is built on measurements of:
- Organisation
- Information
- Human resources
- Technology
- Financial resources

**UN readiness toolkit (2017)**
- Standardised assessment of SDI readiness
- Based on 9 categories:
  - Policy and Strategy
  - Governance
  - Legal Framework
  - Acessibility and Technical Infrastructure
  - Socio-economic impact
  - Capacity Development
  - Use of NSDI and applications
  - Core UN-GGIM datasets
  - Thematic datasets

**INSPIRE "State of Play" (2002-)**
Measures whether SDIs (in EU) have five key components of SDI:
- Legal framework
- Geographic data
- Metadata
- Access services
- Standards

Repeated every year and results collated.

This is also an exercise! – Evaluate your SDI readiness – nationally / regionally...

80

# Where am I? – Readiness vs Performance

- Are you measuring Readiness or Performance of MSDI?
- Once MSDI is implemented performance should be measured periodically
- This assesses if the SDI is meeting its objectives
- Can flow into periodic requirements for funding required by policy/governance frameworks.

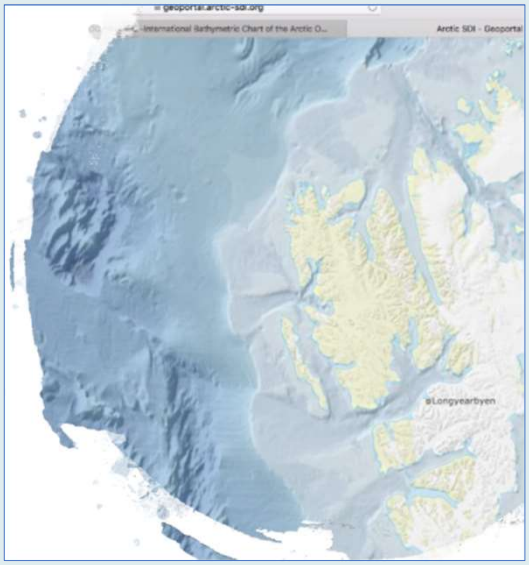
**Balanced Scorecard:**
Measures and monitors SDI performance over time. Measures:
- Data and Services: The availability and access to spatial data via the SDI
- User Satisfaction: the level to which the user community is satisfied with data and services
- Cooperation: Willingness of stakeholders to participate.

81

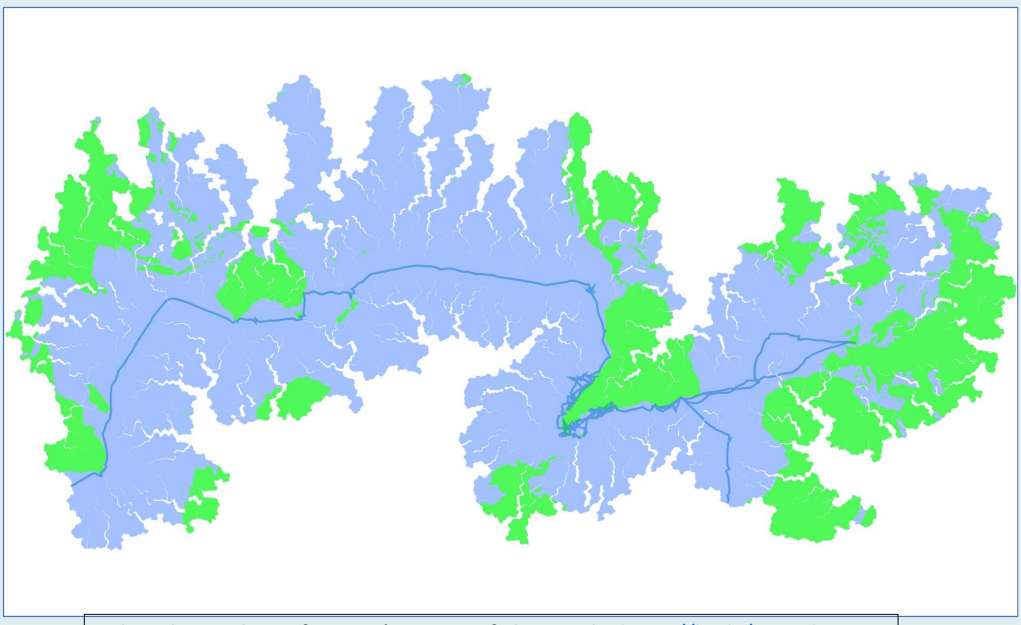
# Regional: Arctic SDI

- Arctic SDI is a collaborative partner-based effort by the National Mapping Agencies of the eight Arctic Countries
- The Arctic SDI Geoportal allows:
  - Data visualization
  - Access to a searchable Metadata Catalogue
  - The Arctic Topographic Basemap – an authoritative Arctic reference map brought together from National Mapping Agency data
  - Authoritative thematic Arctic map data
  - Services:
    - place name search
    - embedded maps to use in own web sites

http://geoportal.arctic-sdi.org



82



A data-driven chart of Darwin's voyage of The Beagle. https://bit.ly/2rJIXXb

83