IHO Special Publication S-XX

Spatial Data Infrastructures

"The Marine Dimension"

(Guidance for engagement by Hydrographic Offices)

### IHO MSDI Working Group
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1. Introduction

This document has been produced by staff employed in Hydrographic Offices on behalf of the IHO for the benefit of all Member States. It seeks to contextualise the way MS's might promote their support for, engagement with and participation in Spatial Data Infrastructures (SDI's) across the World. It is not definitive in its nature preferring instead to provide guidance on how best to achieve this through practical advice, simple step by step processes, useful links to reference material and examples of best practise.

Much has already been written about SDI but primarily from a land based perspective. However, this reference material comprises policy guidelines that are universal not sector specific (e.g. GSDI guidelines). Rather than repeat this information at length, the relevant literature reviews are cited at the back of the document. The reader is encouraged to consult this information before proceeding with SDI engagement.

2. What is a Spatial Data Infrastructure (SDI)?
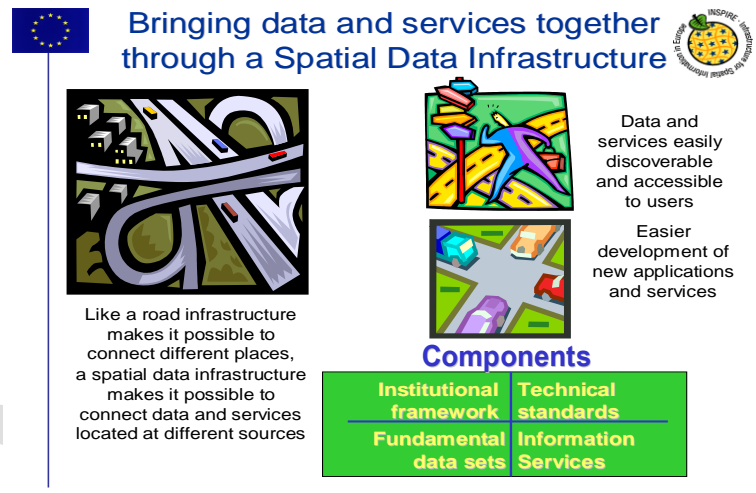
A Spatial Data Infrastructure is a term used to summarise a range of activities, processes, relationships and physical entities that, taken together, provide for integrated management of spatial data, information and services. The term covers the processes that integrate technology, policies, criteria, standards and people necessary to promote geospatial data sharing throughout all levels of Government. It embraces the structure of working practices and relationships among data producers and users that facilitates data sharing and use. It covers the set of actions and new ways of accessing, sharing and using geographic data that enable far more comprehensive analysis at all levels of government, the commercial and not-for-profit sectors and academia. It also describes the hardware, software and system components necessary to support these processes. SDI's are now being developed at the National level (NSDI) and at the Regional level (RSDI) supported by Governments, practitioners and users.

3. What constitutes a SDI?

SDI is a framework comprising the following key components:

3.1 Policy
There needs to be a policy to create information that is interoperable. This is often linked to a nations or organisations strategy for sharing and exchanging geographic information.

3.2 People & Organisations
There needs to be willingness and practical co-operation between the various organisations that create, share and use information to implement the overall policy.

3.3 Enablers
Enablers are essential building blocks in the development of SDI's providing the framework for data acquisition, management and updating. Examples include:

- Standards; Standards for geographic information are being created internationally (ISO19xxx, OGC) and in many areas sector based standards reference to these standards (e.g. S-100).

- Geodetic Reference System; the horizontal and vertical datum to which geospatial information (content) is referenced and the coordinate transformations between systems.

- Metadata; at its simplest metadata is 'data about data' and describes the characteristics of a dataset (i.e. content, value and limitations).

3.4 Content
Content (digital data) is at the core of SDI and should ideally be application-neutral thereby ensuring that it meets the needs of the widest user base. Users should have immediate and easy access to up to date, accurate and appropriate information that is linked to other information in a way that reflects how it exists in the real world. Content can be described in the following way:

- Reference Information; Geographic features that are used as a location reference for application information or are used in geographic analysis by a majority of users. Reference information is formed of base and associated reference information.

- Application Information; Any business-oriented information that requires connectivity through a geographic reference of some kind (such as a building, field, road or user defined feature such as a property parcel) to enable the end-user to analyse and interpret the integrated information from different sources.
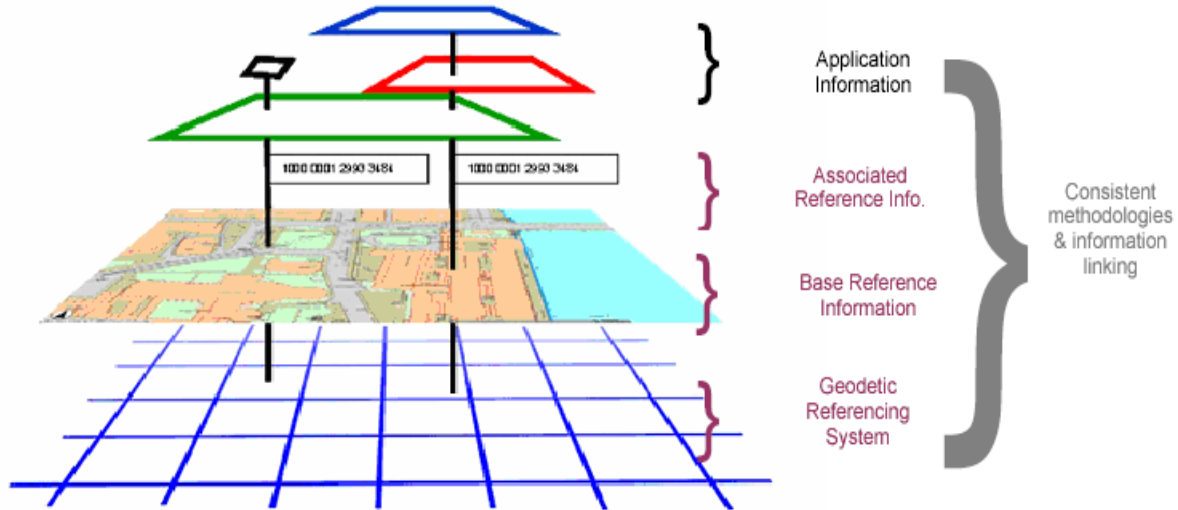
Figure 1 Layers of content within a SDI (Source: DNF [UK] 2004)

4. What is Marine Spatial Data Infrastructure (MSDI)?

Marine Spatial Data Infrastructure (MSDI) is the component of NSDI that encompasses marine geographic and business information in its widest sense. This would typically include seabed topography (bathymetry), geology, marine infrastructure (e.g. wrecks, offshore installations, pipelines and cables etc); administrative and legal boundaries, areas of conservation, marine habitats and oceanography.

5. What role should the Hydrographic Office have in SDI?

The Hydrographic Office (HO) is uniquely placed to play a central role in the development of the marine component of all SDI's. Hydrography, with its subset of data themes, forms the key "base reference" or "core geography" layer for the sea space in that particular country or region. In this capacity, HO data will provide a rich and unparalleled resource for users at all levels.

Some HO's will already have engaged; others will be considering engaging and how such engagement would benefit both the HO and other marine/ maritime data providers. Some will be seeking ways of improving their knowledge and understanding of SDI. This document provides guidance, references, examples of best practise and support in making the right choices whether that HO is, or seeks to take, a leading role in SDI development or whether that HO seeks to support an existing SDI initiative or work with others to develop a SDI.

The IHO therefore recommends that all Member States consider how they might engage and play a full role in the development of the marine elements in their respective SDI's.

6. What are benefits and opportunities to the HO in supporting their NSDI?

6.1 Benefits

It is recommended that HO's engage with stakeholders involved in their NSDI. By doing this the following benefits will be realised:

- access to resources and funding will be stimulated
- data management practises will be improved
- market exposure for information outside of navigation
- additional revenue generation will be identified
- promotion of more effective use of public funds
- the HO will not be organisationally isolated
- co-operation and working together will be enabled
- security in data use and reduction of risk will be identified
- cost savings through efficiencies will be identified and realised

6.2 Opportunities

By engagement, the following opportunities will be presented to the HO:

- The greater appreciation of the inherent value in HO information which will lead to the wider use of its digital data and information in the development of new products and services
- The elimination of data silo's
- Increased efficiencies in organisational processes
- Increased efficiencies in data collection and management by reducing duplication and encouraging co-ordination
- Improved decision making (e.g. managing and mitigating the impacts of natural disasters such as tsunami, flooding and climate change)
- The prestige of being part of the SDI "club"

7. What are the challenges the HO may face when engaging with their NSDI?

- A lack of funding to progress their involvement in NSDI
- Persuading decision makers and budget managers to support this

- Gaining the trust of other stakeholders
- Ensuring the HO has the knowledge, training and skills
- Being able to work with other organisations and adopting a partnership approach
- Changing the organisational culture by winning over the sceptics at the people and / or organisational level
- Working together to develop new joint policy approach to NSDI
- Challenging the way things are currently done to ensure they are undertaken more effectively in the future?

8. What steps should the HO take to become involved in SDI?

1. Identify the SDI "champion" for involvement or leadership (this could be at Ministerial or Senior Management level)
2. Identify key HO stakeholders
3. Identify National or Regional initiatives/legislation which might support SDI
4. Engage with the IHO Regional Hydrographic Commission as a stakeholder
5. Identify other data providers to the SDI:
    a. Who are they?
    b. Who are the key people in that organisation to engage with?
    c. What is their data?
    d. How does that data complement that of the HO?
    e. What do they expect from HO involvement?
    f. How do they interact with other organisations in the SDI?
    g. What are their data sharing and exchange protocols?
    h. Invite other data providers to get involved with you
    i. Plan engagement with stakeholders and all other marine / terrestrial data
6. Providers
7. Work to get stakeholder buy-in (e.g. users, influencers, enablers)
8. If the NSDI is new; (assist in the) preparation of a "White Paper" for discussion and comment at both Ministerial and Senior Management level across all stakeholders (only if HO is the lead organisation in new SDI)

9. Sell the benefits and opportunities to everyone

10. Gain necessary HO approvals for involvement (through benefits and opportunities)

11. Set up and / or participate in stakeholder groups (for example; Steering Group)

12. Scope the work plan required complete with timescale (in the form of a Business Case)

13. Engage, respond, communicate

14. Deliver SDI with HO involvement

9. Suggested content for the SDI Business Plan

- Data Management policy; this will probably include policy and plans necessary to deliver metadata, data sharing and exchange mechanisms, levels of data interoperability, network services including "discovery", "view", "download", "invoke" and "transform" and plans necessary to ensure compliance with SDI requirements (E.G. data licensing, geo rights management, pricing)

- Geographic Reference Systems: Identify which reference systems (both horizontal and vertical) are used, any datum issues (if any) and how they might be resolved and how they relate to the needs of users

- Content: Identify those themes of data identified in the SDI as "core" or "reference" information (e.g. bathymetry; seabed characterisation; coast line)

- Standards: Define which standards the HO is already compliant with and those it is not (see Para 3.3)

- Knowledge and Skills: Identify where skills and knowledge is deficient and plan in necessary training and support and where this might be sourced.

- Monitoring and Reporting: Describe how the HO will report progress against the plan, to whom it will report and when
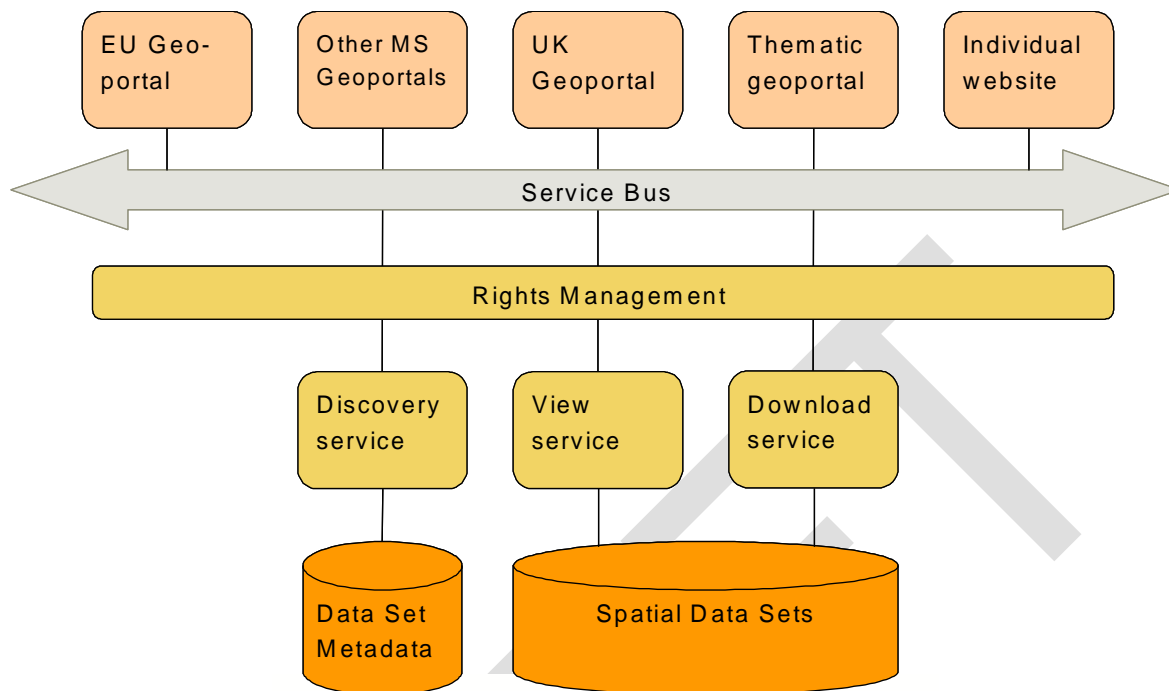
Fig 2: Illustrative federated data model: a key principle of SDI is to publish data once and use many times

10. Data

In order for the SDI to operate at its optimum level, minimum requirements in terms of data management will be required. This is not an onerous task as HO's will be able to define which data is relevant and at what level they wish to provide data.

HO's should be considered to be the competent authority in the provision of Hydrographic data under a National and / or Regional Spatial Data Infrastructure.

10.1 What data are relevant to SDI?

Hydrographic Office data which **should** be part of an SDI relates to any navigational or other[1] water body:

- source data (e.g. dense bathymetric data) and / or
- product data (e.g. ENC data, digital nautical publications) complete with
- metadata (data about data)

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[1] This remit will depend on the constitution of the individual HO

10.2 Other data issues to consider

- Data ownership: Spatial description should optimally be in one single database (feature custodian database) enabling different linked attributes to be held in other databases
- Raster or vector data: If vector data topology is provided it should be described in terms of points, lines, polygons
- Coordinates (e.g. xyz)
- WGS-84 datum
- Vertical Datum (local and regional)
- Time [t] as a vector element
- Conformance to standards: S-57, S-100, ISO 19100 series, OGC standards

11. Coordinate Reference Systems (CRS)

The identification of CRS information from a register of geodetic parameters is an efficient means of transmitting the CRS definition of a geographic dataset. Every CRS definition in the register is given a unique identifier and, if the register is online with a service interface, a computer can interrogate the register to obtain the CRS information (Iliffe and Lott 2008). In addition to CRS definitions a register of geodetic parameters may also contain uniquely identified definitions of coordinate operations.

Online registers of geodetic parameters are important components of SDIs providing both machine and human readable interfaces to their contents.
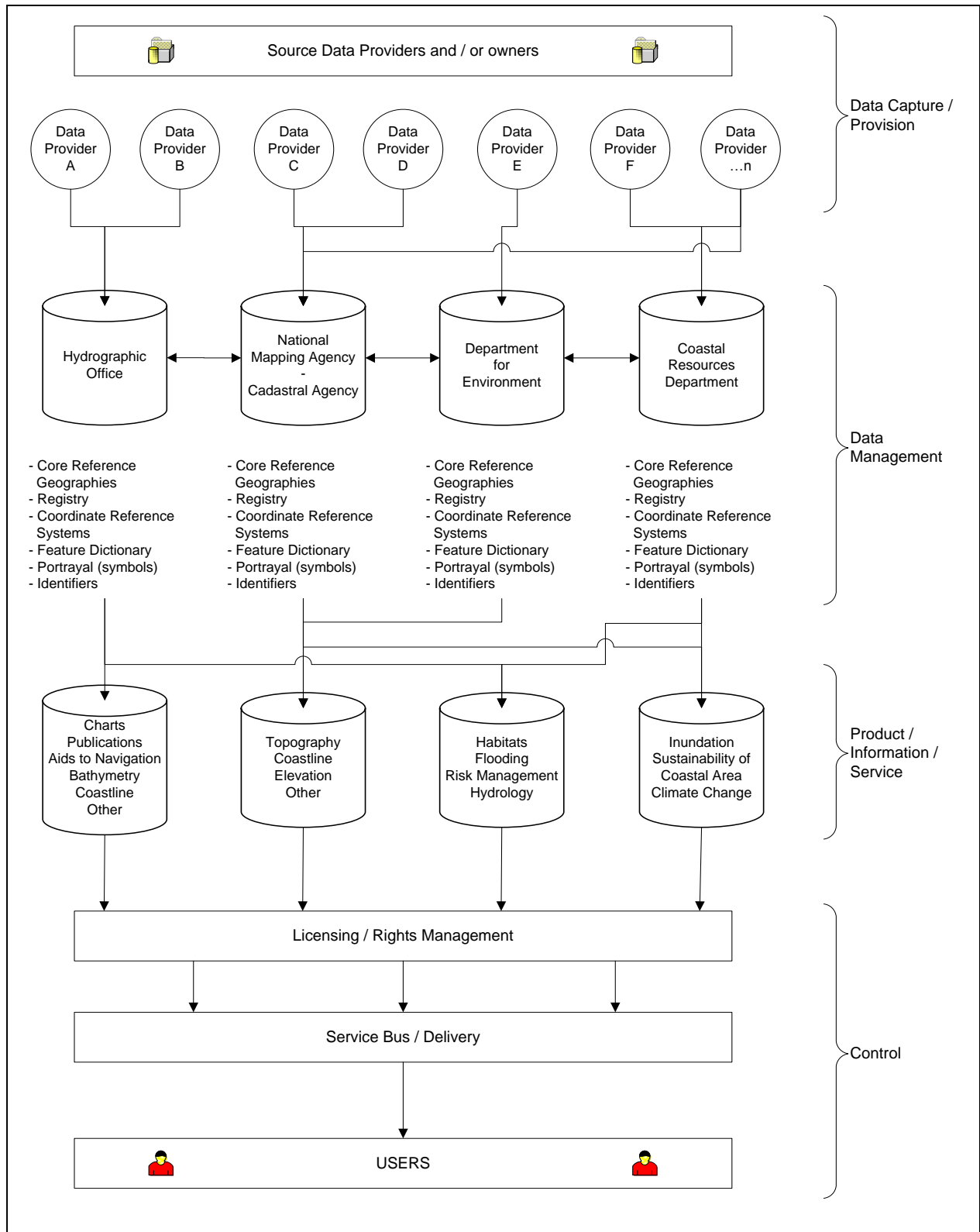
Figure 4: Illustrative Marine Spatial Data Infrastructure Data Management Flow Diagram

12. Content

Types of hydrographic data (by theme) **may** include:

- Bathymetry
- Coast line
- Tidal data (heights and streams)
- Oceanographic data, e.g. sound velocity, salinity, temperature, currents
- Aids to Navigations, 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)
- Shoreline constructions/infrastructures (e.g. tide gauges, jetties) *where not part of Land Mapping SDI input*

13. Standards

14. Knowledge and Skills

15. Monitoring and Reporting

16. Illustrative step by step approach to establishing a SDI capability

- Identify what data you hold, where its held and how it is held

- Assign metadata to the data (e.g. at the very minimum to include a Minimum Bounding Rectangle in Latitude and longitude to provide the geospatial reference)

- Make the metadata searchable through a search engine initially on your website (but ideally through SDI Geo-portal if available)

- Include the search engine capability on the SDI??? web page

- Establish a licensing regime supported and underpinned where required by government policy

- If you have not already done so, capture data sets in **digital form** (e.g. scan manuscript documents into TIFF, GeoTIFF or JPEG format ensuring that the scan density is such that the user community can use it without resorting to the hard copy to resolve readability)

- Capture data as close to source scale or highest resolution as possible (i.e. not at product scale)

- Capture the data in vector format
  - where possible use optical character recognition methods or
  - capture using double digitisation to ensure the quality and completeness of data capture (e.g. hand-drawn soundings)
  - ensure rigorous checking and validation is in place

- Update the metadata search facility to identify raster or vector data availability

- Develop download facilities for data sets (as flat files)

- Develop automated search and download of data sets via web mapping services

- Develop a seamless validated database of vector data using international standards (e.g. S-57 or S-100 feature data dictionary or data model)

- Where security of data is an issue, develop an acceptable level at which data can be made available either in-country or internationally. This may involve data thinning or gridding to a level where data might be declassified.

- Facilitate automated search and download of data via web feature services.

17. Hydrographic Information as part of an NSDI
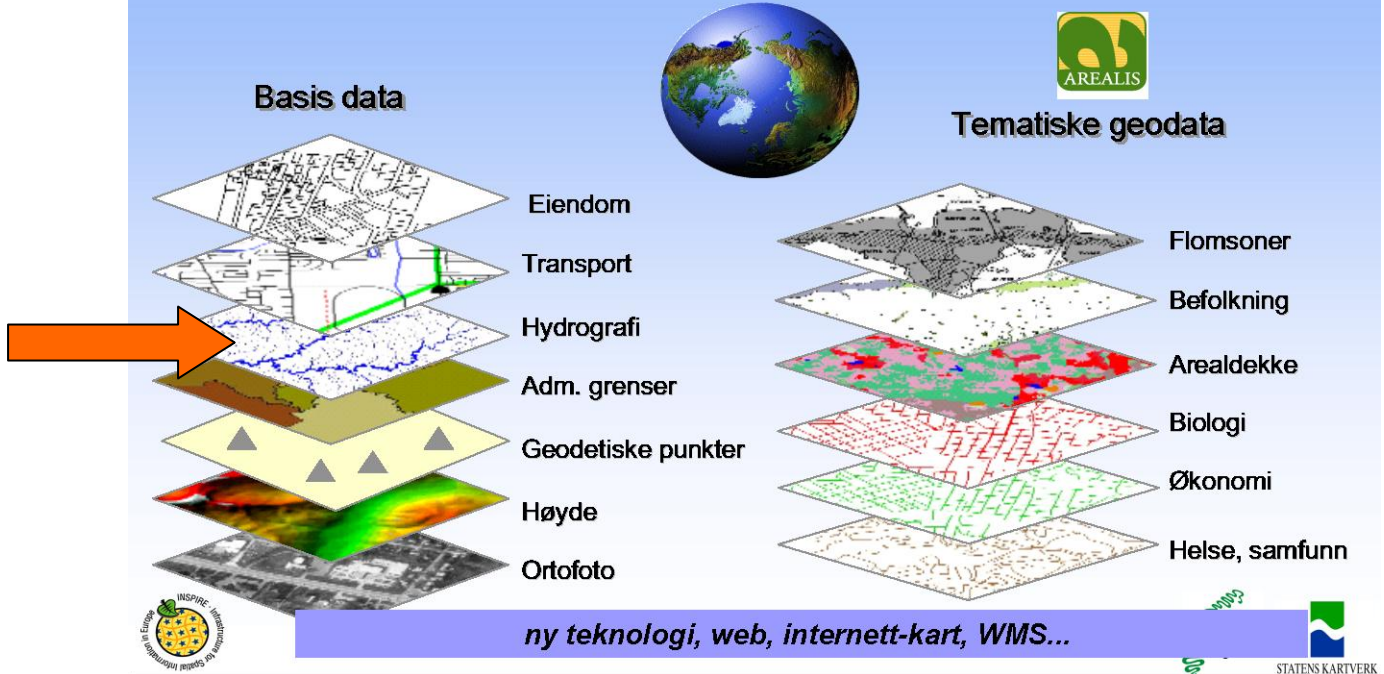
Annex A

SDI References

General: Global Spatial Data Infrastructure (GSDI) Association: *Developing Spatial Data Infrastructures – The SDI Cookbook - Version 2.0 dated 25 January 2004.* This SDI Implementation Guide or Cookbook provides geographic information providers and users with the necessary background information to evaluate and implement existing components of SDI. It also facilitates participation within a growing (digital) geographic information community known as the Global Spatial Data Infrastructure (GSDI). The Cookbook is an excellent guide/introduction to SDI theory and practice. http://www.gsdi.org/docs2004/Cookbook/cookbookV2.0.pdf http://www.gsdi.org/gsdicookbookindex.asp

Australia: Regional SDI development www.anzlic.org.au (Spatial Information Council for Australia and New Zealand)

Belgium: GIS-Flanders - www.agiv.be Walloon SDI and Geoportal – www.cartographie.wallonie.be

France: Marine SDI - http://www.geoconnexion.com/geo_news_article/CARIS-Marine-SDI-Solution-for-France/3260

Germany: EU SDI ⇨ Federal SDI ⇨ Regional SDIs (16) ⇨ Local SDIs (1,000s) www.gdi-de.org/de/f_start.html

UK: MEDIN (Marine Environmental Data and Information Network); a UK wide partnership working together to improve access and stewardship of marine data (merger of MDIP [http://www.oceannet.org/mdip/index.html] and MEDAG). New website and portal currently being developed.

Canada: GeoConnections helps decision-makers use online location-based (or "geospatial") information, such as maps and satellite images, to tackle some of Canada's most pressing challenges. The program focuses on working with partners in public health, public safety and security, the environment and sustainable development, Aboriginal matters, and geomatics technology development. http://www.geoconnections.org/Welcome.do

Norway: Norway Digital - the national geographical infrastructure: http://www.statkart.no/Norge_digitalt/Engelsk/About_Norway_Digital/

Norway digital is the Norwegian government's initiative to build the national geographical infrastructure. Norway digital is already a working co-operation and infrastucture with reference data and thematic data available, more than 100 operational web map services, geoportal and other services. Thus Norway digital is an existing implementation of the infrastructure described by the European Inspire-directive.

Northern Ireland: GeoHub NI is being developed as part of the Geographic Information (GI) Strategy for Northern Ireland. http://www.geohubni.gov.uk/

Spain: The Spatial Data Infrastructure of Spain (Infraestructura de Datos Espaciales de España, IDEE). http://www.idee.es

Sweden: A National Geodata Strategy including a new "gedoadata.se" portal currently under construction. A business model is being produced for introduction in 2010. http://www.geodata.se/en/

USA: The Federal Geographic Data Committee (FGDC – http://www.fgdc.gov/) is an interagency committee that promotes the coordinated development, use, sharing, and dissemination of geospatial data on a national basis. This nationwide data publishing effort is known as the National Spatial Data Infrastructure (NSDI – http://www.fgdc.gov/nsdi/nsdi.html).

Europe: Humboldt Project - a four-year EU project contributing to the implementation of a European Spatial Data Infrastructure (ESDI) that integrates the diversity of spatial data available for a multitude of European organisations. It is the aim of the project to manage and advance important parts of the implementation process of this ESDI. http://www.esdi-humboldt.eu

Europe: INSPIRE - The purpose of this Directive (legislation) is to lay down general rules aimed at the establishment of the *INfrastructure for SPatial Information in the EuRopEan Community* for the purposes of Community environmental policies and policies or activities which may have an impact on the environment. http://inspire.jrc.ec.europa.eu/

Regional SDI Initiatives / Networks:
                Europe European Spatial Data Information Network (ESDIN) http://www.esdin.eu/
                Asia Pacific Permanent Committee for GIS in Asia Pacific (PCGIAP) http://www.pcgiap.org/

Africa Committee for Developing Information - GI Sub Committee (CODI-Geo)   http://www.uneca.org/disd/geoinfo/main.htm
Permanent Committee on SDI for the Americas (PCIDEA)
Caribbean Regional SDI Coordination Body   [in preparation]

Other References

Iliffe, J and Lott, R (2008) "Datums and Map Projections": Whittles Publishing, Dunbeath

ANNEX B

Uses of HO data

- Habitat mapping & heritage assessment
- Conservation assessment & designation
- Site selection and route optimisation
- Vessel location and disposal monitoring
- Homeland security and defence
- Aggregate extraction
- Fisheries regulation
- Coastal protection & shoreline management
- Licensing & consent evaluation
- Emergency planning & management
- Survey planning & execution