Report of International Coastal Atlas Network Workshop 3 on Federated Coastal Atlases: Building on the Interoperable Approach

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Acronyms

ACEP	African Coelacanth Ecosystem Programme
API	Application Programming Interface
BODC	British Oceanographic Data Centre
CAI	Coastal Atlas Interoperability
CF	Climate Forecast
CMRC	Coastal and Marine Resources Centre
COMPASS	Coastal Marine Perception Application for Science Scholarship
COTS	Commercial-Off-the-Shelf
CPMR	Conference on Peripheral Maritime Regions
CSW	Catalogue Services for the Web
CV	Controlled Vocabulary
CWA	Coastal Web Atlas
DBMS	Database Management System
DEDUCE	Développement durable des Côtes Européennes (Sustainable Development of European Coastal Zones)
DG	Directorate-General
DISMAR	Data Integration System for MARine pollution and water quality
DOI	Digital Object Identifier
DRM	Digital Rights Management
EC	European Commission
EEA	European Environment Agency
ECOOP	European Coastal-shelf Sea Operational Observing and Forecasting System
EDINA	Edinburgh Data and Information Access (University of Edinburgh, UK)
EDMS	European Data Management System
EIONET	European Environmental Information and Observation Network
EMMA	European Monitoring and Assessment
ENCORA	EuropeaN platform for Coastal ReseArch
ESRI	Environmental Systems Research Institute
ETC-LUSI	European Topic Centre on Land Use and Spatial Simulation
EU	European Union
EUCC	European Union for Coastal Conservation
EuroDeSS	European Decision Support System for coastal and regional seas
EurOcean	European Centre for Information on Marine Science and Technology
FAO	Food and Agriculture Organization (of the UN, United Nations)
FGDC	Federal Geographic Data Committee
GBIF	Global Biodiversity Information Facility
GCMD	Global Change Master Directory
GEO	Group on Earth Observations (coordinator of GEOSS)
GEOSS	Global Earth Observation System of Systems
geoRSS	Geographically Encoded Objects for RSS feeds
GIS	Geographic Information System
GMES	Global Monitoring for Environment and Security
GML	Geographic Markup Language
GRAME	Global Regular Assessment of Marine Environments
GSDI	Global Spatial Data Infrastructure (association)
IEEE	Institute of Electrical and Electronics Engineers
ICES	International Council for the Exploration of the Sea
ICZM	Integrated Coastal Zone Management

IFEN	Institut Français de l'ENvironnement (The French Institute of the Environment)
IFREMER	Institut Français de Recherche pour l'Exploitation de la MER (French Research Institution for Exploitation of the Sea)
IHO	International Hydrographic Organization
IMCORE	Innovative Management for Europe's Changing Coastal Resource
IMF	Internet Mapping Framework
IMO	International Maritime Organization
IMP	Integrated Maritime Policy
IMS	Internet Map Server
INSPIRE	INfrastructure for SPatial InfoRmation in Europe
InterRisk	*Inter*operable GMES Services for Environmental *Risk* Management in Marine and Coastal Areas of Europe(successor of DISMAR)
IOC	Intergovernmental Oceanographic Commission (of UNESCO)
IODE	International Oceanographic Data and information Exchange
IOOS	Integrated Ocean Observing System
IPR	Intellectual Property Rights
ISDE	Irish Spatial Data Exchange
ISMAR	Institute of Marine Science, National Research Council (Italy)
ISO	International Organization for Standardization (derived from the Greek "isos," meaning "equal")
ISP	International Standardization Profile
ISSN	International Standard Serial Number
JCOMM	Joint Technical Commission on Oceanography and Marine Meteorology (WMO and IOC)
KML	Keyhole Markup Language (Google Earth)
LIDAR	Light Detection And Ranging
MESH	Mapping European Seabed Habitats
MIDA	Marine Irish Digital Atlas
MMI	Marine Metadata Interoperability
MOTIIVE	Marine Overlays on Topography for annex II Valuation and Exploitation
MSDI	Marine Spatial Data Infrastructure
MSFD	Marine Strategy Framework Directive
NDG	NERC Data Grid
NERC	Natural Environment Research Council (U.K.)
NGO	Non-Governmental Organization
NOAA	National Oceanic and Atmospheric Administration (U.S.)
NODC	National Oceanographic Data Centre (UNESCO IOC IODE)
NRC	National Reference Centre (EIONET)
NSDI	National Spatial Data Infrastructure
NSF	National Science Foundation
OBIS	Ocean Biogeographic Information System
OCA	Oregon Coastal Atlas
ODIN	Ocean Data and Information Network (UNESCO IOC IODE)
OGC	Open Geospatial Consortium
OS	Open Source
OSU	Oregon State University
OWL	Web Ontology Language
PSI	Public Sector Information
RDF	Resource Description Framework
ROOS	Regional Operational Oceanographic System
SAIAB	South African Institute for Aquatic Biodiversity
SDI	Spatial Data Infrastructure

SEIS	Shared Environmental Information Systems
SIGLA	Sistema de Información Geográfica del Litoral de Andalucía (GIS for the Coastal Zone Management of Andalucia)
SKOS	Simple Knowledge Organisation System
SSE	Service Support Environment
SVN	Sub-version
UCC	University College Cork
UML	Unified Modeling Language
UNEP MAP	United Nations Environment Programme-Mediterranean Action Plan
UNESCO	United Nations Educational, Scientific and Cultural Organization
URI	Uniform Resource Identifier
URL	Uniform Resource Locator (often a synonym for URI)
URN	Uniform Resource Name (a URI that uses the urn scheme)
US/USA	United States or United States of America
USGS	United States Geological Survey
VLIZ	Vlaams Instituut Voor de Zee (Flanders Marine Institute)
W3C	World Wide Web Consortium
WCS	Web Coverage Service
WFD	Water Framework Directive
WFS	Web Feature Service
WMO	World Meteorological Organization
WMS	Web Map Service
XML	eXtensible Markup Language

Foreword

With great interest and enthusiasm the European Environment Agency (EEA) hosted and co-chaired the International Coastal Atlas Network's (ICAN) 3rd conference in Copenhagen, 7-11 July 2008. Thanks to the commitments of the ICAN members, we believe that the current ICAN achievements and foreseen activities will provide useful operational services to a large community of practitioners and users across the world. The EEA therefore looks forward to ongoing cooperation in these developments towards interoperable coastal information systems. This is particularly important in light of the emerging European Union's Integrated Maritime Policy (IMP), where initiatives like the Atlas of the Seas, broad-scale seabed habitat mapping and promotion of maritime spatial planning have prominent roles.

In this context, and among others, the active transatlantic cooperation between European and American specialists illustrates the concrete potential of the International Coastal Atlas Network (ICAN). We also see the benefits of ICAN cooperation for integrated assessment of coastal zones and the marine environment and wider implementation of a Shared Environmental Information System (SEIS). Development of coastal information systems also facilitates our work in coordination of on-ground monitoring data in the context of the EI initiative on Global Monitoring for Environment and Security.

The EEA is therefore very much looking forward to the holding of the next ICAN workshops in November 2009 and in 2010. We would be interested in contributing to the ICAN activities in view of services such as the methodological outcomes and content-based information, so as to help actions in the field of coastal zone integrated assessments, including coastal zone use potentials, vulnerabilities and adaptation needs to environmental changes.

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EXECUTIVE SUMMARY

INTEROPERABILTY, **in·ter·o p·er·a·bil·i·ty,** noun: the ability of diverse systems and/or organizations to work together, especially in the use and exchange of information.
MERRIAM-WEBSTER DICTIONARY AND IEEE

From July 7 to 11, 2008, the International Coastal Atlas Network (ICAN) held a workshop on "Federated Atlases: Building on the Interoperable Approach" at the headquarters of the European Environment Agency (EEA) in Copenhagen, Denmark. The workshop (aka "ICAN 3") engaged 29 participants from 10 countries, representing 25 organizations and multiple areas of scientific and technical expertise. This meeting was a follow-up to the successful 2007 workshop on "Coastal Atlas Interoperability" (aka "ICAN 2") and the 2006 meeting "Potentials and Limitations of Coastal Web Atlases" (aka "ICAN 1"). These first two workshops examined state-of-the-art developments in coastal web atlases (aka CWAs) from Europe and the U.S., shared several case studies and lessons learned, established key issues and recommendations related to the design, data requirements, technology and institutional capacity needed for these atlases, and examined best practices for achieving interoperability between them, and designed a demonstration interoperability prototype using the metadata catalogues of two atlases. To continue the momentum of ICAN 1 and 2 in identifying the opportunities that exist for increased data sharing in coastal web atlases for coastal management, governance, and conservation, it was the goal of ICAN 3 to:

1. demonstrate the atlas interoperability prototype, report on the lessons learnt and decide on future technical activities;
2. attract and inform a larger group of potential stakeholders of the activity, and promote an exchange of related developments in coastal and ocean information services; and
3. develop a long-term strategy and governance model for ICAN.

In addition, the workshop took place around a two-day conference on Coastal Atlas Development, organised by the EEA itself, whose objective was to inform EEA partners about the development of coastal atlases and the emergence of ICAN in light of relevant European policy developments in the maritime sphere.

Workshop participants discussed the progress-to-date on the ICAN interoperability prototype and agreed upon future technical activities. The relevant policy context within which ICAN must operate was presented, along with an overview of a number of related coastal and marine information management projects which can inform ICAN developments (e.g., ECOOP, the SeaDataNet initiative, the UNESCO IODE Ocean Data and Information Networks of Africa and the Caribbean, the government-funded commercial projects of SeaZone Solutions Limited, and the perspectives and programs of Wisconsin Sea Grant). Workshop participants strategised as to how ICAN might learn from and collaborate with these efforts and how best to engage additional members in the Network. In fact, we learned of emerging projects in the Australian/Pacific region, which may become future members of ICAN.

Workshop participants also investigated ways of disseminating some of the wealth of knowledge and expertise held within the ICAN group. Activities underway in regard to training and publishing were presented, and the potential for additional activities was discussed. Finally a medium to long-term strategy for ICAN and a potential governance model for the Network were developed. These will help to give a coherent focus to the

activities and underpin the structure of ICAN, thereby securing its future and enhancing its relevance among those interested in the future of coastal areas worldwide.

ICAN 3 represented yet another step toward long-term goals of implementing and recommending best practices on all aspects of coastal web mapping, while developing a cadre of scientists who will play a leading role in forging international collaborations and technical solutions of value to their participating nations. The workshop and EEA Conference on Coastal Atlas Development that immediately followed showed clearly that the goals and work of ICAN have great value and potential. In the coming year there will be many avenues for members of the ICAN community to engage in outreach, marketing, and positioning within existing broad initiatives. *ICAN has truly progressed from a project to a full-fledged program.*

Based on the success of the 2008 workshop in Copenhagen, ICAN will convene a **4th international workshop** (aka ICAN 4), at the Adriatico Guest House, International Centre for Theoretical Physics, UNESCO University, **Trieste, Italy**, **November 16-20, 2009**. In addition, the EEA plans to schedule their meeting of the European national reference centres (with an eye toward coastal and marine issues) at the same venue, immediately following ICAN 4. Objectives of ICAN 4 will include the following.

- Engaging and servicing *users* of coastal web atlases, and on continued inventory, assessment, and evaluation of atlases.
- Revisiting the main recommendations of the ICAN 1, especially evaluating atlas impact, and developing analysis and decision-support tools in atlases.
- Continued progress on our ontology and semantic interoperability work, but with an eye also toward articulating the benefits of semantic interoperability at a broader scale, to non-specialists.
- Emerging European coastal web atlases (particularly in the Mediterranean) that are making themselves relevant through policy, environmental and socio-economic indicator work and related themes.
- Finalizing a structure and implementation plan for governance, strategic planning, and technical activities, including formal procedures for receiving new members.

INTRODUCTION

Over recent years there has been significant development in various countries worldwide of national and regional coastal atlases based on web-enabled Geographic Information Systems (GIS). These Internet-based resources are of great value to decision makers, scientists and the general public with an interest in coastal issues. In order to share knowledge and experiences of these developments, primarily in Europe and North America, two transatlantic workshops were organised on this topic. They were entitled "Potentials and Limitations of Coastal Web Atlases" (University College Cork, Ireland, 2006) and "Coastal Atlas Interoperability" (Oregon State University, USA, 2007) and led to the emergence of a strong and focused community of practitioners in the coastal atlas domain. In order to foster collaboration and ensure continuity of the community it was proposed at the Oregon workshop to set up the International Coastal Atlas Network (ICAN). Furthermore, it was decided to continue to organise annual workshops on various topics related to coastal web atlases, and with the support of the European Environment Agency (EEA) a workshop was organised at the headquarters of the EEA in Copenhagen, Denmark from July 7-11 2008. This took place around a two-day conference, organised by the EEA itself, whose objective was to inform EEA partners about the development of coastal atlases in the light of relevant European policy developments in the maritime sphere.

At the workshop in Cork, a number of coastal web atlases from North America and Europe were presented and various issues related to their development were discussed (O'Dea *et al*., 2007). At the second workshop in Oregon, expert participants learned how to use controlled vocabularies and ontologies in order to build a common approach to managing and disseminating coastal data, maps and information (Wright *et al*., 2008). This workshop concluded with the aim of developing a proof-of-concept prototype to demonstrate interoperability between two coastal web atlases (the Marine Irish Digital Atlas or MIDA, http://mida.ucc.ie, and the Oregon Coastal Atlas or OCA, http://www.coastalatlas.net). Work entailed development of an ontology on the topic or use-case of coastal erosion and use of Open Geospatial Consortium (OGC) services, namely Catalogue Services for the Web (CSW) to retrieve relevant metadata from the catalogues of both atlases. Furthermore a simple interface was designed in order to allow a user enter search parameters and to display the results.

The long-term view that emerged from these two workshops is for global level operational interoperability, which will evolve as the ICAN community strives to increase awareness of the opportunities that exist for increased data sharing among policy makers and resource managers as strategic users of a coastal web atlas. In the light of this aspiration the workshop held in Copenhagen was entitled "Federated Coastal Atlases: Building on the Interoperable Approach" and had three main goals:

1. to demonstrate the atlas interoperability proof-of-concept, report on the lessons learnt and decide on future technical activities;

2. to attract and inform a larger group of potential stakeholders of the activity, and promote an exchange of related developments in coastal and ocean information services; and

3. to develop a long-term strategy and set out a governance model for ICAN.

In addition to addressing these goals the workshop investigated ways of disseminating some of the wealth of knowledge and expertise held within the ICAN group. Activities underway in regard to training and publishing were presented and the potential for additional activities were discussed.

The relevance of CWAs to users is mediated to some extent by the policy context within which they exist. Therefore recent and emerging developments in this area were presented and discussed. In Europe the Marine Strategy Framework Directive (MSFD) aims at applying the ecosystem-based approach to the management of human activities, whilst during 2008 the European Commission published its vision for an Integrated Maritime Policy for the European Union, which includes a proposal to develop an Atlas of the European Seas as an educational tool to highlight the importance and diversity of the oceans. Meanwhile in the United States shortly before the workshop, the State Governors of Washington, Oregon and California signed the West Coast Governors' Agreement on Ocean Health. This highlights the need for harmonised information, which crosses administrative boundaries and underlines the timeliness of this workshop on federated atlases. At the global level activities within ICAN are of relevance to the Global Earth Observation System of Systems (GEOSS) and indeed immediately following on the Copenhagen workshop a submission was made in response to the GEOSS call for participation in the GEOSS Architecture Implementation Pilot.

This report presents the outcomes of the workshop deliberations. The details of the prototype development are outlined and agreed future technical activities described. The relevant policy context within which ICAN must operate is presented along with an overview of a number of related coastal and marine information management projects, which can inform ICAN developments. Activities over the last year in regard to outreach and training are outlined along with successful efforts to engage additional members in the Network. Finally a medium to long-term strategy for ICAN and a potential governance model for the Network are presented. These will help to give a coherent focus to the activities and underpin the structure of ICAN therefore securing its future and enhancing its relevance among those interested in the future of coastal areas worldwide.

INTEROPERABILITY PROTOTYPE DEVELOPMENT

One of the major activities since the July 2007 workshop was the development of a prototype to demonstrate atlas interoperability (Wright *et al*., 2007). The Oregon Coastal Atlas (OCA) and the Marine Irish Digital Atlas (MIDA) were chosen for this demonstration activity due to their advanced state of development, their use of a similar technology platform (Minnesota Map Server) and the strong working relationship between Oregon State University/the Oregon Ocean-Coastal Management Program and the Coastal and Marine Resources Centre.

The development was carried out in order to demonstrate the benefits of integration and interoperability such as improved data search, discovery, documentation, and accessibility. If a dataset is missing in one atlas, it may be immediately located in another. If similar datasets are found in both atlases, they may wish to be combined to enhance study in either region. This is based on the notion that "no atlas is an island." Sometimes more than one atlas is needed in order to address complex regional problems such as hazard mitigation, climate change, intergovernmental marine spatial planning, and many others.

Use-cases can be developed around related topics to facilitate ontology development and ultimately interoperability across coastal atlases. Selection of one use-case helped to focus prototype development. Coastal erosion was chosen as being of global relevance and pertinent data layers existed in both atlases with which the demonstration could be illustrated. It is understood that there are many more topics that interoperable coastal atlas databases can address.

Although the atlases used in the prototype cover geographically diverse areas, the demonstration was developed as a proof-of-concept exercise. It illustrates how regional connections may be made between atlases. It also shows how to overcome the technical challenge of interoperability by developing a set of local and global ontologies and a mediation system which facilitate access to the individual atlases through one central system. This is known as the ICAN global atlas and can be accessed at http://ican.ucc.ie. It should be noted that the term "global" does not refer to the globe/World in this context. Rather, it is the term used by the database community to refer to the integrated data schema in a mediated approach as opposed to local schemas. This section summarises the main technical aspects involved in the implementation of the prototype. A fuller discussion can be found in Lassoued *et al.* (2008).

Defining Local and Global Ontologies

An ontology is defined briefly as the formalization of concepts and terms used in a practice or discipline. Ontologies can thus provide the semantic aspects of metadata, including lists of terms with definitions, more complex relationships between terms, rules governing those relationships, and potential values for each term. Ontologies represent, in a machine-readable language, terms of importance to domains of interest (e.g., CWAs) *that conform to a community agreement about a domain and design for a specific purpose* (Gruber, 1993).

In order to create the local ontologies both atlases created a master list of keyword vocabulary from existing metadata for layers relevant to the coastal erosion use case. These were then sorted into five lists corresponding to the ISO keyword types (discipline, place, stratum, temporal and theme). For each keyword type, the list was organised into classes

and sub-classes. Relationships between the terms contained within an ontology are provided as part of the same ontology. Figure 1 illustrates an extract of place keywords from the MIDA ontology. Examples of places are respectively Europe, Ireland and Cork. Relationships between places such as "Cork *is within* Ireland", and "Ireland *is within* Europe", can be expressed. This helps improve keyword search using an inference engine. For example, if the place keywords for a dataset only contain the term "Cork", and a user queries the metadata catalogue using the place term "Europe" or "Ireland" they still will get this dataset in the response, because Cork is in Ireland and Ireland is in Europe, which also infers that Cork is in Europe. Ontologies are expressed in the OWL-DL language (Herman, 2007) in the prototype. This language was presented at the 2007 workshop.

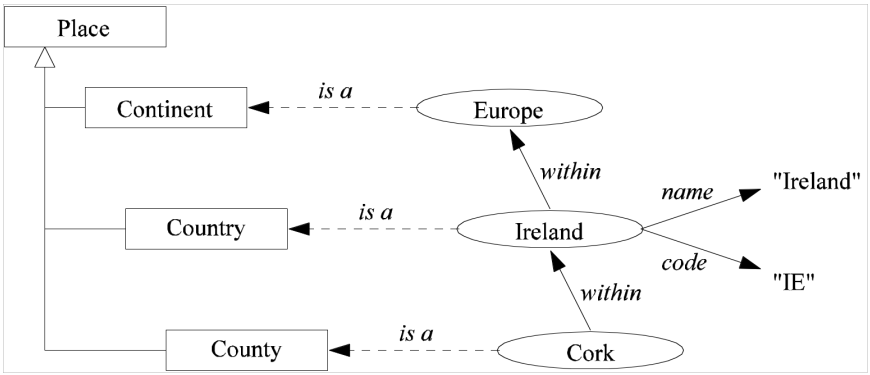

***Figure 1**: Terms and their relationships within part of the MIDA ontology.*

Terms can fall into multiple ISO keyword types. Figure 2 illustrates an example of how particular data could be categorised in the discipline of biology, the fisheries management theme and during the Summer time period. As an example for the coastal erosion use-case, data that records the heaviest time of year for beach erosion would fall into the following.

- The **discipline** of geomorphology.
- The **temporal** period of winter.
- The **theme** of coastal erosion.

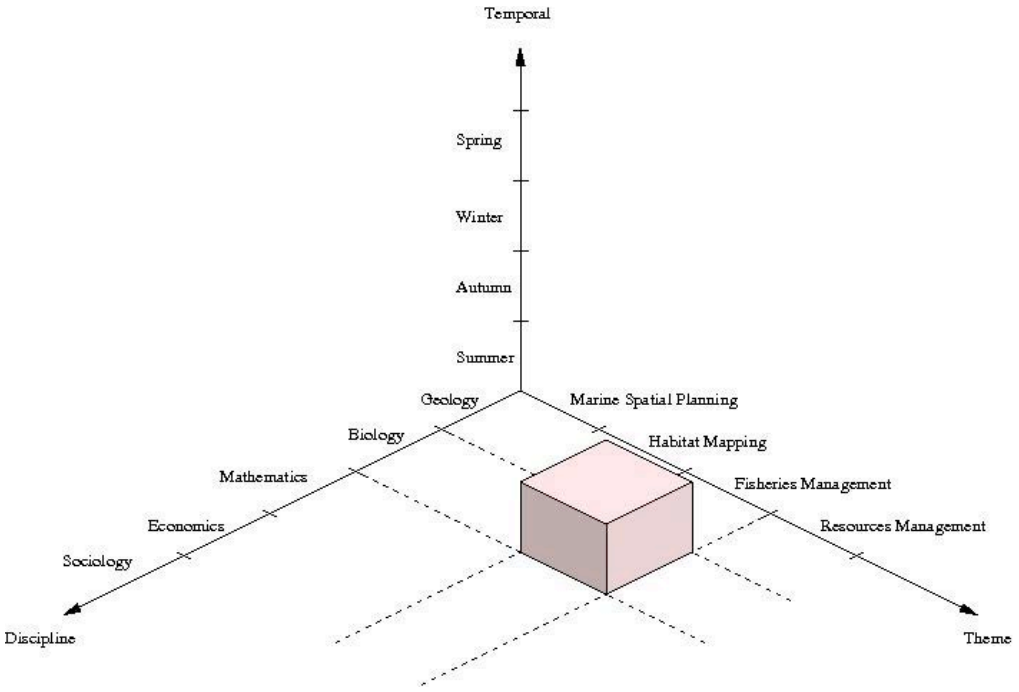

***Figure 2**: A biological example that illustrates how a dataset can fall into multiple keyword types.*

For each local ontology a mapping ontology defines the mappings between the local ontology and the global one. A mapping ontology imports both a local and the global ontology and defines relationships between their concepts. An example showing extracts of the MIDA and the OCA mapping ontologies is illustrated in Figure 3. In this figure, terms preceded by prefix "*global*" are from the global ontology. Those with prefixes "*mida*" and "*oca*" are from the MIDA and OCA ontologies respectively. Relationships represented with thin lines are defined as part of the local ontologies. Those represented with thick lines are defined as part of the mapping ontologies. For example, *Coastal Protection* and *Shore Stabilization* are defined in the MIDA and OCA mapping ontologies as narrower terms than *Human Responses to Coastal Change*.

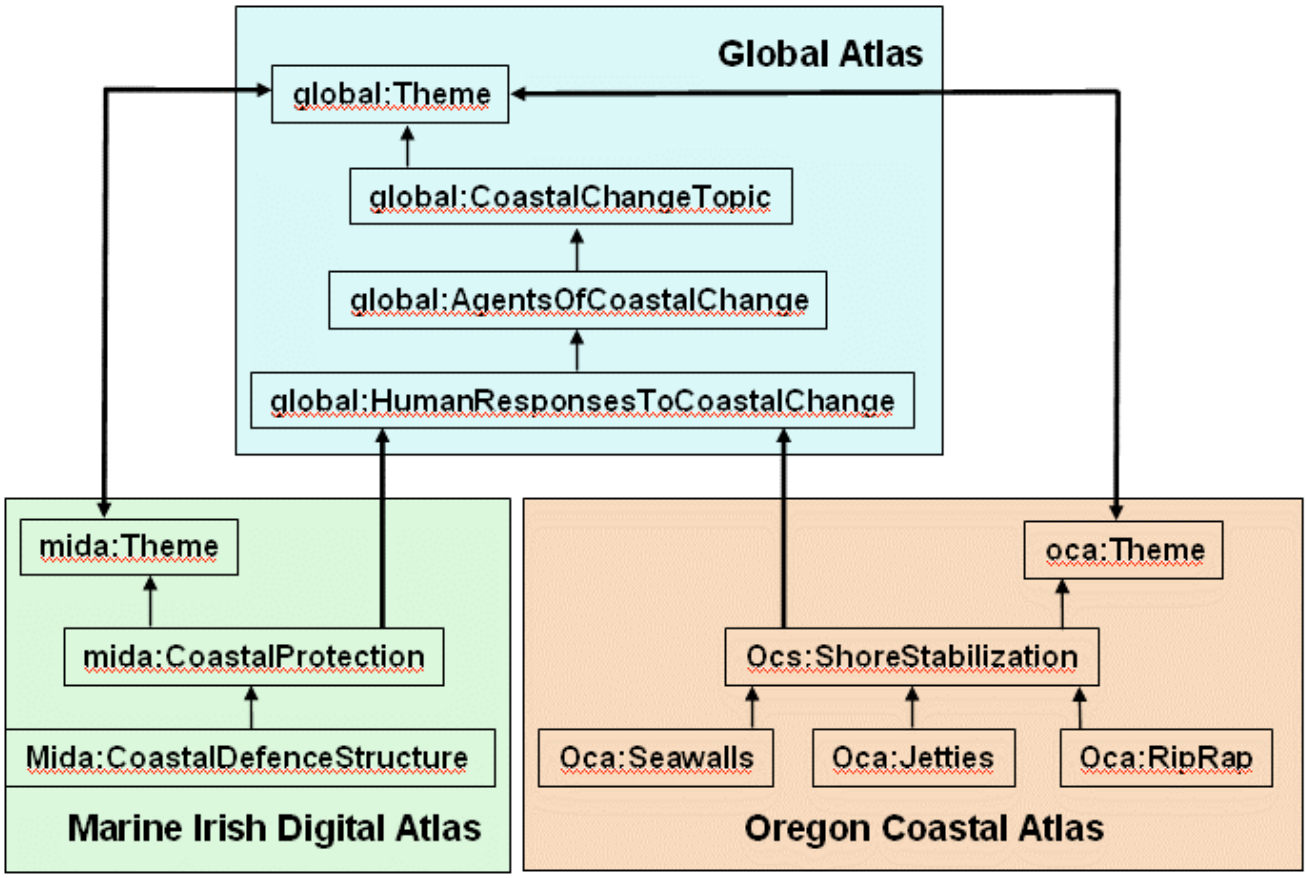

***Figure 3**: Mapping of the local ontologies to the global ontology.*

Implementing Semantic Interoperability

Semantic interoperability can be achieved via harmonisation, mediation or a combination of both (Figure 4). Harmonisation involves the use of common access interfaces and resource formats. These include OGC web services such as Catalogue Service for the Web (CSW), Web Feature Service (WFS), Web Coverage Service (WCS) and Web Map Service (WMS) and metadata standards such as ISO-19115 and ISO 19139.

The other approach, known as mediation, allows local atlases to use their own data structures, semantics and vocabularies (ontologies). For the global atlas a common data structure and a common ontology are used. Mapping is then provided between the local ontologies and the global one. When a user makes a query via the global atlas, the mediator uses mapping rules in order to rewrite the query into queries understandable by the local atlases. Responses from the local atlases are gathered and reformulated by the mediator and delivered back to the user via the interface to the global atlas. The ICAN prototype uses a combination of harmonisation and mediation.

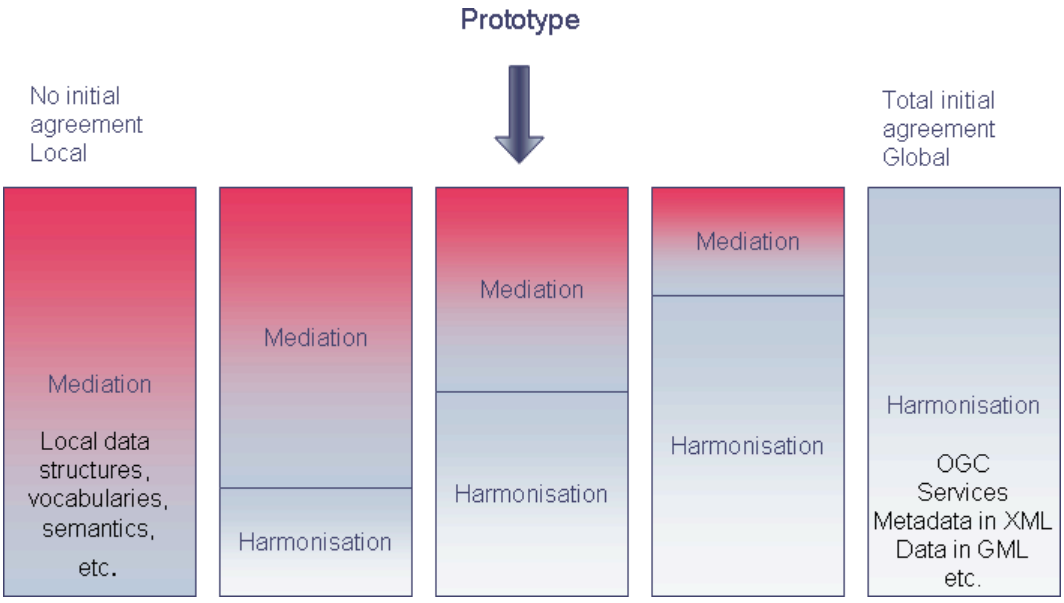

Figure 4: *Interoperability is achieved by a combination of harmonisation and mediation.*

The Catalogue Service for the Web (CSW) (Nebert and Whiteside, 2005) mentioned above is an OGC abstract specification that supports the ability to publish and search collections of descriptive information (metadata) for data, services, and related information objects. CSWs allow a unified access to metadata records within a community or an organization, thus harmonizing the discovery of and search for GIS resources. For this reason, CSWs are required for the ICAN prototype in order to facilitate syntactic and schematic interoperability. CSWs support several operations. The focus for the prototype has been on the *GetRecords* operation for searching metadata records, possibly using filters, such as keyword, location and time search.

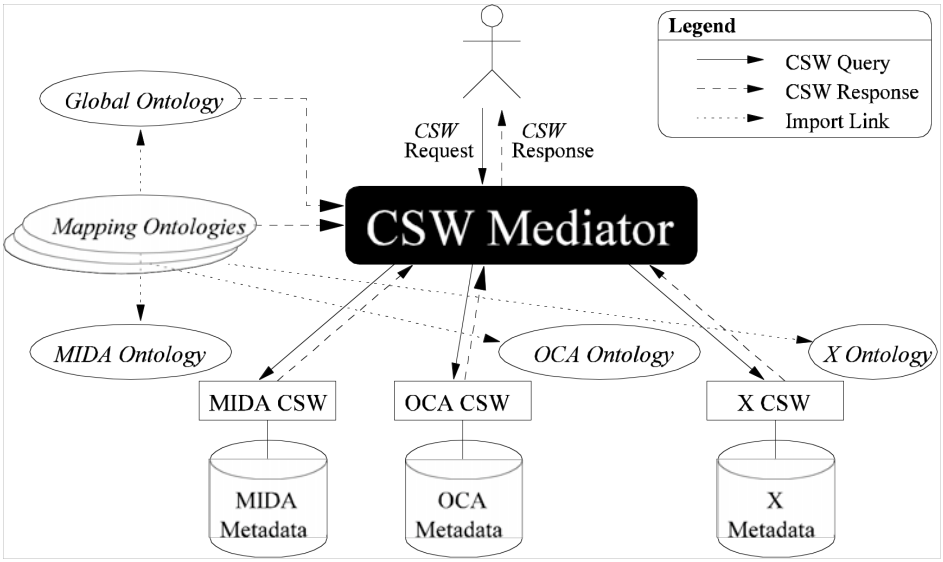

***Figure 5**: Ontology-based CSW mediation architecture.*

The global atlas offers a virtual CSW, called global CSW, which acts as a CSW mediator and which offers unified and transparent access to all of the atlases' CSWs. As illustrated in Figure 5, users of the global CSW are provided with a global ontology of terms. The user refers to the global ontology and formulates a CSW *GetRecords* request using an area of interest and keywords defined in the global ontology. The global CSW rewrites the user's request into CSW requests to the local atlases' CSWs using their local ontology terms, executes the requests, and collects metadata records (responses) from local CWAs. These responses are then returned to the user in the Global Atlas CSW.

This architecture facilitates extensibility as new catalogue services can be added and removed at any time without affecting the global CSW, provided that they come with local ontologies for the terms used by their metadata records and that mappings between these terms and the global ontology's terms are provided. Another advantage of this architecture is that the global CSW acts itself as a catalogue service, which in turn can be queried by another external application or even integrated in a similar CSW mediation architecture, as a local CSW.

Prototype Interface and Operation

To summarise the steps that were taken to develop the prototype, data layers relevant to the coastal erosion use-case were identified in both local atlases, keywords were extracted and local ontologies built. The global ontology was then developed and appropriate mappings between the local and global ontologies were then defined. The global atlas CSW was developed to communicate with the local atlas CSWs using the ontology mappings.

The global atlas is accessible using a web page interface as shown in Figure 6. The user chooses the resource of interest from the scrollable list of terms and the area of interest from the map. The request is submitted and if matching records are found in the local atlas CSWs, a summary metadata record is returned with its title, abstract and keywords as well

as a logo to indicate the atlas from which the record comes. The user can then choose to view the full metadata of any records returned.

In addition to the OCA and MIDA, a metadata record regarding global maritime boundaries which is held by the Flanders Marine Institute (VLIZ) has been linked to the demonstration to illustrate the extensibility of the system.

Future Developments

At the workshop it was decided to build on the work done in the prototype development. The following tasks were agreed.

- OGC services will be extended to include WMS in addition to CSW.
- Additional coastal atlas nodes will be added to the interoperable network.
- Streamline and improve functionality of the current prototype, including metadata database population, management of errors, exception handling, enable Smart Searches.
- A demonstration implementation of WFS and WCS for actual data delivery will be implemented for OCA and MIDA in a later prototype.
- Documentation on technology development, ontology development and a cookbook for new ICAN Prototype members.

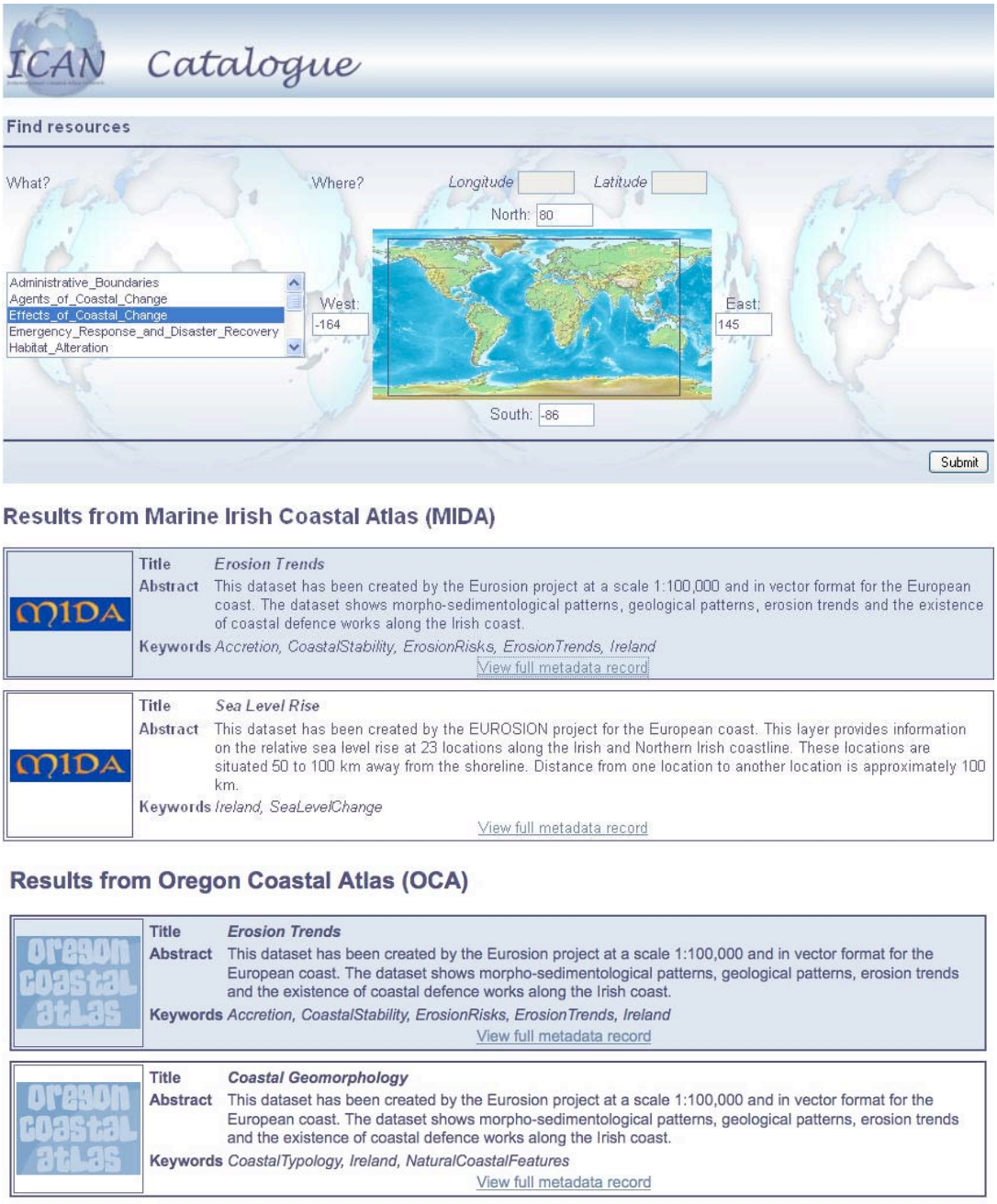

Figure 6: *Search interface of the ICAN prototype and returned metadata records.*

ICAN AND EMERGING MARITIME POLICIES

European Policy Context

Recently a number of important policy decisions and developments took place in Europe regarding the management of coastal, marine and maritime resources. These will shape the design, functioning and sharing of coastal and marine information services in the coming years. There was agreement on a marine environmental law (Marine Strategy Framework Directive, MSFD), which aims at applying the ecosystem-based approach to the management of human activities. Furthermore the European Commission published its vision for an integrated maritime policy for the European Union (European Commission, 2007). The vision document – also called the Blue book – was accompanied by a detailed Action Plan, an impact assessment and a report on the results of the broad stakeholder consultation. There was also some re-organisation within the European Commission itself. The former Directorate-General "DG Fish" was re-branded as "DG-MARE" - the Directorate-General for Maritime Affairs and Fisheries. This new DG will have responsibility for both fisheries policy and the Integrated Maritime Policy. It should therefore bring more coherence to fisheries and maritime management within Europe.

Marine Strategy Framework Directive

In May 2008 the Council of the European Union (EU) adopted a marine environmental law known as the MSFD, with the aim of ensuring healthy European marine waters by **2020**, taking into account the geographic and climatic specificity of different marine ecosystems. The goal of the MSFD is the achievement of 'good environmental status' (GES) in the marine environment. This Directive is coherent with existing EU legislation. It is aligned with the Water Framework Directive (WFD), which aims at achieving as a minimum 'good ecological status' for all freshwater surface and groundwater bodies as well as inshore waters by 2015. It is also supported by the Habitats Directive, which includes the designation of Marine Protected Areas.

According to this Directive, Member States will have to develop marine strategies for their European waters, including: a detailed assessment of the state of the environment, a definition of "good environmental status" at regional level by 2012, and the establishment of national targets and indicators to measure progress towards "good environmental status". This will be followed by the development of national monitoring programmes (2014) and their implementation (2015, 2016).

The MSFD could have an impact on countries outside the EU; these will be able to cooperate in the development and implementation of marine strategies using existing structures including European regional sea conventions. Furthermore EU Member States will be asked to consider the implications of their actions on waters beyond their national jurisdiction in order to minimise risk of damage and, if possible, have a positive impact on them.

The European Environment Agency has supported the development of the monitoring and assessment components of the MSFD (e.g., clarification of data and information needs) via its work as co-chair of the European Monitoring and Assessment (EMMA) informal Working Group, with participation of European regional sea conventions, European Commission (EC)

services, EU Member States and Accession countries, and international bodies (e.g., the International Council for the Exploration of the Sea, ICES). This Working Group has developed and is implementing a road map to help countries meet their MSFD obligations. The EEA will also have a role supporting MSFD implementation, e.g., in the review of the status of the marine environment in the European Community (2016-2019), to be carried out together with EC services, European regional sea conventions and other relevant bodies. For this reason, the EEA is currently working towards the establishment of a limited set of pan-European common indicators for the marine environment in the context of EMMA by 2010.

Integrated Maritime Policy

The publishing in 2008 by the European Commission of its vision for an Integrated Maritime Policy for the European Union is based on the recognition that all matters pertaining to Europe's oceans and seas are interlinked, and that sea-related policies must develop in a joined-up way. It aims to provide a coherent policy framework that will allow for the optimal development of all sea-related activities in a sustainable manner in the face of challenges of globalisation and competitiveness, climate change, degradation of the marine environment, maritime safety and security, energy and sustainability matters. The above-mentioned MSFD constitutes the environmental pillar of such a policy. The main goals of the maritime policy are to:

- enable economic development without compromising the marine environment;
- make full use of knowledge and innovation in maritime affairs
- deliver a high quality of life in coastal regions;
- raise the visibility of maritime affairs; and
- develop a maritime leadership role for Europe.

An action plan has also been developed in tandem with the policy. Two of the measures are of particular relevance here. In order to help raise awareness of maritime heritage a European Atlas of the Seas will be developed as an educational and informational tool. The need for a data and information infrastructure is also highlighted and the Commission is committed to the development of a European Marine Observation and Data Network, which is to be made accessible as a tool for better governance, expansion of value-added services and sustainable maritime development.

US Initiatives

The recent reports of the Pew Oceans Commission and the U.S. Commission on Ocean Policy (Pew Oceans Commission, 2003; Juda, 2005) have clearly shown that coastal communities are critical to the economy of the U.S., and to its overall health and well-being as a nation, and further that geographic technologies will be a fundamental, critical tool to address the threats of climate change, coastal hazards, overpopulation, and more. There are also several U.S. initiatives underway regarding coastal and marine policies (see the Joint Ocean Commission's summary of over 25 U.S. regional and state ocean governance initiatives at http://www.jointoceancommission.org/rc-summary-of-regional-initiatives.html). Many of these initiatives are aided by the Federal Geographic Data Committee's Marine and Coastal Spatial Data Subcommittee (http://www.csc.noaa.gov/mcsd). This subcommittee, coordinated by NOAA Coastal Services Center (CSC) and made up of representatives from most of the U.S. federal agencies with a purview over the coast and territorial ocean, works to advance and implement a marine and coastal national spatial data infrastructure (NSDI), by implementing a clearinghouse (namely the Geospatial One-

Stop portal) for coastal/ocean mapping metadata, data, and interpretive information, to aid in minimizing redundant data acquisition efforts at the federal level, to foster and develop strategic partnerships and relevant standards, and to maximize the access to and use of foundational coastal and ocean datasets. A few key initiatives were reported on at the workshop with reference to their immediate relevance to ICAN.

West Coast Governors' Agreement on Ocean Health

On the west coast of the US, California Governor Arnold Schwarzenegger, Oregon Governor Ted Kulongoski, and Washington Governor Christine Gregoire, have partnered to form the West Coast Governors' Agreement on Ocean Health (named also in the Joint Ocean Commission's summary). The agreement represents a pro-active collaboration on the part of these leaders to advance the goals of (http://westcoastoceans.gov).

- Clean coastal waters and beaches.
- Healthy ocean and coastal habitats.
- Effective ecosystem-based management.
- Reduced impacts of offshore development.
- Increased ocean awareness and literacy among the region's citizens.
- Expanded ocean and coastal scientific information, research, and monitoring.
- Sustainable economic development of coastal communities.

As all of these goals will require access to timely geographic data, maps, and tools that comprise a coastal web atlas, the emergence of this new agreement was reported on at the workshop primarily as a news item and an initiative to watch for the future. The example set by the connection of the Oregon Coastal Atlas to the Marine Irish Digital Atlas in the interoperability prototype, will lead the way for the Washington Coastal Atlas, as well as efforts that are beginning in California. We therefore envisage a future linkage of the Oregon Coastal Atlas, Washington Coastal Atlas, and California Coastal Atlas in support of this initiative. The Oregon Coastal Management Program, which hosts and maintains the Oregon Coastal Atlas, is also linked closely to the Ocean Policy Advisory Council (OPAC), which serves the governor of Oregon (named also in the Joint Ocean Commission's summary). There is ongoing dialogue about OPAC's role in the implementation of the West Coast Governors' Agreement on Ocean Health, now that the Action Plan for the Agreement has been released (summer 2008). Workgroups comprised of representatives from relevant state, federal agencies, non-governmental organizations, academia, industry, tribes, etc, from all three states, will be set up to address priority issues/actions (pers. comm., July 2008, J. Hamilton, Natural Resources Advisor, Oregon Governor's Office).

Another initiative for ICAN to follow is the new Pacific Coast Collaborative Agreement between British Columbia, Washington, California, Oregon and Alaska (British Columbia Premier Gordon Campbell, Washington Governor Christine Gregoire, California Governor Arnold Schwarzenegger, Oregon Governor Ted Kulongoski and Alaska Governor Sarah Palin). The governors of these states forged this partnership in June 2008 as a forum for leadership, cooperative action, and a common voice on issues affecting the Pacific coast region. Their focus will be information sharing and cooperation on clean energy, regional transportation, innovation, research and development, enhancing a sustainable regional economy (especially with respect to environmental goods and services), and emergency management.

Selected U.S. Coastal Atlas Development Efforts

NOAA CSC has launched the "Digital Coast" initiative, which seeks to build the U.S. coastal and marine NSDI, initially by way of a portal to the large store of existing web-based data and services developed by the NOAA CSC. This includes NOAA CSC's Legislative Atlas for identifying laws and jurisdictions (http://www.csc.noaa.gov/legislativeatlas), their multipurpose marine cadastre for marine spatial planning (http://www.csc.noaa.gov/mbwg/htm/ multipurpose.html), and their shoreline atlas (http://www.shoreline.noaa.gov) for providing access to vector data in support of shoreline/coastline change analysis, map and chart production, and boundary determination. The overall vision for Digital Coast is that by serving as an umbrella to these and many more web sites, it will ensure that U.S. coastal communities have easy access to organized and relevant data and tools needed to make more informed decisions. Phase I of Digital Coast has just been released (http://www.csc.noaa.gov/digitalcoast) with an ArcIMS front end interface that sits on top of EarthServer for raster data, as well as a LIDAR server and ArcSDE for vector data. Digital Coast also includes a Google Earth interface that shows where people have already used data to address coastal habitat change, inundation, and other issues. As NOAA CSC already serves as an existing partner of ICAN, there will be many fruitful avenues for collaboration and incorporation between Digital Coast and ICAN.

In addition, NOAA CSC has been working on an inventory and registry of planned, current and completed Federal and non-Federal mapping activities, including coastal web atlases. There is also the goal to develop a baseline assessment of existing coastal atlases, especially those maintained by the state coastal zone management programs that NOAA CSC works closely with. This work, led by Tony LaVoi, has now been tied directly into the current activities of the ICAN Atlas Assessment working group.

Global Research Alliance for Digital Data

Tim Nyerges of the University of Washington reported briefly on a U.S. National Science Foundation (NSF) proposal that he is involved in as part of the new Sustainable Digital Data Preservation and Access Network Partners (DataNet) program. Projects funded under this program will receive up to $20 million to develop new methods and management structures for optimizing current and future data sets and data streams, especially as exemplars to current national and global research data infrastructures. The University of Washington and partners have proposed a new Global Research Alliance for Digital Data (GRADD) of which ICAN would be a member, if funded. NSF has chosen to fund its first two DataNet projects (at Johns Hopkins University and the University of New Mexico), and in succeeding years there will be three more centres funded at this level. All five centres will focus on semantic interoperability of digital products, again a niche for ICAN in the coastal realm. Efforts toward funding GRADD are still ongoing, and other efforts are discussed below in the section on **ICAN Strategy and Governance.**

Global Initiatives

There was brief discussion at the workshop of initiatives beyond the European/US realm, and these discussions were continued in more detail at the EEA Conference on Coastal Atlas Development (http://ican.science.oregonstate.edu/eea_prog) which immediately followed the ICAN workshop and sought to expose a larger community of coastal experts from Europe to the goals and potential of ICAN. Chief among the global initiatives mentioned was the Global Earth Observation System of Systems (GEOSS) which promotes scientific, data-centric connections networks of observational systems (hence the "system of systems"),

while also promoting applications across nine societal benefit areas (water, climate, weather, ecosystems, energy, health, agriculture, disasters, biodiversity; Craglia *et al.*, 2008). GEOSS is administered through a complex, multi-layered intergovernmental organization (the Group on Earth Observations or GEO), and it was suggested that ICAN engage with GEOSS as the coastal data model and coastal system for GEOSS. With GEOSS looking to build on existing systems, and coastal and marine portals not yet heavily imbedded into their system, this was deemed a useful avenue. ICAN has since submitted a proposal for participation in the GEOSS Architecture Implementation Pilot program, which was accepted.

The Global Biodiversity Information Facility (GBIF) is another initiative that ICAN might consider working closely with in the future. GBIF has nearly 150 million records as the world's foremost network for biodiversity data). They participate in GEOSS in order to make their data available to a broader network of users. In the future ICAN might consider targeting GBIF nodes so as to provide ICAN users with the biodiversity data sets that they would need for their coastal web atlases. GBIF is just now exploring how best to use the various OGC services, which are currently difficult for them to implement because of the huge size of their databases.

Another project that was mentioned was the Southeast Pacific data and Information Network in support to Integrated Coastal Area Management (SPINCAM), which seeks to establish an environmental, and socio-economic indicator framework within 5 countries in South America (Chile, Colombia, Ecuador, Panama and Peru), and eventually to develop a distributed coastal atlas. This is a 3-year project with limited funding from UNESCO IOC, along with other cash and in-kind support.

The Arctic is an international region of special interest due to the recent revelations about the impacts of climate change there, and with potentially explosive politics surrounding shipping, oil and gas exploration, the effects of oil spills on *ice*, as opposed to just open water, and more. The US, Canada, and the EU have realized that they need to form a position on the Arctic, but they currently lack a working atlas, as well as the ability to compare and interoperate among maps and between datasets.

EXTENDING THE ICAN COMMUNITY

ICAN has thus far proven to be an organic, highly motivated, productive organization that, although informal, is generating tangible, useful products that are attracting users. There were many discussions at the workshop and a specific breakout group that focused on a possible governance model for ICAN, including structures for formalizing current members and admitting new ones. These are presented in a later section of this report (**ICAN Strategy and Governance**). Here we focus on immediate extensions to the ICAN community by way of the UNESCO IOC IODE and Wisconsin Sea Grant program, as well as to potential future partners in ICAN.

By way of background, the Wisconsin connection was made immediately after the 2007 ICAN Workshop 2 on Coastal Atlas Interoperability, when several ICAN workshop participants presented a panel at the Coastal Zone '07 conference in Portland, Oregon. David Hart of the Wisconsin Sea Grant institute attended the panel and immediately

expressed interest in joining ICAN activities. And during the 2007 ICAN Workshop 2 itself, the connections between the US and Europe were broadened to include the African Marine Atlas, as represented by Lucy Scott of African Coelacanth Ecosystem Programme (ACEP), South African Institute for Aquatic Biodiversity (SAIAB). This connection to the African Marine Atlas led further to a connection with the agency that has fostered the development of the African Marine Atlas, as well as the development of the Caribbean Marine Atlas: the International Oceanographic Data and Information Exchange (IODE) of the UNESCO's Intergovernmental Oceanographic Commission (IOC), headquartered in Oostende, Belgium. This led to ICAN coordinators Dawn Wright and Ned Dwyer being invited in February 2008 to the IODE Workshop on Coastal Atlas Requirements, to speak about coastal atlases and ICAN. They were joined there by Kathy Belpaeme of the Belgian Coastal Atlas team, who was also a participant in the 2006 Trans-Atlantic Coastal Informatics Workshop (also referred to now as "ICAN 1"). In addition, Yassine Lassoued of the ICAN Technical Task Force was invited in June 2008 to participate in the IODE Training Course on MapServer for the Caribbean Marine Atlas to share best practices in implementing MapServer for a coastal web atlas as developed by the MIDA team. IODE has since itself become a member of ICAN and, through its current mandate and existing partnerships will be a very important partner in broadening ICAN's reach and relevance on a truly international scale.

Overview of IODE and Coastal Atlas Development

Capacity building is a cornerstone of the IODE which was established in 1961 "to enhance marine research, exploitation and development by facilitating the exchange of oceanographic data and information between participating Member States and by meeting the needs of users for data and information products" (http://www.iode.org/). It is currently its own network of 76 national oceanographic data centres, which are tasked with providing ocean data and information in a usable form to a wide user community. At the national level this means to acquire, process, perform quality control, inventory, archive and disseminate data, and at the international level to exchange data across the entire IODE network.

IOC enforces a data policy mandating the timely, free and unrestricted access to all data, associated metadata and products generated under the auspices of IOC programs. It has also devised an "IOC Strategic Plan for Oceanographic Data and Information Management" with a vision for *comprehensive and integrated ocean data and information system, serving the broad and diverse needs of IOC Member States, for both routine and scientific use*. The area of data standards is also critical to IODE which is leading an initiative to achieve broad agreement and commitment to adopt a number of standards related to ocean data management and exchange. To wit, the IODE hosted IODE/JCOMM Forum on Oceanographic Data Management and Exchange Standards in January of 2008. This is the first in a series of meetings on fostering and furthering marine data interoperability, particularly by way of adopting a number of standards related to ocean data management and exchange (IOC, 2008).

In the realm of data distribution, IODE is developing the Ocean Data Portal, consisting of a standards-based infrastructure to provide integration of marine data from its network of distributed NODCs and provide on-line access to the marine data and information resources of the participating data centres including SeaDataNet (and hopefully in the future ICAN).

IODE's Ocean Data and Information Networks (ODINs) link training, equipment, and operational support (i.e., how to set up data centers) within regional contexts focused on Africa, South America, the Caribbean, and Pacific. As mentioned above, two major ODIN efforts are the African Marine Atlas and Caribbean Marine Atlas, which now also represent new parts of the ICAN community. ICAN looks forward to assisting with the building of additional coastal web atlases within the IODE community based on the principles of shared best practices for atlas development and interoperability.

The African Marine Atlas

The African Marine Atlas (http://www.africanmarineatlas.net) is a project of ODINAfrica, a network of 40 national institutions in 25 African countries funded by the Government of Flanders and the IODE. There are currently 11 IODE NODCs participating in the development of the atlas. Current challenges being addressed include the fact that:

- the coastal and offshore regions of Africa are biologically diverse, physically complex, and not well studied.
- spatial data from past/published studies are not easily available.
- coastal and marine management and decision-making is complex and requires easy access to reliable information.
- there is insufficient human capacity and data to meet management needs.
- there is a broad understanding of the usefulness of GIS and remote sensing, but actual use in Africa is limited.
- there is limited access to publicly funded data in Africa.
- global data resources are not easily accessible.
- useful data products are urgently needed for natural resource management, coastal planning, and management of marine protected areas at a national and regional level.
- expectations are high for a coastal web atlas in terms of usability, speed, remote access to servers.
- metadata management can still be complex.
- choosing data formats and standard legends can still be confusing.
- selecting appropriate data of interest and meaning at the *continental scale* can be difficult.
- the logistics of several countries working together is complex.
- specific permission has to be requested and recorded for many biological datasets, and these data citations are often complex.
- the need to sustain the project financially and in terms of personnel will be ongoing.

The atlas incorporates data sets that are relevant in any way to coastal/marine science or management (over 200 data categories) in Africa, within five themes (geosphere, hydrosphere, atmosphere, biosphere, and human-environment), and including some datasets that are transboundary or at a continental scale. Over 800 individual data sets are now downloadable from the atlas as a zip file, each one documented with brief metadata and linked to an image and a source citation.

The African Marine Atlas is now the largest online resource of multidisciplinary, downloadable spatial information for the African continent, and has proved to be a valuable information resource, but there is considerable opportunity for further development. To this end, the African Marine Atlas is now aligned with ICAN, as mentioned above, as well as to many regional information systems such as the Nairobi Convention Clearinghouse Mechanism and African large marine ecosystem data networks. The African Marine Atlas has recently implemented WMS and aims to participate in the next phase of the ICAN

interoperability prototype as an additional "node." The team will also continue to adopt the recommendations and best practices of ICAN.

The Caribbean Marine Atlas

The Caribbean Marine Atlas (http://www.caribbeanmarineatlas.org) is a pilot project of ODINCARSA (Caribbean and South America), a joint initiative of nine countries in the Caribbean region (Barbados, Cuba, Dominica, Grenada, Guyana, Jamaica, Saint Lucia, Trinidad and Tobago, & Turks and Caicos Islands). The project will identify, collect and organize all available geographical datasets into an atlas of environmental themes, thereby providing support for the integrated management of marine and coastal areas in the Caribbean region. The atlas team is currently compiling three categories of data layers: regional scale covering the entire region, national/local scale specific to individual island nations and collected/organized by each nation, and WMS layers that will be integrated into the overall atlas. Each category will include four themes: base map and human-environment, geosphere and atmosphere, biosphere, and hydrosphere.

The Caribbean Marine Atlas team is currently assessing available resources and identifying resource requirements, attending training courses on ocean data management, data mining, data assimilation, and MapServer implementation and refinement, building the atlas itself and demonstrating it at national and regional events. The atlas is now aligned with ICAN, as mentioned above, and will be working collaboratively with communities throughout the Caribbean to develop a Caribbean SDI.

US Sea Grant and the Wisconsin Coastal Atlas

The US Sea Grant program is a nationwide network administered by NOAA at over 30 universities to work with coastal communities toward long-term environmental stewardship, economic development and responsible use of America's coasts, nearshore regions, and lakes. Data handling and harmonization are a major part of this effort. In the midwestern, Great Lakes region of the US, Wisconsin Sea Grant was, in 1968, among the first Sea Grant programs to be established in the nation. It is based within the Aquatic Sciences Center at the University of Wisconsin-Madison. A closely related program is the Wisconsin Coastal GIS Applications Project (http://coastal.lic.wisc.edu/), a cooperative partnership between UW Sea Grant and the Land Information and Computer Graphics Facility at UW-Madison. The project has for many years addressed a wide variety of web-based products in support of coastal erosion and hazard mitigation, coastal management, stormwater management, community planning, and public education. Plans are now underway for a Wisconsin Coastal Atlas, which would foster collaboration with additional agencies such as the Wisconsin Coastal Management Program, the Wisconsin Department of Natural Resources, and Wisconsin Emergency Management. As with other coastal web atlases in ICAN, the Wisconsin coastal atlas is envisioned as a means to discover, acquire, and integrate the extensive coastal GIS data holdings within that state. There is also the potential to partner with other states such as Ohio, New York, Minnesota, and Indiana to form an integrated coastal atlas of the entire Great Lakes region. Ohio and New York already have well-established coastal atlas projects, and there would be a desire to include Illinois and perhaps Pennsylvania and the neighbouring Canadian provinces of Ontario and Quebec as well.

The Wisconsin Coastal Atlas is now confirmed as yet another new member of ICAN. As such, it will work closely with the Oregon Coastal Atlas team toward becoming an additional node in the ICAN interoperability prototype, and in securing additional Sea Grant funding to further its efforts. Specific technical issues that arose in the Wisconsin workshop presentation included:

- customizing the GeoNetwork interface as part of the prototype;
- GeoNetwork vs. Geo-enabling an open access institutional repository (ePrints, DSpace, Fedora);
- FGDC vs. ISO metadata and how to convert or "crosswalk" between these standards when linking metadata into ICAN;
- data distribution options (WMS, KML, etc.); and
- levels of participation by local governments and other coastal data custodians (metadata and data uptake).

The Wisconsin Coastal Atlas team also has plans to develop and incorporate several decision-support tools, which will be focused on the new national Sea Grant priority themes of "Sustainable Coastal Development," "Healthy Coastal Ecosystems," "Hazard Resilience in Coastal Communities," and "Safe and Sustainable Seafood Supply."

Atlas Efforts in Other Parts of the World

There are undoubtedly scores of coastal web atlases around the world that we have yet to learn about, and these will be teased out as ICAN continues to conduct outreach and to host and attend specialist meetings in the coming months and years. However, at the ICAN 3 workshop Greg Reed of IODE gave a brief presentation on coastal atlas developments in Australia and the Pacific, and Lucy Scott of the SAIAB and African Marine Atlas team described related efforts in Africa (Figure 7).

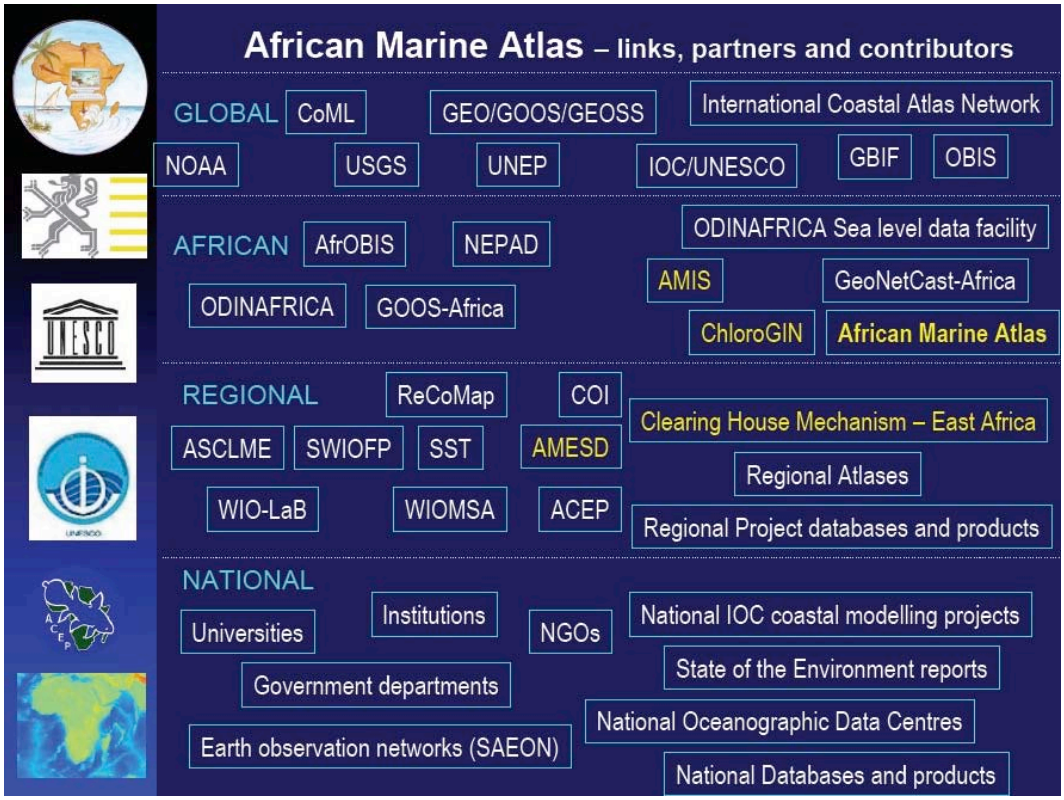

***Figure 7**: Example of the many partners of, contributors to and linkages with the African Marine Atlas project at global, continental, regional, and national levels, as presented at the workshop. See acronym list at beginning of report for definitions at the global level.*

With regard to Australia, there was a coastal atlas project launched in 1998, originally conceived of as a network of Australian government and state/territory nodes using a variety of interactive mapping tools. The nodes were largely managed by the Commonwealth of Australia, as well as by various states and territories. The commonwealth node has now been incorporated into an Australian Natural Resources Atlas, which is primarily focused on terrestrial data. Coastal data can be found primarily in the New South Wales Coastal Atlas.

Another major effort is the Australian Marine Spatial Information System developed by Geoscience Australia, which contains over 80 layers of information including maritime boundaries, bathymetry, physical and environmental information, legal interests, fisheries and shipping, extending beyond the coastal realm to the Australian Exclusive Economic Zone and in the Antarctic.

In the Pacific region the IOC Regional Sub-Commission for the Western Pacific (WESTPAC) focuses on small Pacific island nation states and their vulnerabilities to climate change. IODE is in the process of establishing an ODIN-WESTPAC to strengthen regional networking of marine related libraries and information resources in the region. Similarly, the South Pacific Applied Geoscience Commission (SOPAC), administered and funded by member counties, as well as the EU, the Office of US Foreign Disaster Assistance, and several UN agencies, has set up MapServer installations on 14 Pacific islands. Both WESTPAC and SOPAC represent two possible areas for future coastal web atlas collaboration.

Outreach and Training

Another aspect of extending the ICAN community is provision of workshops and publications. In addition to ICAN participation in the IODE workshops mentioned above, ICAN is now being represented at a variety of conferences and specialist meetings worldwide, which represents another important aspect of extending its community. In addition, ICAN is slowly branching out into the training realm also, as evidenced by its invited participation in the aforementioned IODE workshops. Ned Dwyer, Kathy Belpaeme, Simon Claus, Roger Longhorn, and Kathrin Kopke will present a short workshop and promotional poster about ICAN at the Littoral 2008 meeting in Venice, Italy, 27 November 2008. The many opportunities for outreach and training were discussed in brief at the workshop and have resulted in the following oral or poster presentations (chronicled also at http://ican.science.oregonstate.edu/ican_events).

- July 2008 – EUCC - The Coastal Union Meeting [presented by Roger Longhorn].
- September 2008 - OGC Geosemantics Working Group, web conference [Luis Bermudez].
- September 2008 - GEOSS Architecture Implementation Pilot Workshop, Boulder, Colorado, USA [Luis Bermudez].
- September 2008 - GIScience 2008, 5th international conference, Park City, Utah, USA [Dawn Wright].
- October 2008 - FGDC Marine and Coastal Spatial Data Subcommittee Meeting, NOAA Headquarters, Silver Spring, Maryland, USA [Dawn Wright].
- October 2008 - Spatial Ontology Community of Practice (SOCoP) Workshop, McLean, Virginia, USA [Luis Bermudez].

In addition, the upcoming events were discussed at the workshop as perfect venues for ICAN participation, and abstracts are currently in preparation or have been submitted:

- November 2008 - Littoral 2008, Venice, Italy.
- March 2009 - Coastal GeoTools '09, Myrtle Beach, South Carolina, USA.
- June 2009 - Third INSPIRE Conference, in conjunction with the Eleventh International Conference of the GSDI (GSDI 11), Rotterdam, the Netherlands.
- July 2009 - Coastal Zone '09, Boston, Massachusetts, USA.
- September-October 2009 - CoastGIS '09, Florianopolis, Brazil.

And ICAN will hold its fourth international workshop in November 2009 in Trieste, Italy.

The above conferences provide publication outlets in the form of extended abstracts, full conference papers, and the opportunity to submit to special issues of peer-reviewed journals. Other papers are being prepared for regular journal article submission (as mentioned in the **ICAN Strategy and Governance** section below), but the most ambitious project is a book contract recently secured by IGI-Global. A *Handbook of Research on Coastal Informatics: Web Atlas Design and Implementation* will be edited Dawn Wright of OSU, Ned Dwyer, and Val Cummins of the CMRC, and is scheduled for released by IGI-Global in 2010. The project was announced at the workshop and a table of contents and author commitments were secured soon thereafter (see also http://ican.science.oregonstate.edu/handbook).

The purpose of the handbook is to present the latest developments in the new field of coastal web atlases and to share best practices and lessons learned, which will in turn help readers to determine future needs in mapping and informatics for the coastal practitioner community and improve spatial thinking in the coastal context. The handbook will provide a complete guide to coastal web atlas development and implementation including established principles and recommendations for atlas design, data requirements, necessary

software technology and institutional capacity, as well as best practices for achieving interoperability between coastal web atlases (where concepts, terminology, and even abbreviations that are shared between two or more atlases are understood by all to mean the same thing).

The prime audience for the handbook will be coastal resource managers and consultants, coastal scientists, coastal technologists (e.g., information technologists, GIS specialists, software developers), government researchers, and graduate students. The handbook should be especially valuable to coastal resource managers who need to tackle such topic-based issues (explaining environmental concepts to the public and reaching them with current information has always been a difficult task). It may also be suitable for intermediate, advanced courses in coastal/marine GIS or coastal zone management (i.e., courses toward a related BSc., MSc. or PhD degree, in the classroom but also potentially for distance education as well).

MARINE HARMONISATION INITIATIVES

Selected European and US Efforts

In Europe and the US there is significant activity in the area of marine data harmonisation. A small number of relevant projects and initiatives were presented at the workshop. The European Commission research framework programme funds a number of projects to advance data handling and information sharing in the marine domain, two of which, called ECOOP and SeaDataNet, being reported on here. We were also introduced to the government-funded commercial projects of SeaZone Solutions Limited, as well as to additional perspectives on federated coastal atlases in the US.

European Coastal-Shelf Sea Operational Observing and Forecasting System

The European Coastal-shelf Sea Operational Observing and Forecasting System (ECOOP) project is funded by the European Commission as part of its Framework 6 research programme. It involves 71 partners in 31 European countries and the project duration is 2007 to 2010. The overall goal of ECOOP is to: consolidate, integrate and further develop existing European coastal and regional seas operational observing and forecasting systems into an integrated pan-European system targeted at detecting environmental and climate changes, predicting their evolution, producing timely and quality assured forecasts, providing marine information services (including data, information products, knowledge and scientific advices) and facilitate decision support needs. This is being attained through the following activities.

1. Integration of existing coastal and regional sea observing (remote sensing, *in-situ*) networks into a pan-European observing system.

2. Integration of existing coastal and regional sea forecasting systems into a pan-European forecasting system and assimilating the pan-European observation database into the system.

3. Assessing the quality of the pan-European observing and forecasting system.

4. Advancing key technologies for the current and next generation of the pan-European observing and forecasting system.

5. Developing and generating value-added products for detecting environmental and climate change signals.

6. Integrating and implementing a pan-European Marine Information System of Systems (EuroMISS) for general end user needs.

7. Developing a methodology and demonstrating a European Decision Support System for coastal and regional seas (EuroDeSS) that responds to the needs of targeted end users, as emphasized in the GEOSS and GMES (Global Monitoring for Environment and Security) initiatives.

8. Carrying out technology transfer both in Europe and at an intercontinental level; establishing education and training capacities to meet the needs of ocean forecasters.

Underpinning the above is the development and implementation of a pan-European Data Management System (EDMS) for marine data. The EDMS is being developed in line with the INSPIRE Directive and therefore discovery, view and download services are key components.

The EDMS focuses on marine observational data including sea temperature, salinity, wave, currents, sea level and river run-off data. Currently, there are many different systems and processing chains existing in-house within the Regional Operational Oceanographic System (ROOS) centres that manage these types of data. The EDMS does not aim to re-engineer these internal systems, rather the principle of the architecture is that regional data centres make their real-time and near real-time data and metadata available in harmonised data formats. It is then possible to build INSPIRE-type services on top of these common data formats. In fact, the EDMS acts as a component that simply sits over this harmonised data and metadata. Once the regional centres conform to the harmonised formats, the EDMS component can be simply installed within each centre. Also, common quality control procedures can be more easily implemented and reused on top of this harmonised data. This generic approach reduces duplication of effort and cost, compared to each organisation individually implementing services, quality control procedures, etc., possibly in slightly different ways, which can affect interoperability.

To facilitate the implementation of this architecture, the various standards adopted, developed and maintained within SeaDataNet (discussed below) play an important role within ECOOP. Finally, open source technology, such as GeoServer and GeoNetwork (free, open-source, web-based geographic metadata catalogue systems developed by the FAO and UNEP) are used in implementing this architecture.

The CMRC has a key role in the development of the EDMS. Relevant experience gained through the ECOOP project, particularly in the area of harmonisation and the use of open source technology, can therefore be channelled directly into the technical development tasks of ICAN.

SeaDataNet

SeaDataNet is an EU funded project that runs to 2011 and it aims to create and operate a pan-European, marine data management infrastructure, accessible online through a unique portal (Maillard *et al*., 2007). Its primary goal is the development of a system, which provides access to marine data sets and data products from 35 countries in and around Europe. It will construct a standardised, distributed system for managing the large and diverse data sets collected by oceanographic fleets and the new automatic observation systems.

Key elements in the realisation of such a distributed system include common standards for data processing, communication and quality assurance. This includes the use of XML and international standards, such as ISO 19115, and shared vocabularies.

These shared or governed vocabularies facilitate interoperability between the different databases within SeaDataNet. They are managed in a semantic technical infrastructure, known as the NERC Data Grid (NDG) Vocabulary Server (Lowry and Williams, in press). The semantics in the data and metadata are represented by permanent machine-readable labels (URNs). The metadata schemas incorporate Schematron facilitating content validation against master vocabularies. The URNs are converted into URLs, which are NDG Vocabulary Server term identifiers which are used to return Simple Knowledge Organisation System (SKOS) documents on the searched for concept and its mappings. SKOS provides a standard way to represent knowledge organisation systems using the Resource Description Framework (RDF). Encoding this information in RDF allows it to be passed between computer applications in an interoperable way.

The Vocabulary Server is a Semantic Web resource for the technical governance of controlled vocabularies. Within the Server the fundamental entity is a concept that is represented by an identifier, a term, an abbreviation and a definition. Each concept has a URL corresponding to a dynamically generated SKOS XML document. This document delivers the concept identifiers and labels plus its mappings to other concepts. Within the Server over 122,000 concepts organised in 112 lists were defined as of July 2008.

The SeaDataNet experience can be of great value to ICAN in its development of interoperable atlases. More specifically the SeaDataNet Vocabulary Server is already operational and the existing lists and rich semantics could be reused in an ICAN environment. The content governance structure is also of great relevance to ICAN as it addresses metadata validation by ensuring that only terms from the master vocabulary are used in metadata as well as doing correctness checks on the words being entered.

More on Marine SDI and Related Issues for Coastal Atlases

As discussed and reiterated throughout the workshop, marine SDI (spatial data infrastructure) is largely comprised of national-level datasets that are created with consistent technical standards, quality, and under adequate licensing terms, accessible for use in GIS and Web GIS, with accompanying metadata at appropriate standards, all complying with best practice in industry. Indeed, the experience of the private sector can aid in developing and implementing an effective marine SDI, and is also of great value to ICAN in its mission to develop interoperable atlases that would contribute to such.

Sea Zone Solutions, Ltd. has for many years strived towards a coherent and coordinated approach to marine data acquisition, management and service provision supporting a wide

range of activities and application. They also undertake the collection of comprehensive and authoritative digital marine reference data, comparable to land mapping. Recently SeaZone Solutions has been involved in a survey of International Hydrographic Organization (IHO) member states to establish levels of knowledge of SDI, levels of involvements in national SDI, and status of data to support SDI creation (including for purposes other than navigation), overall willingness to support an NSDI. They will analyze the results and establish a benchmark for future IHO support, while also providing an IHO SDI Guide for Member States.

The examples posed by SeaZone Solutions, Ltd. challenged workshop participants to look beyond the fairly "esoteric" academic community to the sharp end of industry, and to realize that the technologies developed in ICAN may very well be used in the context of the private sector (such as British energy, a whole new industry of sorts). The biggest barriers to integration are people, institutions, and institutional objectives, *not* the technology. ICAN can make a huge contribution by providing solutions in those areas.

On the US front, there were interesting discussions at the workshop on the notion of a federated coastal atlas for the US and why this has not yet come together. The following are some of the probable reasons behind this.

- Most coastal web atlases have not yet become truly operational or mainstream, especially as operational decision-support systems. Education and advocacy work still needs to be done to show the added value that these systems bring (a key role for ICAN).

- There is currently no vocal champion for a *federated* atlas. Now that the Digital Coast initiative has been launched, the time is ripe for this. NOAA CSC and the FGDC Marine and Coastal Spatial Data subcommittee will begin to make inroads here, and this is another key role for ICAN.

- Regional ocean governance is not constrained by state boundaries, and yet it is still often hard to implement partnerships between states. Oftentimes it is easier to take a “silo” approach to one’s atlas, worrying only about datasets, concepts, and language within your own state (and not having to worry about vocabularies or ontologies that must translate to project and initiatives in other regions).

- In recent years, there has not been a critical, systemic issue that coastal web atlases could address. However, this is changing with the emerging awareness of the *impacts* of sea level rise and of global climate change on coastal communities, which are enabling states to get additional funding for high-resolution LIDAR mapping and other surveys.

Tony LaVoi of NOAA CSC pointed out that 200 people at CSC (out of 20,000 employees in all of NOAA) are not going to change coastal zone management practices in the US to better engage with coastal web atlases and SDI, but the new partnership program within Digital Coast could very well make a huge impact. ICAN will pursue joining this partnership, which already includes the powerful National States Geographic Information or NSGIC (along with their Coastal Caucus within), the Association of State Floodplain Managers, the National Association of Counties, the Coastal States Organization, and the Nature Conservancy.

ICAN STRATEGY AND GOVERNANCE

Strategy Statement

Aim of ICAN

In recent years significant advances have been made in the development of Internet resources for decision makers, scientists, resource managers and the general public who are interested in coasts around the world. A key element has been coastal web atlases (aka CWAs), based on web enabled geographic information systems (GIS). Those who have collaborated on coastal web atlas developments over recent years have now come together as part of the International Coastal Atlas Network (ICAN). ICAN aims to be a global reference for the development of coastal web atlases. Here we define coastal web atlases as *collections of digital maps and datasets with supplementary tables, illustrations and information that systematically illustrate the coast for the purposes of coastal zone management and planning, oftentimes with cartographic and decision support tools, all of which are accessible via the Internet.* Via the expertise of its members, ICAN intends to inform, guide and influence in a coherent manner on matters related to research, development and use of coastal web atlases. Furthermore, it will encourage and help facilitate global operational interoperability between coastal atlases in order to enhance data and information sharing among users.

Goal and Objectives

The long-term strategic goal of ICAN is to encourage and help facilitate the development of digital atlases of the global coast based on the principle of distributed, high-quality data and information. These atlases can be local, regional, national and international in scale. This can be achieved by sharing knowledge and experience among atlas developers in order to find common solutions for coastal web atlas development whilst ensuring maximum relevance and added value for the users. In some cases users may be significantly involved in atlas development itself. In order to reach this goal ICAN has the following objectives.

- Ensure that ICAN has representation from coastal web atlas development and user groups from across the world.
- Develop technical and policy guidelines to assist coastal web atlas developers in acquiring data and engaging with data providers. Accordingly, collate and publish a set of best-practise guidelines for the development of coastal web atlases.
- Highlight the benefits of interoperability and standards based systems to the coastal atlas developer communities.
- Develop collaborative projects for the sharing of know-how, implementation of technical solutions and demonstration of atlas benefits to users.
- Align the atlas efforts of the Network partners in order that interoperability can be facilitated.
- Engage with other relevant international projects and developments.
- Involve representatives of the relevant user communities to help in tailoring coastal web atlases to their needs.

Strategic Activities

To further these objectives ICAN has identified a range of activities in which it will engage, arranged under a number of topics:

Technical

The main thrust of activity in the technical area is to research and develop solutions for coastal web atlas (CWA) advancement. A major focus will be on a cooperative interoperability and network project to globally-integrate locally-maintained coastal atlases. Some of the specific activities which will contribute to this are to:

- identify and develop appropriate collaborative applied research projects (e.g., enabling semantic interoperability between existing atlases);
- document and promote specifications and standards of relevance to the coastal atlas community taking into account existing regional and global marine data standards-related projects; and
- identify the information needs for large scale interoperable CWAs.

Awareness Raising

An on-going effort is required to raise awareness and promote the benefits of ICAN to the developer and user communities including non-technical, high-level decision makers. A range of activities has been identified, including the following.

- Participating in and contributing to relevant workshops and conferences (e.g., Littoral 2008, CoastGIS 2009, Coastal GeoTools 2009).
- Publishing in relevant magazines and newsletters.
- Development and dissemination of promotional brochure and poster.
- Development and maintenance of an ICAN Web site and ICAN mailing list; dissemination of an ICAN-specific electronic newsletter.

Outreach and Training

ICAN encompasses a wide range of knowledge and expertise from different disciplines, which will be made available to atlas developer and user communities via:

- contribution of written material to magazines, books and scholarly journals (e.g., handbook on web atlas design and implementation, articles for Journal of Coastal Conservation);
- participation in on-site training (e.g., IODE course for Caribbean Marine Atlas) and development of short distance-learning courses on CWA, potentially within the EUCC CoastLearn distance-learning package, which is to be housed in the IOC-IODE's Ocean Teacher content management system; and
- convening of workshops at conferences to disseminate the knowledge of ICAN, as appropriate.

Assessment and Evaluation

CWA are information tools used by a disparate user community. It is important that efforts are made to ascertain the impact of CWA. This can be furthered by:

- assessing how CWAs are used by different user communities and determining if user expectations are being met;
- carrying out a comprehensive baseline inventory of existing coastal atlases and their functionality; and
- articulating the benefits of atlas semantic interoperability for users.

Funding of ICAN Activities

Funding of the ICAN itself (especially in terms of a central secretariat) is currently not envisaged. However, in order to further the aims of the Network, its activities will need to be funded. Those areas include the following.

- Networking and Workshops: The annual ICAN workshop is a vital event in the ICAN calendar which provides a forum for discussion and progression of ICAN activities as well as helping to consolidate links between the Network participants. Promotion of ICAN at other relevant events is also important. Travel grants and funds to facilitate workshop organisation are required.
- Technical Development: Individual CWA developments are funded from a range of sources. Demonstration activities carried out as part of ICAN have been funded by the participating organisations. In order to upscale these efforts and move towards interoperable CWAs significant funding is required.
- Outreach and Training: The production of training materials and the development of distance-learning modules will need to be financed.

Funding sources will be quite varied – disparate in geographic coverage from national to regional (as with EU) to global (World Bank, UNEP, etc.); disparate in programme goals or objectives into which proposals with a CWA focus can be inserted, or attached to as part of a related project that would benefit from CWA activities. All ICAN members need to take responsibility with regard to highlighting specific funding opportunities to the Network and working on relevant proposals. A list of relevant national and international programmes is provided below in Table 1.

Table 1: *Potential National and International Funding Programmes for Furthering the Aims of ICAN.*

Networking and Workshops

National

- Irish Marine Institute, Sea Change Networking Initiative (http://www.marine.ie/home/funding/FundingCalls/opencalls/NetworkingInitiative.htm)
- United States, National Science Foundation, Office of International Science and Engineering, (http://www.nsf.gov/od/oise/about.jsp)

International

- European Science Foundation, Research Networking Programme (http://www.esf.org/activities/research-networking-programmes/rnp-call-for-proposals.html)
- European Union, Seventh Research Framework Programme, Coordination and Support Activities

Technical Development

National

- United States, National Science Foundation, Office of Cyberinfrastructure (http://www.nsf.gov/dir/index.jsp?org=OCI)

International

- European Science Foundation – COST (http://www.cost.esf.org/index.php)
- European Union, Seventh Research Framework Programme – Environment and ICT themes (http://cordis.europa.eu/fp7/dc/index.cfm)
- INTERREG, European Interregional development programmes. (http://ec.europa.eu/regional_policy/index_en.htm)

Table 1. continued …

Table 1. continued

Outreach and Training

National

- United States, The William and Flora Hewlett Foundation (http://www.hewlett.org/Programs/Environment/)

International

- IODE Project – Ocean Teacher Programme (http://www.oceanteacher.org)
- Europe, EUCC – The Coastal Union – CoastLearn Project (www.coastlearn.org)

ICAN Governance

In order for ICAN to function properly a governance structure is vital. A draft model was agreed during workshop discussions. This presents a possible approach to ICAN governance.

ICAN Governance Model

Participants in ICAN would need to sign up to a Memorandum of Agreement (MOA) or non-contractual arrangement that has clear objectives, milestones and deliverables. Participants can comprise two levels: *full participating membership* and *associate membership*. The former gives "executive" benefits in terms of defining the strategic direction of ICAN, objective setting and input to technical and business developments. The latter gives a passive benefit in being able to keep abreast of developments.

The three main bodies that need to be formed in order to steer the strategic and technical activities of ICAN are a Central Coordination team (CCT), a Steering Group (SG) and a Technical Task Force (TTF). The relationship between these bodies is illustrated in Figure 8. The figure also shows how individual atlas service providers are related to the CCT and interact with the user communities. The form and functions of these coordination entities are described here.

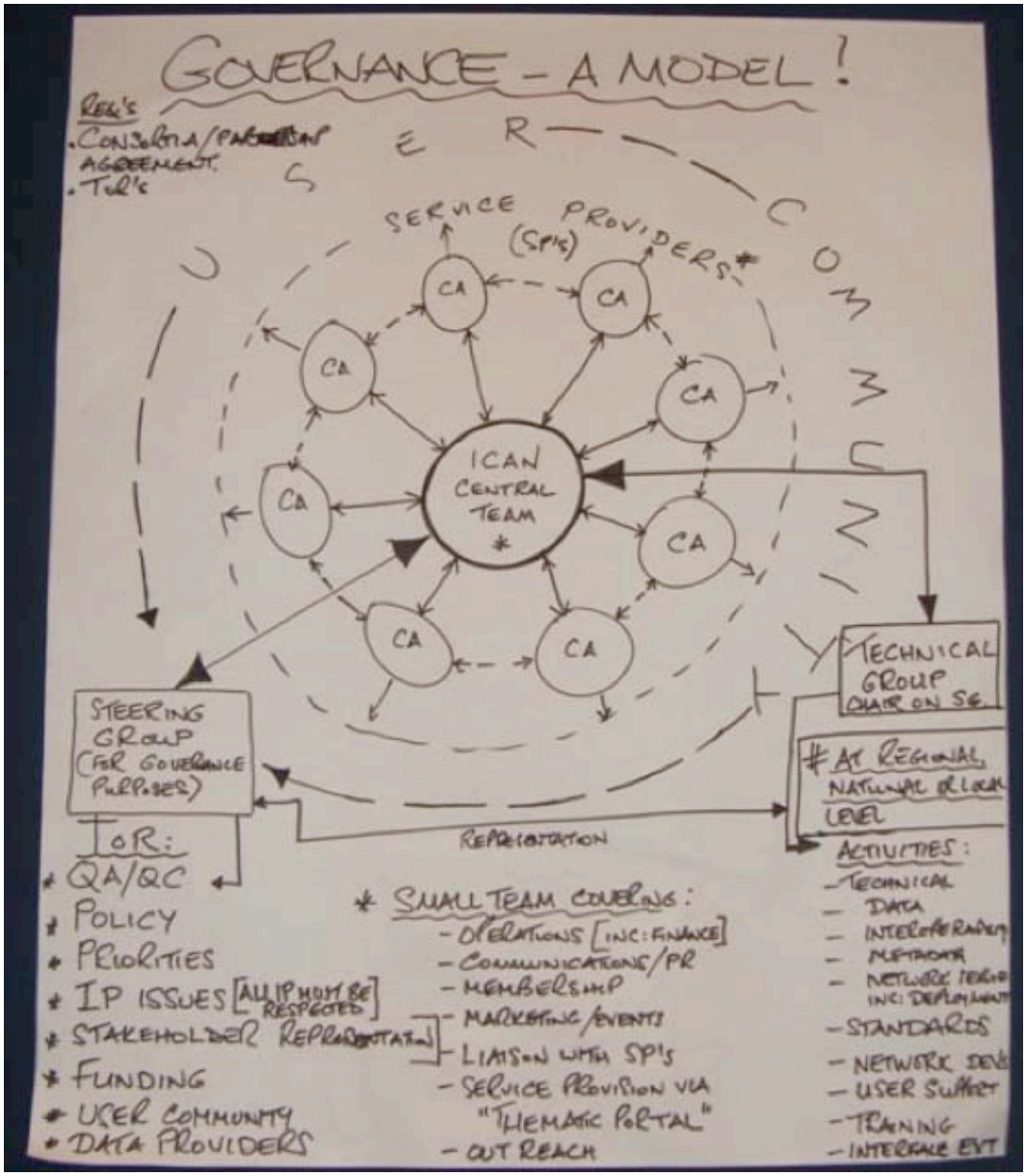

***Figure 8**: Illustration of governance model for ICAN as photographed after the conclusion of the governance breakout report to all workshop participants. See an associated concept diagram at http://ican.science.oregonstate.edu/ican_gov.*

Central Coordination Team [CCT]

The proposal for the long term governance of ICAN is that a management cell comprising of 3 to 4 people would be set up with the primary aim of overseeing all marine and coastal atlas activities of the Network on a global basis whether such initiatives are trans-national, national or regional in nature. The activities of such a body would comprise:

- ❖ delivering the Network strategy;
- ❖ operations (including finance, staff management and work plan);
- ❖ communications and public relations (including events and marketing);
- ❖ membership matters (including quarterly e-newsletter);
- ❖ liaison with service providers;

- management of service provision through the ICAN portal; and
- outreach activities.

Steering Group [SG]

In order to ensure that the objectives of ICAN are delivered on time, to budget and in a responsible manner and to ensure good governance, the setting up of a steering group is vital. Membership of the group would be open to full participating members and representatives from the user community. A properly constituted SG comprises a chairperson, a secretary and ordinary members, although the role of secretary (meeting organisation and minutes) may be spread between ordinary members on a rotational basis. Guidelines for the SG include the following.

- The Chair would be independent of the ICAN membership to ensure transparency in activities is preserved.
- Membership would be on a consensus/volunteer basis although it may be necessary for group members to be elected if competition for seats exceeds the number required.
- Members should serve a maximum period of 3 years to ensure fresh impetus is injected.
- A committee requires a certain number of members in order to function, but equally will not function effectively if it is too large. Experience shows that between 8 and 12 works best.
- The secretariat should be provided by the CCT.
- The chair of the Technical Task Force (TTF) shall be a member of the SG for the purposes of reporting.
- The Chief Operating Officer of the CCT shall be a member of the SG for the purposes of reporting.
- The SG should have a physical meeting once a year with frequent teleconferences (e.g., monthly) throughout the remainder of the year.

The key activities of the SG would centre on:

- a network strategy development and endorsement in partnership with the CCT;
- ratifying operational issues requiring SG endorsement;
- policy area decisions;
- prioritising activities of the Network;
- funding of ICAN, including securing funding streams where necessary;
- ensuring appropriate representation of the CWA user community;
- ensuring appropriate representation of data providers; and
- arbitration on any Intellectual Property Rights issues and in the case of disputes and /or grievances amongst ICAN members.

Technical Task Force [TTF]

In order for ICAN to progress on the technical development and delivery front, there is a need for a technical task force (TTF). TTF membership would be open to full participating members who have an interest in technical issues (e.g., atlas design, ontologies, metadata, network services, interoperability, etc.). The actual number of members would depend on the level of technical activity. The chair of the TTF would be elected from the TTF membership and a chairing period would be no longer than 3 years. To maintain momentum within the TTF teleconferencing and periods of co-located working can both be effective. Moderated discussion fora could be maintained in order to engage the wider community including the associate membership. The secretariat role would be provided by the CCT.

The key activities of the TTF would include:
- metadata issues;
- data and organisational interoperability;
- data specifications;
- data theme requirements;
- network services;
- rechnology tracking;
- research and development of innovative solutions;
- updating structure and architecture of ICAN web portal and interoperability prototype;
- interface extensions to CWAs;
- ontology content and technical governance.
- evaluation and selection of interoperability standards for use in ICAN;
- contribution to the interoperability standards development process;
- supporting and responding to the user community;
- technical training of CWA developers, especially in the form of documentation, cookbooks, how-to user manuals, etc.;
- knowledge transfer; and
- digital rights management (DRM).

The TTF would also oversee technical project activities that are agreed on by the SG and undertaken within an ICAN context. The TTF would be involved in co-ordinating:
- project selection;
- technical development, assessment and selection;
- project implementation; and
- project evaluation.

Ontology Content and Technical Governance

Achieving interoperability between CWA requires the use of ontologies. Ontology content and technical governance is therefore an issue that needs to be addressed within the TTF.

Ontology Content Governance relates to the determination of the terms and definitions to be included in ICAN interoperability ontologies. One possibility is that of an 'ontology development' specialist subgroup reporting to the TTF. This would provide the ideal nucleus for ICAN ontology content governance.

Technical governance covers the storage, security, change management and serving of the ontologies developed by ICAN. Such governance has to deliver:
- stability and permanence for at least the lifespan of ICAN;
- data security with backup policies conforming to digital preservation best practice standards (e.g., daily backup with copies in at least two physical locations);
- managed file versioning with preservation of previous versions;
- version time stamping; and
- effective serving to both humans and software agents.

The principles and best practice for feature type catalogue content and technical governance are specified in ISO19135. These are equally applicable to vocabulary and ontology repositories.

ICAN will need to make a choice as to whether it wants to develop its own ontology technical management infrastructure or outsource the work through either a service level agreement or by establishing a partnership with an existing repository.

Associate Membership

Those with an interest in CWA come from a variety of backgrounds and represent a wide range of application areas. These include the following entitites.

- Central/Federal Government (e.g., Defra; NOAA).
- Regional / Local Government including coastal groups (e.g., Flanders; Wisconsin State; Irish Coastal network).
- Content Providers (e.g., SeaZone/UKHO; NOAA).
- Industry Groups (e.g., Oil & Gas UK).
- Technology Providers (e.g., Google; ESRI).
- Research Groups (e.g., university research groups such as CMRC of University College Cork, Ireland, OSU; national research groups such as NERC-UK).
- Educational Bodies (e.g., universities, curriculum development groups).
- Inter-Governmental Bodies (e.g., EU; IOC; IMO).
- Non Profit Organisations (e.g., MapAction; World Wildlife Fund; OGC).

Memorandum of Agreement

The Memorandum of Agreement (MOA) drafted during the first ICAN workshop in Cork, Ireland, (http://workshop1.science.oregonstate.edu/mou) forms a sound basis for an initial agreement between full participating members. It covers organisational commitment for participation by its employees in ICAN activities. An adaptation of this preliminary MOA reads:

> *Pursuant to the stated aims and objectives of the International Coastal Atlas Network (ICAN) we, the undersigned, are endorsing this Memorandum of Agreement. This is an agreement between the signatory institutions to jointly pursue funding and projects in the interest of advancing the utility and interoperability of coastal web atlases. Our goals are to develop a community of common purpose to improve collectively and individually the information resource represented by the existing resources and to develop standard and practices that will improve the value of these for the future.*
>
> *These efforts will encompass information technology, geographic information systems, and data and metadata content standardization to enhance comparability of information and interoperability of data systems. ICAN participants will be involved in the development and subsequent shared use of resources subject to which the developers have Intellectual Property Rights. ICAN participants agree to respect these rights by not distributing these resources without the developers' permission and by providing full acknowledgement to the developers where these resources are deployed.*

What remains to be clarified is the identity of the entity signing up to the agreement. Is it an individual, a group, a department, or a 'legal entity' (e.g., NERC for BODC)? This needs to be clearly resolved.

As ICAN develops, it is inevitable that the situation will arise where circumstances force a partner to withdraw from the Network. Any conditions associated with such circumstances need to be documented in the MOA. It might also include a 'will clause' to cover the unlikely circumstance of full dissolution of ICAN.

TECHNICAL DIRECTIONS/DEVELOPMENTS

Interoperability Prototype

A technical breakout group met several times over the course of the workshop to discuss in detail several issues with regard to the next versions of the ICAN interoperability prototype, what is needed in order to broaden the prototype to a wider network of atlas nodes (i.e., new atlas participants), and what are the general technical services that will be required in order to maintain all aspects of ICAN's work. Continuing progress is now being documented at http://ican.science.oregonstate.edu/ican_tech.

An initial item of discussion was the next iteration of the user interface for the prototype, and the service that would be available to ICAN users. The user interface is indeed a prime consideration and an excellent opportunity to learn from existing examples, most notably the InterRisk project (http://interrisk.nersc.no/) and the Irish Spatial Data Exchange (ISDE; http://www.marine.ie/isde/default.htm). ISDE focuses on structured level integration whereas ICAN is taking a semantic approach. The InterRisk approach is to totally harmonize, while ICAN wants a more mediated approach because of the need to link to a wide range of external, locally maintained atlases. It was discussed how the next iterations of the ICAN interoperability prototype could combine both approaches, as they are complementary (Figure 9).

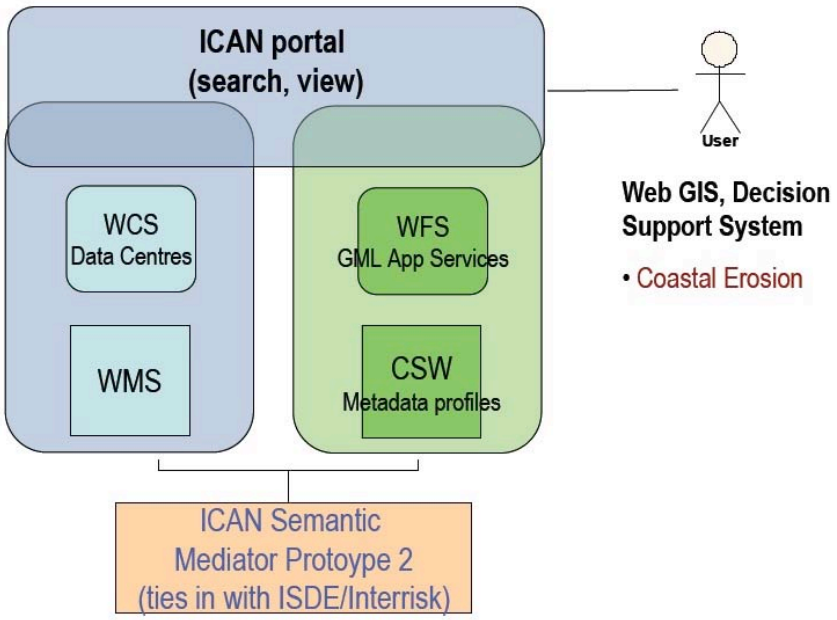

Figure 9: *A conceptual diagram of what the next iteration of the ICAN interoperability prototype might look like, given a revamped interface with access to several more OGC services, following the example of InterRisk and ISDE.*

In terms of semantic mediation (as reviewed in Wright *et al.*, 2007 and Lassoued *et al.*, 2008), the prototype is already performing this on the CSW side, but what about at the other end? The real technical interoperability question to be addressed is the mediation of disparate features (from multiple data sources). Therefore, should the next version of the prototype perform mediation by way of WFS rather than WMS? Discussions are still ongoing regarding this issue, and leaning toward mediating (mapping) WFSs, while using only one main WMS at the ICAN interface level, thereby saving the need to restructure data, tags and content on the fly.

Key action items for the immediate future are listed below.

- Expand interoperability prototype participants to include:
  - the African Marine Atlas (Selorm Ababio)
  - Flanders Institute of Marine Science (VLIZ), especially their marine boundaries layer (Simon Claus)
  - the Washington Coastal Atlas (Liz O'Dea)
  - a new Wisconsin coastal atlas (David Hart)
  - Institute of Marine Science, Venice, Italy (ISMAR-CNR) (Alessandro Sarretta)
  - ISDE/Interrisk web services (Eoin Ó Grady, Declan Dunne)
- OCA and MIDA team to work on and provide a cookbook for the new participants above so that they can fully participate in Prototype version 2.
- All Prototype version 2 atlases to implement WMS.
- An advanced subset will implement WFS.
- Full documentation of all procedures at all stages will be ongoing, and ultimately included in the handbook to be published by IGI-Global.
- Create an email listserv for ontology maintainers to discuss, get guidance (or consider participating in the SeaDataNet ontology listserv)
  - ICAN's listserve should include coastal erosion domain experts (based on experience of successful listserves in SeaDataNet and Marine Metadata Interoperability or MMI).
  - Local ontology maintainers should also seek out a coastal erosion domain expert in their own organization to discuss with.
  - Use CmapTools as a tool to help domain experts visualize the ontology.
- ICAN should anticipate broadly sharing existing ontologies by way of ontology registries (e.g., the MMI ontology registry at http://marinemetadata.org/community/teams/ont/mmirepository/orinstructions, SeaDataNet, a GEOSS architecture implementation registry, etc.), so that local atlas maintainers can access and use them to create their local Web ontology language (OWL) files. Any existing ontology can be adopted and customized as appropriate to a specific atlas.
- Articulate benefits to be gained by new participants from *both* the user *and* data provider perspective (and for supervisors of current participants). For example, one of the benefits would be a "we can" approach on broader scales for regional, international governance (e.g., EU). It is easy to identify issues on a national scale, but beyond this it can be difficult to get support from neighbouring member states. The "we can" (or to use the Bob the Builder slogan, as adopted by Barack Obama,"yes we can") perspective will help to ease this.

In terms of the different roles for people to play in building this wider network of atlas nodes, ICAN anticipates the need for:

- several local atlas administrators (one per local atlas node in the prototype) to serve as "OWL keepers," those who will maintain the local atlas ontology. These people should

also consult with a domain expert within their local organisation (e.g., a coastal erosion expert) to ensure that the CSW catalogue has correct information.

- ❖ one "mapper" overall to maintain ICAN vocabulary mappings between the global, "super" ontology and all of the local ontologies (keeping the global files separate from the local ones). The need for a mapper is anticipated because an ontology person may not always understand how to perform the mappings.
- ❖ one committee to maintain global, super ontology; and
- ❖ one person (with a strong computer science background) to keep track of and share with the technical team the latest existing ontologies that have come online in allied fields, ontologies that we can customize so as not to completely reinvent the wheel. This person will also recommend any new ontology-creation or -maintenance tools that might be adopted.

Below is a list of software, personnel and financial resources that are anticipated for the future.

- ❖ Each local atlas administrator will need, at a minimum, the following free software: Protégé (http://protege.stanford.edu/) for creating ontologies, CmapTools (http://cmap.ihmc.us) for visualizing ontologies, and GeoNetwork (http://geonetwork-opensource.org) for building a local CSW node.
- ❖ The ICAN Technical Task Force will need to keep in touch with GeoNetwork staff so that they know what we are trying to accomplish with their software, and can perhaps fastrack us from time to time toward best practices. Their software needs to allow for the incorporation of ontology-based searches. Yassine Lassoued will be a point person on this item.
- ❖ Future ICAN grants should anticipate providing 1-3 months of salary for local atlas administrators to cover the ontology work that they will need to perform.
- ❖ It may be appropriate from time to time to employ undergraduate students to assist with simple, repetitive tasks, and advanced graduate students may be suitable for advanced technical work.

ICAN Portal

There was also an extended discussion of what an overarching ICAN portal should include, as the portal will provide access not only to the interoperability prototype where coastal web atlases will be linked together, but also to the many coastal web atlas resources (e.g., user and developer guides, handbooks and articles on best practices, information on standards and web services, expertise and technical support directories, education, outreach, and funding opportunities, etc.) and other community-building features that ICAN would like to provide to the coastal zone management community.

The group decided that an open source content management system such as Drupal (http://drupal.org), would be best for building an initial portal, and that a small group of people (e.g., one portal administrator and several authenticated users) should be given accounts for updating and adding new content to the portal.

Desired features of the portal include the following features.

- ❖ A **definition/mission statement** for ICAN as well as a section to clearly explain what the current ICAN prototype does.

- ❖ An **expertise directory** in a relational database of coastal web atlas experts (starting with name, institution, and area of expertise). Ultimately this will allow a user to send a

message to an expert, not necessarily by simple email, but by an internal messaging system. Simon Claus has experience setting up a similar system at VLIZ, which can maintain modular projects, publications, conferences, other sub-selections of an expertise directory within the same the database (their IMS or integrated marine information system). The group agreed to initially adopt Simon's approach at VLIZ and to investigate integrating this into Drupal.

- A **resource directory,** also in a relational database. Links to pieces of code, APIs, where and how to obtain MapServer software, GeoNetwork files, OGC specifications and instructions, etc.

- **Threaded discussion fora** with email notifications to subscribers whenever a new posting has been added. The email would provide a teaser of the post with a link to take one directly to the forum without having to log back in. All emails and transactions would be archived and searchable. It would also be nice to have the ability to post directly to a blog by email. These fora would facilitate communications between the main strategic planning/funding, governance, and technical working groups, but would also cover various themes started in Trans-Atlantic Workshop 1 in Cork (aka ICAN 1, O'Dea *et al.,* 2007), such as use cases, atlas design, atlas technologies, institutional capacity, etc. A moderator for a forum would send out discussion questions and ask for feedback. Again people would get an email when something new is posted (check on that capability in Drupal). People would need to volunteer to be a moderator. This is for our existing community of ICAN. Forum topics could link back to documentation and to the OWLs.

- **Cookbooks with tutorials**, especially for people who are starting a new atlas. Our handbook published by IGI-Global will cover this but we will want to have material online as well. The handbook will be more theoretical whereas the web content will refer more to step-by-step instructions. A chapter written for the handbook might refer to an appendix that would in reality be a section of the portal with the related step-by-step instructions.

- A **map of current ICAN participants (atlas nodes)** with the ability to add oneself to the map, or to download the map in KML. This may also be folded into the interoperability prototype at some point.

- An **inventory or directory** of atlases, regardless of whether they are in ICAN or not. NOAA CSC is working on inventory of U.S. efforts and EurOcean could help with an inventory of European atlases. These inventories will serve to confirm and refine the definition of a modern coastal web atlas, and would include an ICAN list of standard features and services. This feature is also closely related to atlas assessment, and at another level, evaluation.

- A **bibliography** of ICAN conference papers, journal articles, workshop reports, books, etc.

- **Support for working tasks**, such as collaborative writing and task scheduling with milestones and units (as in a standard GANTT chart, a popular type of bar chart that illustrates a project schedule or timeline, http://www.ganttchart.com).

In November 2008 most of these features were implemented in Drupal at the web address http://ican.science.oregonstate.edu, with additional work that will be ongoing throughout 2009. The group chose the domain name of **icoastalatlas.net** as a general alias. This domain name has been purchased and registered to Oregon State University, and will now function properly as an alternate address for the portal.

CONCLUSION AND FUTURE DIRECTIONS

The workshop on "Federated Atlases: Building on the Interoperable Approach" (known also as "ICAN 3") was a successful follow-up to the 2007 workshop "Coastal Atlas Interoperability" (known also now as "ICAN 2") and the 2006 meeting "Potentials and Limitations of Coastal Web Atlases" (known also now as "ICAN 1"). ICAN 3 represents yet another step toward long-term goals of implementing and recommending best practices on all aspects of coastal web mapping, while developing a cadre of scientists who will play a leading role in forging international collaborations and technical solutions of value to their participating nations.

The workshop and EEA Conference on Coastal Atlas Development that immediately followed showed clearly that the goals and work of ICAN have great value and potential. Truly there are many avenues for members of the ICAN community to engage in outreach, marketing, and positioning within existing broad initiatives. The prior sections of this report have highlighted some of the potential "hooks" for ICAN to link to in terms of proposals, partnerships, and gaining the interest of similar groups who want to join in. Discussions will be ongoing in the coming year as to how we might best absorb all of this, and what will be feasible along lines of strategic planning, financing and governance, as well as technical considerations (organizing the actual work).

We are reminded that while the technical activities of ICAN (e.g., our ambitious interoperability prototype) are critically important, ICAN is also all about education, outreach and general capacity building regarding coastal web atlases. As Tony LaVoi of NOAA CSC ably expressed it, "we are trying to help our community buy down the cost of getting into the game of coastal atlases." ICAN has laid out some very specific action items for working groups to pursue along these lines (available now on the ICAN portal), and we will continue to refine our strategic plan and to craft a sustainable "business model." *ICAN has truly progressed from a project to a full-fledged program.*

We still face many challenges in terms of long-term funding, and will need to consider focusing on one or two high-profile issues in order to attract funders/advocates. One such issue would be climate change *impacts* (especially decision support for coastal communities vulnerable to climate change, island nations threatened by sea level rise, and the like). ICAN will need to articulate the practical, applied products that it would make available (e.g., the MIDA "engine" that could be shared with fledging coastal web atlases, cross-walks between FGDC and ISO metadata standards for trans-national sharing of metadata catalogs, best practices for implementing OGC web services for coastal web atlases, available solutions to help an agency or organization do better what they are *already* mandated to do, provision of the knowledge gained as a result of working closely with partners on a common, proven approach, etc.). As ICAN moves forward with its atlas inventory and assessment work, we hope to come up with real numbers in terms of who is using and benefiting from our atlases (i.e., how many users, who they are, how much

money they are saving as a result of using our atlases, etc.). And the EEA has pledged to advocate on behalf of ICAN to broader initiatives such as GMES (Global Monitoring for Environmental Security), GRAME (Global Regular Assessment of Marine Environments) and GEOSS (Global Earth Observation System of Systems), among others.

Indeed, ICAN very much appreciates the support of EEA in hosting our workshop and in securing the participation and interest of members of the EU Commission and of various projects around Europe. ICAN will greatly benefit from the continued advocacy and partnership of the EEA. Toward this end, the EEA will be a co-organizer, along with OSU and CMRC, of a **4th international workshop**, which will be held at the Adriatico Guest House, International Centre for Theoretical Physics, UNESCO University, **Trieste, Italy**, **November 16-20, 2009**. The EEA plans to schedule their meeting of the European national reference centres (with an eye toward coastal and marine issues) at the same venue, immediately following ICAN 4.

Preliminary objectives and topics for ICAN 4 include the following.

- A focus on users: better knowledge of our users, their needs, and on continued inventory, assessment, and evaluation of atlases.

- Revisiting the main recommendations of the ICAN 1 workshop, picking up where we left off there in 2006 and addressing the recommendations that have not yet received adequate attention. One recommendation was the needed emphasis on users, already mentioned above. Others would include evaluating atlas impact, and developing analysis and decision-support tools in atlases.

- Continued progress on our ontology and semantic interoperability work, but with an eye also toward articulating the benefits of semantic interoperability at a broader scale, to non-specialists. In this we look forward to the advice and assistance of MMI and SeaDataNet, who have already developed conceptual framework documents in this area. Both groups plan to have representation at ICAN 4.
    - A small "workshop within a workshop" for atlas administrators on how to become a new node in interoperability prototype.
    - Strategize on developing further improvements of all those nodes (according to the SEIS principles of sharing information for *multiple* purposes, using data and systems that are accessible and interoperable).
    - Discuss further work needed on partnerships, infrastructure and data exchange formats, all with the overall objective of enabling the nodes to share and communicate with each other, avoid duplication, and streamline information management.

- A small "workshop within a workshop" general atlas users, how to function effectively in CWAs, especially as the technology continues to change.

- Presentations on emerging atlases in European countries (especially the Mediterranean) that are making themselves relevant through policy, environmental and socio-economic indicator work and related themes.

- Roll out final implementation structures on governance (including formal procedures for receiving new members), strategic planning, and technical activities so that ICAN can formally incorporate as an organization.

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Appendices

Appendix A: Participating Institutions in ICAN

ICAN is still an informal partnership and at the time of this writing has not yet been officially incorporated, or defined by memoranda of understanding. Additional members will be welcome as we formalize!

Coastal and Marine Resources Centre, University College Cork, **Ireland**
Department of Geosciences, Oregon State University, **USA**

African Marine Atlas (South African Institute for Aquatic Biodiversity and University of Ghana)
British Oceanographic Data Centre, **England, UK**
California Coastal Commission, **USA**
Caribbean Marine Atlas (9 Caribbean nations including Barbados and Trinidad & Tobago)
Co-ordination Centre for ICZM, **Belgium**
Department of Geography, University of Washington, **USA**
Department of Agriculture, Fisheries and Food, **Ireland**
Environment & Heritage Service, **Northern Ireland, UK**
EurOcean European Centre for Information on Marine Science and Technology, **Portugal**
European Environment Agency, **Denmark**
Flanders Marine Institute, European Network for Coastal Research, **Belgium**
Geological Survey of **Ireland**
Institute of Marine Sciences, National Research Council, **Italy**
Institute for Natural Resources, Oregon State University, **USA**
Marine Institute, **Ireland**
Marine Metadata Interoperability (MMI)
Maritime & Coastguard Agency, **UK**
Memorial University Newfoundland, **Canada**
NOAA Coastal Services Center, **USA**
NOAA's Digital Coast Initiative, **USA**
Oregon Ocean-Coastal Management Program, **USA**
San Diego Supercomputer Center, **USA**
Scripps Institution of Oceanography, **USA**
SIGLA (GIS for the Coastal Zone Management of Andalucia), **Spain**
Strangford Lough Management Committee, **Northern Ireland, UK**
Southeast Universities Research Association (SURA), **USA**
Ulster Museum, **Northern Ireland, UK**
UNESCO IOC's IODE (International Oceanographic Data and Information Exchange)
University of Ulster, **Northern Ireland, UK**
Université Paul Cézanne, **France**
Virginia Institute of Marine Science, **USA**
Washington (state) Department of Ecology, **USA**
Wisconsin Sea Grant's Digital Great Lakes and Coastal Communities, **USA**

Appendix B: Workshop Program, 7-11 July, 2008

Workshop Chairs: Dawn Wright (DW) of OSU, Ned Dwyer (ND) of CMRC
Host: Ronan Uhel (RU) of EEA

Time	Day 1 - Monday, 7 July 2008
1:30-2:00p	**Registration** Secretariat
2:00-2:15p	**Opening Statement** *ND* to welcome participants and introduce *RU*
2:15-2:30p	**Introduction to Workshop Objectives & Agenda** Review outcomes of workshops 1 & 2 (*DW*) Agenda and objectives of Workshop 3 (*ND*)
Session I	**Review of Ontology Prototype Development** *Chaired by ND*
2:30-3:15p	**Presentation and Demo** *Yassine Lassoued, Ned Dwyer (CMRC); Tanya Haddad (OCMP)* - Aims of prototype development - How the work programme went - Demonstration of prototype - What was learned - Next steps - Discussion
3:15-3:45p	**Coffee Break**
Session II	**ICAN and Emerging Maritime Policies** *Chaired by RU*
3:45-4:05p	**European Policy Context/Overview** *RU* - Integrated maritime policy - EU Atlas of the Seas - Formation of DG Mare - European Marine Observation and Data Network or EMODNet - Emerging GMES fast track MyOcean
4:05-4:30p	**U.S. Initiatives** *DW, Tony Lavoi, NOAA; Tim Nyerges, U-Washington* - West Coast Governors' Agreement on Ocean Health - NOAA report on federated U.S. coastal atlases - Global Research Alliance for Digital Data (GRADD)
Session III	**Extending the ICAN Community** *Chaired by DW*
4:30-4:40p	**Rationale for New Participants** *DW* - Appropriate membership standards for ICAN - New participants introduced, their goals and objectives - Other international initiatives
4:40-5:00p	**IODE Overview** *Greg Reed, IODE*
5:00-5:20p	**Caribbean Atlas Developments** *Greg Reed, IODE*
5:20-5:40p	**African Atlas Developments** *Lucy Scott, South African Institute for Aquatic Biodiversity*
~6:00p	**Icebreaker reception sponsored by SeaZone**

Time	Day 2 - Tuesday, 8 July 2008
Session IV	**Marine Harmonisation Initiatives** *Chaired by ND* Raise awareness of other projects, initiatives, and groups doing work of relevance to ICAN.
9:15-10:10a	**Europe** - ECOOP (*Declan Dunne, CMRC*) - SeaDataNet (*Roy Lowry, BODC*) - Marine SDI and Base Mapping Needs of Coastal Atlases (*Mike Osborne, SeaZone Solutions Ltd., UK*)
10:10-10:30a	**U.S.** - Wisconsin Sea Grant (*David Hart*)
10:30-10:45a	**Other Regions** - Australia and the Pacific - (*Greg Reed*) - Africa - (*Lucy Scott*)
10:45-11:15a	**Coffee Break**
Session V	**ICAN Outreach and Training** *Chaired by DW*
11:15-11:30a	**Training Workshops and Writing Opportunities** *Yassine Lassoued, DW* - CMRC's experience at IODE MapServer Workshop for the Caribbean Marine Atlas - Abstract submitted to Littoral 2008 - Extended abstract submitted to GIScience 2008 - Terra Cognita 2008 call for papers - Manuscripts for *Coastal Management* on ICAN 1 and 2? - New IGI book contract for *Handbook of Coastal Informatics: Web Atlas Design and Implementation* - CoastGIS 2009, Brazil - Coastal Zone 09, Boston, MA - Coastal GeoTools 09, Myrtle Beach, SC
Session VI	**The Future of ICAN** *Chaired by ND*
11:30a- 11:45a	**Introduction to Breakout Groups** *ND* - Introduction of aims of the groups and outline some of the issues to be discussed, with expected outcomes
11:45a- 12:45p	**Breakout Groups** *All participants* - **Technical** (*led by DW*) (e.g., metadata alignment and profiles, vocabularies, ontologies, OGC services) - **Strategic Planning/Funding** (*led by ND*) (e.g., interim and long-term funding initiatives, strategy document) - **Governance** (*led by Roy Lowry, John Pepper*) (e.g., proposed models, structure, remit) GEOSS Example
12:45-2:00p	**Lunch**
2:00-2:40p	**Breakout Groups (continued)**
2:40-3:15p	**Presentations of Breakout Deliberations** Strategic/Funding Governance Technical: Presentation | Follow-up Notes Task/Timeline Spreadsheet
3:15-4:00p	**Discussion**
4:00-4:30p	**Coffee Break**
4:30-5:30p	**Writing Groups**
~7:00p	**Dinner at EEA**

Time	Day 3 - Wednesday, 9 July 2008
Session VII	**ICAN Governance, Strategy, and Technical Development** *Chaired by ND/DW*
9:00-11:00a	**Plenary Discussion Session** *led by DW and ND* - Agreement on critical activities of ICAN, final governance structure and people assigned to roles. The interim and long-term strategies to be outlined, technical issues in coming year to be further discussed. Venue and goals for Workshop 4. - Including time to introduce/discuss how ICAN will be represented within the EEA conference and our expectations for that conference
11:00a- 12:00p	**Break**
12:00p- 1:30p	**Lunch**
1:30-6:00p	**EEA Conference**
	Dinner and evening activities on your own

Time	Day 4 - Monday, 10 July 2008
9:00a-5:30p	**EEA Conference**
	Dinner and evening activities on your own

Time	Day 5 - Friday, 11 July 2008
10:00a- 1:00p	**ICAN Workshop 3 Group to meet informally for further concluding discussions and way forward** *Chaired by ND/DW*
	Departure for most ICAN participants

Appendix C: Access to Presentation Files, Notes, Photos, Links

This workshop report has an accompanying web site at

<http://ican.science.oregonstate.edu/ican3>

from which the reader may download all PowerPoint files presented at the workshop, as well as working papers and prior reports, breakout group notes, photographs, and links to related web sites.

Appendix D: Chair & Speaker Profiles

Ned Dwyer

Remote Sensing Specialist
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Ned has a MSc and a PhD in Remote Sensing. He has worked for many years with both optical and radar satellite data for a range of applications including fire detection, rice mapping and natural disaster monitoring. Since joining the CMRC in 2002 he has been working on development of the Marine Irish Digital Atlas (MIDA). Activities have included project management, atlas design, dataset sourcing and preparation and development of educational and informational elements. He also contributes to teaching in University College Cork's Department of Geography, at both undergraduate and postgraduate level, on remote sensing and GIS. Since December 2005, Ned is in receipt of a fellowship from the Environmental Protection Agency to work on aspects of climate change research related to the Global Climate Observing System (GCOS).

Ronan Uhel

Head, Spatial Analysis
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European Topic Centre Land Use and Spatial Information
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Ronan has 20 years in environmental and sustainable development information and analysis at the European and international level. He specializes in bridging between science (knowledge) and policy (actions), and in assessing the state-of-the-environment and policy effectiveness. Ronan has had coordination and editorial responsibility for many studies, reports and publications on these topics, with broad coverage from economic sectors to technologies to education. He has participated in many committees and working groups at the European and international levels on environmental governance, and has been a speaker/discussant at conferences and workshops covering all aspects of environment and development issues. Ronan's academic background is in geography, physical planning, and oceanography, with additional training in EU environmental legislation and regional policies.

Dawn Wright

Professor of Geography and Oceanography
Director of the Davey Jones' Locker Seafloor Mapping/Marine GIS Laboratory
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Dawn Wright's research interests include geographic information science, benthic terrain and habitat characterization, tectonics of mid-ocean ridges, and the processing and interpretation of high-resolution bathymetry and underwater videography/photography. She has completed oceanographic fieldwork in some of the most geologically-active regions of the planet, including the East Pacific Rise, the Mid-Atlantic Ridge, the Juan de Fuca Ridge, the Tonga Trench, and volcanoes under the Japan Sea and the Indian Ocean. She serves on the editorial boards of the "International Journal of Geographical Information Science," "Transactions in GIS," "The Journal of Coastal Conservation: Planning and Management," and "The Professional Geographer," as well as on the National Academy of Sciences' Ocean Studies Board, Committee on Strategic Directions for the Geographical Sciences in the Next Decade, the Standing Committee on Geophysical and Environmental Data, and the Steering Committee and Technical Team of the Marine Metadata Interoperability project. Dawn's most recent books include Arc Marine: GIS for a Blue Planet" (with Michael Blongewicz, Pat Halpin, and Joe Breman, ESRI Press, 2007), "Place Matters: Geospatial Tools for Marine Science, Conservation, and Management in the Pacific Northwest" (with Astrid Scholz, Oregon State University Press, 2005), "Undersea with GIS" (published by ESRI Press, 2002), and "Marine and Coastal Geographical Information Systems" (with Darius Bartlett, Taylor & Francis, 2000).

Declan Dunne

Geomatics/GIS Specialist
Coastal & Marine Resources Centre
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Declan graduated from University of Limerick, with a BSc in Computer Systems (1.1 Hons) in 1998. After graduation he worked as a software engineer with Oracle in Dublin for 3 years. He joined the Coastal & Marine Resources Centre in November 2002 as a researcher in the Marine Geomatics team where he worked on the three-year Marine Geographic Information Systems and High-Performance Computing Network (HyperGIS/MarineGrid) project funded by HEA PRTLI III. In 2006, Declan graduated from University College Cork with a M.Sc. in Applied Science (Modelling and Numerical Computing). Declan developed the Marine Irish Digital Atlas (MIDA) website middleware and database components using PHP/MapScript and PostgreSQL RDBMS, which is accessed through a web-mapping interface.

Tanya Haddad

Coastal Atlas Administrator
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Tanya has an Master of Environmental Management degree in Coastal Environmental Management from Duke University. She has worked at the Oregon Coastal Management Program since fall 1998, the first 2 years as a NOAA Coastal Management Fellow working on the Dynamic Estuary Management Information System (DEMIS), and subsequently on Dawn Wright's NSF grant to construct the Oregon Coastal Atlas. She currently maintains and updates the Atlas and is always looking for ways to improve it.

David Hart

Coastal GIS Specialist
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David joined the Wisconsin Sea Grant Advisory Services team in 2002, after working with Sea Grant on coastal GIS applications through the UW-Madison Land Information and Graphics Facility. As one of the few full-time Sea Grant GIS specialists in the country, David provides assistance to local governments and other coastal constituents in the areas of coastal hazards, land use, floodplain management and water quality. He also makes these tools available for other Sea Grant Advisory staff. David holds an M.S. in Urban and Regional Planning from the University of New Orleans and a Ph.D. in Land Resources from the University of Wisconsin at Madison.

Yassine Lassoued

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Yassine Lassoued is a computer science and GIS researcher interested in several fields, notably: geographic data integration, ontologies, metadata and data quality, and the use of Artificial Intelligence (AI) for data and metadata integration. He graduated from the National Civil Aviation Faculty (Toulouse - France) with an engineering diploma in Computer Science and Air Traffic, as well as a MSc in computer science and Artificial Intelligence (AI), in 2000. In 2005, he graduated from University Aix-Marseille 1, with a PhD in Computer Science and GIS. During his PhD, he worked as a temporary researcher and teacher in Universities Aix Marseille 1 & 2, and the Institute of Advanced Internet Applications. After graduation he joined the Coastal and Marine Resources Centre in 2006 as a researcher on the GIS team. In addition to ICAN, he is working on a host of projects within the IMAGIN and InterRisk initiatives.

Tony LaVoi

Chief of Coastal Information and Application Services
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Tony LaVoi is the Chief of the Coastal Information and Application Services (CIAS) Division at the National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center in Charleston, South Carolina. The Coastal Services Center was established in 1995 with a mission to support the environmental, social, and economic well being of the coast by linking people, information, and technology. The Center assists its primary customers, the United State's coastal resource managers, by providing access to information, technology, and training. The CIAS division focuses its efforts on geospatial standards and interoperability, software application and database development, Internet programming and visualization, and network and desktop IT support. Tony also serves as the NOAA representative to the Federal Geographic Data Committee (FGDC), the Geospatial One-Stop Board of Directors, and the Ocean.US Data Management and Communications Steering Team. He chairs both the NOAA GIS Committee and the Marine and Coastal Spatial Data Subcommittee of the FGDC, and leads the development of the National Ocean Service Data Explorer GIS data portal. Tony is a graduate of the University of Wisconsin School of Engineering.

Roy Lowry

Technical Director
British Oceanographic Data Centre
Natural Environment Research Council
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Roy Lowry is the Technical Director of the BODC. He took on that role in 2000 after working in the organisation for 6 years as a programmer followed by 13 years developing the concept of "project data management" and running the data management for UK projects such as the NERC North Sea Project, Biogeochemical Ocean Flux Study (BOFS) and Land Ocean Interaction Study (LOIS), and EU projects such as Ocean Margin Exchange (OMEX) and Inlet Dynamics Initiative Algarve (INDIA). During this period he chaired the international Joint Global Ocean Flux Study (JGOFS) Data Management Task Team for nearly nine years. During this time considerable practical experience was gained in the collection and handling of physical, chemical, biological and geological oceanographic data, including participation in more than 10 oceanographic research cruises on the vessels of three nations.

In addition to IT management responsibilities within BODC Roy researches and develops technologies that have potential to enhance BODC's operational capabilities. This work has focused on the issues of interoperability between distributed metadata and data repositories through the adoption, and if necessary, development of standards. This has included active participation in two projects, NERC DataGrid and SeaDataNet, both building distributed data systems. Within these projects Roy's work has focused on facilitating semantic interoperability through development of a well-managed controlled vocabulary infrastructure, including ontologies to support semantic cross-walking. To this end , Roy also serves on the Technical Advisory Panel and the Ontology Team of MMI. He

holds a Ph.D. in experimental geochemistry from the Imperial and Chelsea Colleges, London.

Tim Nyerges

Professor of Geography
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Tim Nyerges is professor of geography at the University of Washington, with research interests in GIScience and society, public participation GIS and decision support, land use, transportation and water resources. He is also president-elect of the 70+member University Consortium for Geographic Information Science. Among his many research activities and accomplishments is the development and evaluation of geospatial decision support tools (local area network and broadband network) for stakeholder groups on six grants (4 as PI, 2 as Co-PI) over the past ten years (approx $3.2M funded by NSF, NOAA, DoE). His tools help elicit stakeholder concerns about regional water resource planning, transportation improvement, hazardous waste cleanup, and regional climate change, then translate these concerns into database representations, and use these concerns together with engineering/scientific databases to foster diverse perspectives in public, analytic-deliberative environmental decision making. In August 2006, Tim was certified as an advanced open water scuba diver to bolster his experiential insight and future scholarly activity about the challenges facing coastal areas around the world. He holds a Ph.D. in geography with an emphasis on GIS, an M.A. in urban and cognitive geography, and a B.A. in economic geography with distinction, all from Ohio State University.

John Pepper

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John Pepper is the Head of Geographic Information (GI) Services, UK Hydrographic Office (UKHO), responsible for developing new markets and business opportunities for marine and coastal GI services across the world. He holds a postgraduate Diploma in Marketing & Strategic Planning in addition to professional qualifications in Surveying Science, Geodesy and Cartography. John spent over 25 years in a variety of disciplines. He joined the UKHO in 1998 as a Senior Products Manager for their worldwide series of navigational and thematic charts. As director of the Association for Geographic Information (AGI) and a member of the Intra-governmental Group for Geographic Information (IGGI) in the UK, his focus has been on developing the Marine and Coastal Zone special interest group, to further the use of GI in coastal and offshore planning and asset management.

Greg Reed

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Greg Reed is an internationally recognised marine data expert and currently serves as the Executive Officer of the Australian Ocean Data Centre Joint Facility, a national multi-agency distributed data management system, as well as Head of the Ocean Data Services Group of the RAN Directorate of Oceanography and Meteorology. He is Co-chair of the IOC's International Oceanographic Data and Information Exchange (IODE) committee, and a member of the Management Committee and the Data Management Coordination Group of the Joint IOC-WMO Technical Commission on Oceanography and Marine Meteorology (JCOMM). He is also involved in developing international standards for oceanographic data management and exchange. Greg has participated as course coordinator and lecturer at a number of international capacity building activities including more than twenty IODE training courses. He is also an editor for OceanTeacher, the IODE training system for oceanographic data and information management and has been actively supporting the development of the African Marine Atlas and the Caribbean Marine Atlas.

Lucy Scott

GIS Coordinator
African Coelacanth Ecosystem Programme
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Lucy Scott is the information and GIS Coordinator for the African Coelacanth Ecosystem Programme within the South African Institute of Aquatic Biology. She is also heavily involved as editor-in-chief for the marine biosphere for the ODINAFRICA African Marine Atlas Project, (ODINAFRICA = Ocean Data and Information Network for Africa), supported by the IODE. She received an MSc with distinction from Rhodes University in Grahamstown, South Africa and does an extensive amount of world travel annually!

Appendix E: Participant List

NAME	ORGANISATION	COUNTRY	E-MAIL
Selorm Ababio	University of Ghana	Ghana	sdababio@gmail.com
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Dawn Wright	Department of Geosciences, Oregon State University	USA	dawn@dusk.geo.orst.edu

Appendix F: Selected Workshop Photos

A full collection of photos may be accessed at <http://ican.science.oregonstate.edu/links3>.
Photos by Liz O'Dea and Dawn Wright.

Headquarters of the EEA where the workshop was held.

We welcomed approximately 30 participants to the workshop….

… which was introduced by our host, Ronan Uhel, EEA Head of Spatial Analysis,

…and Ned Dwyer of the CMRC, who gave an overview of the goals and planned content for the entire workshop (Ronan Uhel and Andrus Meiner of EEA to the left).

This was followed by an overview by Dawn Wright of Oregon State University of what had been accomplished during ICAN 1 in Cork and ICAN 2 in Corvallis.

Ned and Dawn strategised throughout the week.

Monday evening icebreaker reception at EEA hosted by SeaZone Solutions Ltd.

EEA executive director Jacqueline McGlade welcomes workshop participant at the Tuesday evening dinner held there.

We heard a series of excellent presentations throughout the week, including this one by Mike Osborne of Sea Zone Solutions, Ltd.

David Hart of the University of Wisconsin shares a timeline of various coastal GIS projects in his region. Andrus Meiner of EEA sits to the left.

Small breakout groups at the workshop were very productive. Ned Dwyer (centre) leads the Strategic Planning/Funding breakout. L to R around table from Ned: Tony LaVoi, Tim Nyerges, Mike Osborne, Laurent d'Ozourville, Greg Reed, Roger Longhorn, and Marcia Berman.

Several workshop participants enjoyed the charms and thrills of Tivoli amusement park after the workshop!