Coastal Informatics:
Web Atlas Design and Implementation

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Section 3

Coastal Web Atlas Management and Governance Issues

Chapter 15
The International Coastal Atlas Network

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ABSTRACT

This chapter introduces coastal web atlas (CWA) management and governance issues by way of a summary of the International Coastal Atlas Network (ICAN). ICAN is a newly-founded, informal group of over 30 organizations from over a dozen nations who have been meeting over the past two years to scope and implement data interoperability approaches to CWAs. The strategic aim (or mission) of ICAN is to leverage the expertise of its members to find common solutions to CWA design and implementation (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.). It also seeks to encourage and facilitate global operational interoperability between CWAs in order to enhance data and information sharing among users, and assist in the translation of coastal science to coastal decision-making.

INTRODUCTION

It is important to note further that while individual atlas efforts are important, as evidenced by the chapters in Section 2 of the book, collaboration between atlases on a regional and international scale can be critical as well. As a springboard to understanding the many dimensions of such collaboration, including both the inherent potentials and limitations, a trans-Atlantic workshop was held in Cork, Ireland, in July 2006. This gathering enabled participants from Europe and North America to assess the potential and the limitations of selected CWAs from the United States and Europe (O'Dea *et al.,* 2007). The catalyst for the workshop came initially from bilateral discussions between atlas developers in Oregon State University (OSU) and in University College Cork.

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A community of interested parties grew as the two university groups facilitated the introduction of larger networks from both continents. One of the central outcomes of the workshop was recognition of the value of networking among the CWA workshop participants, and a desire for further opportunities to share valuable data and information. Thus, the seed was sown for the development of the International Coastal Atlas Network (ICAN), the subject of this chapter.

The strategic aim of ICAN, as initially established in an initial workshop (described in the next section), is ***to share 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***. These atlases can be local, regional, national and international in scale. This is a mutually beneficial international activity with complementary strengths in evidence from North America, Europe, Africa, the Caribbean and Australia. ICAN participants can play a leadership role in forging further international collaborations of value to participating nations. This has tremendous potential for global spatial data infrastructures and Internet mapping projects. Benefits of participation in ICAN include: (1) receiving guidance and best practices for your own local CWA development from a community of experts in the information technology, GIS, data management and coastal/marine governance domains; (2) making your CWA interoperable with a larger universe of resources and communication channels that are needed for effective marine spatial planning, resource management, and emergency planning; and (3) participation in teaching and learning activities organized by ICAN or other organizations in the CWA domain; and (4) collaborative research proposal development (Wright *et al*., 2009a & 2009b).

Given our long-term strategic goal of encouraging and facilitating the development of digital atlases of the global coast based on the principle of distributed, high-quality data and information, ICAN continues to convene workshops to:

- 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-practice 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.

FORMATIVE WORKSHOPS: 2006-2007

The first workshop, entitled "Potentials and Limitations of Coastal Web Atlases," was hosted by the Coastal and Marine Resources Centre (CMRC) at University College Cork in Ireland from July 24th to 28th, 2006 (O'Dea *et al.,* 2007). This workshop brought together over 40 participants from academia, government agencies and conservation organizations from Europe and North America to share technological knowledge and lessons learned from the development of national, state and regional CWAs. Among the aims of this workshop were the identification of state-of-the-

art approaches to marine and coastal mapping and informatics and the development of guidelines as a resource for developers and decision makers on CWA projects. (O'Dea *et al.,* 2007).

Four key issues were examined: institutional capacity, technology, atlas design and data issues. Table 1 provides a summary of the top five "strengths, weaknesses, opportunities and threats" (SWOT) for each issue. This process helped to identify themes to be collectively addressed via future networking. In particular it helped to refine the selection of a topic for a second workshop on "Coastal Atlas Interoperability" on the campus of OSU in 2007 (Wright *et al*., 2008).

Oregon workshop participants recognized that the terminology used to describe similar data can vary between specialties or regions, which can complicate data searches and integration. Current inventories within coastal atlases are insufficient for the purposes of networking *between* them. Each atlas has different classifications of data and information (e.g., critical information on coastal erosion that may be needed across a broad geographic region as supplied by several different atlases). Use of the word *seabed* in Europe versus use of the word *seafloor* to describe the same feature in North America is a good example of this scenario, as is the interchangeable use of *coastline* versus *shoreline* in both regions. Agreements on content can help to eliminate such problems, leading to a condition of "semantic interoperability" that will make searches between disparate, but mutually beneficial, projects feasible. Semantic interoperability is defined in Graybeal (2009) as "the ability of multiple systems to exchange information in useful ways; in particular, the ability for each system to 'understand' the terms of the other sufficiently to use those terms correctly." The topic is also discussed in much more detail in Chapter 4 (Lassoued *et al*., this volume).

Ontologies provide the mechanism to enable semantic interoperability. An ontology, as defined in Lassoued *et al*. (this volume), is an organized list of terms that defines a set of concepts along with their meanings, the relationships among the concepts, and the logical rules that these meanings and/or relationships need to follow within a broader catalog of maps and data. Workshop 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.,* 2007), and concluded with the aim of designing and developing a demonstration interoperability prototype using the metadata catalogues of two mature atlases. The Oregon workshop also helped to crystallize the aforementioned long-term aims and objectives for ICAN through the formation of a strategy working group.

ICAN PROCESS

ICAN has grown from an idea at the first workshop to the cusp of a formal "virtual organization"/ community of practice, which has captured the interest of local and state governments, non-governmental organizations, universities, NOAA, the European Environment Agency (EEA), and UNESCO's Intergovernmental Oceanographic Commission. OSU in the U.S. and the CMRC of University College, Cork, Ireland have emerged as the lead universities and hubs of this nascent international network. ICAN has thus far proven to be an organic, highly motivated, productive informal group that despite its informality and lack of incorporation, is capable of generating tangible, useful products that attract and help users. Thus far these products are in the form of short workshops that ICAN members have given at various conferences (such as the international CoastGIS and the US Coastal Zone meetings) to introduce the notion of coastal web atlases, why they are important, and initial best practices for implementing them. This book is also a tangible product of ICAN. Other products in progress include user and developer guides, handbooks and articles on best practices, information on

Table 1. Results of a SWOT analysis: Top five issues relating to CWA development for atlas design, data and metadata, technology and institutional capacity. Source is O'Dea et al. (2007) and (in prep.).

Atlas Design
Strengths
- **Intuitive structure** of web sites and map pages; - Inclusion of **contextual information** in order to better understand the data; - **Hierarchical** data organization; - **Multiple user pathways** to retrieve maps and layers of interest; - **Tools** for data analysis and creating reports.
Weaknesses
- The **cartography / design** challenge of displaying many layers; - **Inadequate database management system** (DBMS) for efficient management of information, metadata and data; - Inadequate **search functions** for data and content; - Failure to meet user needs where atlas developments are **technology-driven**; - **Lack of distributed systems** to enable data owners to share and manage their own data.
Opportunities
- **Open source** technology; - **Enhanced DBMSs** to accompany open source web mapping technology to efficiently manage data, metadata and CWA content; - Improved **cartographic display** of large quantities of layers in coastal atlases; - Potential for sharing data through **distributed networks** (e.g., utilising Web Map Services and Web Feature Services); - Potential to develop **regional nodes** that tie in with larger atlases (e.g., national or statewide).
Threats
- **Funding** limitations (e.g., focus on technology rather than maintenance; staff turnover); - Keeping up with **design expectations** of users (e.g., Google Earth); - **User interpretation**: misunderstanding of how to use atlases or their components; - **Data policies, cost and Intellectual Property Rights** issues impact atlas design in data quality and accessibility, and thus atlas functionality (e.g., spatial analysis using large scale data).
Atlas Technology
Strengths
- **Improving technology** for publishing maps on the web: choice between open source (OS) and commercial-off-the-shelf (COTS) products; - Maturing **standards and specifications** (e.g., OGC specifications, ISO metadata and W3C standards); - Progress in **network capacity & hardware** (e.g., processor speeds, storage capacity and monitor resolutions); - Contribution of **other technologies and tools** (e.g., XML, UML and content management systems) to web mapping development; - Advantages of **OS tools** (e.g., broad community support, access to source code, low cost; Lack of COTS levels of technical support is possible disadvantage).
Weaknesses
- **Software support issues**: COTS software may offer more readily available commercial support, although OS software does not preclude this; - **Large datasets** can require significant disk space and are not always supported by web GIS software (e.g., raster data); - **Hardware becoming obsolete** (e.g., media obsolescence; backup software cannot deal with physical media; compatible drives no longer available); - **Inadequate metadata** may limit functionality (e.g., be incomplete, out of date and not match the data object; digital object identifiers (DOI) could be used to link data to metadata); - Web GIS is presently poor at dealing with **time series** and **3D/4D data**.
Opportunities
- **3D and 4D web GIS** riding on increased hardware and network capacity; - Simulation and **online spatial analysis**. - **Data mining**; - Widespread use of **geo-tagging** (e.g., geoRSS) to facilitate incorporation of many more items in web mapping systems; **Recommender systems** to supplement search queries; - Increased interest in CWA by policy makers and regulators as SDI initiatives become established leads to **funding potential** (e.g., EU Marine Green Paper).

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Table 1. continued

Threats
- Difficulty in coping with **high server loading** during peak use; - **Technology evolution** can be disruptive: need to balance the exploration of new technologies against maintaining a stable and functioning system; - The challenge of **keeping data current**; - **Lack of funding** and consequent personnel turnover; - **Partners who are weak** or unwilling to co-operate.
Atlas-Related Data and Metadata
Strengths
- **Growing awareness** and acceptance of standards; - **Regulation** is driving the need for data; - Provides **publicity** for data products; - **Reduced labour costs** for routine searches; - **Widely accessible** to a broad range of users.
Weaknesses
- **Limited quantitative and analytic utility**: tools can sometimes produce suspect/alarming results; - **Data patchiness**; - Assessment of **data quality** is difficult on map presentations, original purpose and fitness for use can be hidden: 'pretty map syndrome'; - **Inadequate metadata**; - Existence of **multiple portals** to same data.
Opportunities
- Focus on the delivery of **source data** and **value-added products**, not only interactive maps; - **Identification of data gaps** and need for data collection requirements; - **Community-building** and **harmonization** among atlas providers (e.g., ontologies); - Become the **definitive reference** for certain data, if it contains current, good quality data; - Use **new, emerging technologies** for data and metadata presentation/delivery.
Threats
- **New competitive technologies** for improved data access (e.g., Google Earth); - **Intellectual property restrictions** limit data re-distribution; - Data viewed as **source of income**; - **Erratic funding** affects ability to develop and maintain atlas data as well as causes loss of skilled staff; - **Lack of incentives** for data providers.
Atlas-Related Institutional Capacity
Strengths
- **Academic CWA host institutions** have the ability to leverage additional research and education funds; - **Government CWA host agencies** may have **mandate** for CWA development; - Opportunities for **collaboration** with other institutes; - The permanent nature of government agencies ensures long-term **institutional support**; - Data and information requirements for the **Coastal and Marine sector** stimulate demands for CWA development.
Weaknesses
- Volatile and **short term nature of funding** and all associated impacts (e.g., staff turnover; difficult to maintain atlases); - Vulnerability to **political trends** and changes in priorities; - **Data access limitations**, licensing, and desire to recoup costs; - Limited experience in **marketing** and building awareness; - Tendency towards **project control** limits the formation of partnerships for data sharing.
Opportunities
- **Collaboration**: availability expertise and experience in CWA community; - Movement to E-GOV and **knowledge-based economy** (e.g., geospatial data can underpin many government activities); - Delivering on **government policy** (e.g., implement ICZM mandate); - **Economic development**: open data licenses could lead to new products; - **Leveraging data acquisition** (e.g., opportunities to pool resources to obtain more or better datasets).

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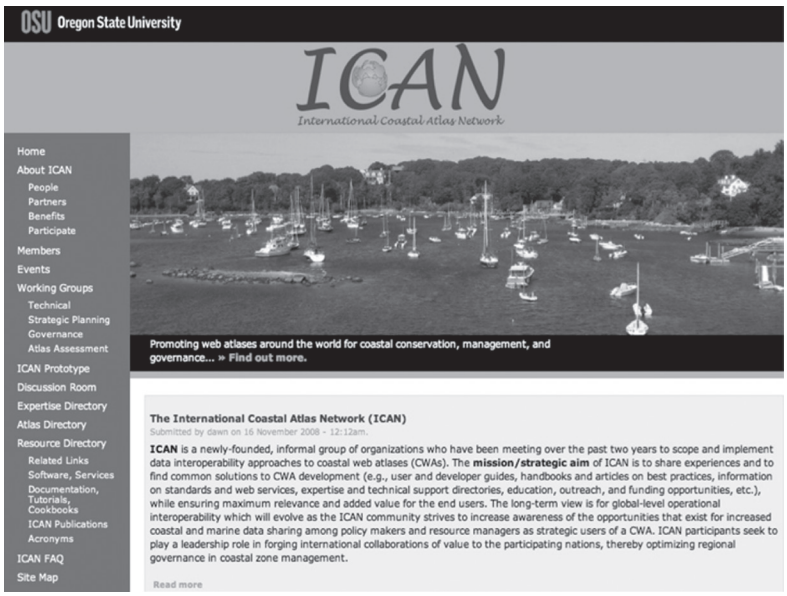
Threats
- Changing **policy drivers**; - Perception of **'too many' databases** and mapping applications; - Credibility is affected by **poor quality data and metadata**, poor models and decision support software; - Over or **poor marketing** means user expectations not met; - **Challenges of collaboration**: partner doesn't deliver up to specifications.

standards and web services, expertise and technical support directories, education, outreach, and funding opportunities.

In 2008 the EEA invited and funded core ICAN members to present the idea of ICAN and to foster further collaborations at their headquarters in Copenhagen, Denmark (Dwyer & Wright, 2008). The value of the annual ICAN workshop event is evidenced by plans for a fourth annual ICAN workshop in Trieste, Italy, November 2009 (Wright & Dwyer, 2009), with a focus on end users; and a fifth annual workshop planned for Oostende, Belgium in 2010.

To implement these objectives ICAN has identified a range of activities in the areas of strategic planning, technical implementation, atlas assessment, outreach, training, and participation in scholarly communities, and strategic planning and funding. ICAN has established a web site to coordinate and report upon these activities (Figure 1) The web site is powered by Drupal, a powerful, flexible, open source, web-based content management system, suitable as an intranet and extranet server, as a document and image publishing system, a portal server and as a groupware tool for collaboration between entities. It follows standards for usability and accessibility, is licensed under the GNU (GNU's not Unix) General Public License (similar to Linux), and even has tools for managing multilingual content. It is therefore an

Figure 1. Example of ICAN's new web presence via Drupal hosted by the OSU College of Science, which will provide web resources in support of the workshop planning and proceedings (http://icoastalatlas.net).



ideal platform for supporting a virtual organization such as ICAN.

CURRENT MANAGEMENT AND GOVERNANCE ISSUES

There is a growing need to move beyond the demonstration of a conceptual framework towards a more formal organizational structure for ICAN. This will help to deliver the aspiration of operational interoperability in terms of a functioning web-based catalog of linked CWAs, so that in time, users will be able to conduct sophisticated and meaningful queries across a range of atlases. As a result, the long-term view 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 CWA.

Current management and governance approaches are being reviewed to address these issues. Structures on governance (including formal procedures for receiving new members), strategic planning, and technical activities are under consideration so that ICAN can formally incorporate as an organization. The decision formally incorporate was made at the Oregon workshop, as this seems the best way to keep the momentum of current initiatives going, to attract more coastal atlas projects to use the products and services of ICAN, as well as to provide more nodes in the interoperability prototype, and to more readily secure funding. Plans are underway to assign chairs and members to a central coordination team, an advisory steering group, and within the existing technical task force, an ontology content governance group to manage storage, security, change management and serving of the ICAN interoperability ontologies (e.g., the fourth ICAN workshop in Trieste, Italy; Wright & Dwyer, 2009).

ICAN partners have had a high success rate in securing research and travel grants from national programmes in the past. However, future governance arrangements will provide a roadmap for greater diversity and innovation in securing funding for international collaboration. Examples of funding programmes to be targeted include the National Science Foundation (NSF) INTEROP (Community-based Data Interoperability Networks), NSF PIRE (Partnerships for International Research and Education), and, NSF STCI (Strategic Technologies for Cyberinfrastructure), the European Science Foundation (COST programme) and European Union Framework Programme proposals.

Future sustainability will also require collaborative partnerships with ongoing initiatives such as the European Environment Information and Observation Network (EIONET) of the EEA. For example, EIONET brings together nationally funded experts or groups of experts in organizations, which are regular collectors, or suppliers of environmental data at the national level and/or possess relevant knowledge of specific environmental issues (http://www.eionet.europa.eu/partners). Affiliation with international initiatives such as LOICZ (Land Ocean Interactions in the Coastal Zone), part of the International Geosphere-Biosphere Programme (IGBP) also provides a forum for additional exposure.

FUTURE DEVELOPMENTS

At the time of writing, ICAN still has much more work to do to: (1) formalize the governance and strategic planning structure for this new organization; (2) further its mission of establishing scientific grounding and knowledge base among the important knowledge domains of CWA development (geography, computer science, and coastal resource management); (3) develop advances in semantic interoperability of CWAs; (4) exchange lessons learned in spatial data infrastructure between the participating regions and (5) prepare

collaborative submissions to funding programmes. Topics for future technical exploration include:

- Continued growth of ICAN as a formal organization.
- Implementation of a Shared Environmental Information System using ICAN's interoperability prototype (for a complete overview of the ICAN prototype and lessons learned thus far, please refer to Chapter 4).
- Applications emphasis on coastal zone vulnerability, climate change impacts.
- ICAN involvement in Ocean Teacher Academy project, "Training Academy for IODE Ocean Data and Information Networks."
- A continued focus on users: better knowledge of our users, their needs, and on continued inventory, assessment, and evaluation of atlases.
- Evaluating atlas impact, and developing analysis and decision-support tools in atlases.
- Updated guidelines to the coastal/marine research community and decision makers on the development of coastal atlas projects.
- Recommendations on the development of a joint program of work to the NSF, European Science Foundation, and the UNESCO IODE which will also provide international research experiences for the enhancement of doctoral dissertation research.

SUMMARY

In summary, ICAN seeks to further its mission of establishing scientific grounding and knowledge base among the important knowledge domains of CWA development (geography, computer science, and coastal resource management). In its formative stage ICAN has served to mobilise an international community of interest by demonstrating the added value of participation in a series of networking events. This process has been coupled with the production of a range of didactic material for technicians and coastal resource managers, which is also disseminated through a centralised web portal (by which continuing developments may be tracked at http://icoastalatlas.net or http://ican.science.oregonstate.edu). The commitment to the future enhancement of ICAN through evolving governance structures and technical plans, in addition to buy-in from multiple organisations, is evidence of the important role that ICAN has to play in fostering connectivity among geographic subfields and across disciplines in ways that enhance basic knowledge and methods that benefit all participating scholarly communities.

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KEY TERMS AND DEFINITIONS

Coastal Web Atlas: A collection of digital maps and datasets with supplementary tables, illustrations and information that systematically illustrate the coast, oftentimes with cartographic and decision support tools, all of which are accessible via the Internet. Also known as web atlas, digital atlas, digital coastal atlas.

Capacity Building: With regard to coastal atlases, the actions involved in building local GIS infrastructure, including maintenance and update of GIS data layers, software, computer equipment and labs/offices, salaried personnel, and action items for project initiatives.

Coastal Informatics: A broad academic field encompassing the management and analysis of data collected from and representing the coast. Informatics can include spatial data infrastructure, hardware and software infrastructure, computational networking, modeling, and experimentation, the design and deployment of data portals and Internet mapping sites, as well as the creation, analysis, and understanding of data/metadata vocabularies and ontologies, metadata creation/extraction/cross-walking tools, geographic and information management systems, and grid computing.

Information Management: The means by which an organization, agency, or individual collects, documents, shares, and uses information. It often involves creating or identifying the appropriate resources to find quality information in order to fill gaps in knowledge. Coastal web atlases are therefore a key component of information management as applied to coast region of the world.

Marine Spatial Planning: A critical part of regional governance that involves the integrated, forward-looking planning and consistent decision-making regarding various uses of the coast and nearshore. Marine spatial planning must be guided by specific policies and regulations governing usage, the conditions that apply, and an eye toward what possible conflicts in use may arise. Marine spatial planning is often aided by a coastal web atlases which can provide data on habitats, species migrations, land and territorial sea use by humans, navigation, managed areas (parks, reserves, disposal sites, etc.), commercial and recreational fishing, and the like.

Ontology: A type of knowledge organization system that defines a set of concepts with meanings, relationships among them, and logical rules on these meanings and/or relationships.

Regional Governance: Policies and initiatives that allow state and local governments to pursue concrete, practical steps toward more coordinated and holistic management of ocean and coastal resources. This often includes establishing lines of communication among regions to facilitate implementation of best practices, forming partnerships among regions, and deploying proven management principles and approaches (e.g., ecosystem-based management). Coastal web atlases often provide the datasets, mapping tools, and contextual information needed for effective regional governance.

Research Collaboration Network: A collaboration of research scientists, resource managers, technical staffers, and other interested parties to develop a coordinated research network focused on a particular topic. The group fosters communication among those with common goals and interests, along with collaboration on common projects across disciplinary, organizational, institutional and geographical boundaries. The International Coastal Atlas Network is an example of a research collaboration network.

Semantic Interoperability: The ability of multiple systems to exchange information in useful ways, in particular, the ability for each system to "understand" the terms of the other sufficiently to use those terms correctly. In the computing and GIS world, this is a condition where two or more computer systems are able to exchange information and have the meaning of that information accurately and automatically interpreted by the receiving system.

Spatial Data Infrastructure (SDI): A framework via an organization of people or government agencies, via the Internet, or via a series of guiding policies or standards to assist people with acquiring, processing, using, and preserving spatial data. The spatial data are often in geographic information system (GIS) format, are not, but not limited to this.

Virtual Organization: A group of individuals, agencies, whose members and resources may be geographically dispersed, yet function as a coherent unit through the use of information technology to share knowledge, skill sets, and access to each others' resources and expertise in nontraditional ways.

Web GIS: Geographic information systems functions as deployed via a web site or series of web sites rather than just on the desktop.