Bibliography of the International Coastal Atlas Network (ICAN), 2006-2014

This bibliography contains a mix of references to official ICAN technical reports (dating back to the founding of ICAN in 2006) along with references to many other papers in the published literature, not written by ICAN members but considered helpful to our research and implementation of coastal web atlases. The full-texts of official ICAN documents are now available in OceanDocs, but to obtain full-text of the other papers, please consult your local university or government library, or seek online access directly from the journal so as not to violate journal copyright.

original source of the bibliography online: http://ican.science.oregonstate.edu/biblio
Dawn Wright, dwright@esri.com, 9 April 2015

Aditya, T. and M. J. Kraak (2006). "Geospatial data infrastructure portals: Using the national atlas as a metaphor." Cartographica 41: 115-133.

The concept of geospatial data infrastructure (GDI) has been put into practice in some countries by providing portals allowing users to search for multiple geospatial data sets. Our review and inquiry activities show that current portals suffer from two potential setbacks: inappropriate navigation tools and a lack of supports for users' understanding. This article defines a new approach to portal development using the atlas as metaphor. This allows the atlas to be used not only to access assorted thematic maps but also to discover data sets. Within the atlas, an information structure plays an important role in organizing the content. Metadata published by providers are incorporated into this structure as metadata summaries. Based upon the topical relevancy of the data, each metadata summary is linked to a specific map within a particular topic. These summaries can be represented as symbols to support discovery tasks, either loosely or strictly defined. Browsing can be used to deal with the first via navigations and map interfaces. Searching can be used to deal with the second via explorer and search presentation interfaces. A working prototype to enable users to browse and search is built as a Flash-based ArcIMS client. Whether browsing or searching, users are offered interfaces to effectively assess data suitability.

Athanasis, N., et al. (2009). "Towards a semantics-based approach in the development of geographic portals." Comp. Geosci 35: 301-308.

As the demand for geospatial data increases, the lack of efficient ways to find suitable information becomes critical. In this paper, a new methodology for knowledge discovery in geographic portals is presented. Based on the Semantic Web, our approach exploits the Resource Description Framework (RDF) in order to describe the geoportal information with ontology based metadata. When users traverse from page to page in the portal, they take advantage of the metadata infrastructure to navigate easily through data of interest. New metadata descriptions are published in the geoportal according to the RDF schemas.

Baker, D. N., et al. (2008). "Informatics and the 2007-2008 Electronic Geophysical Year." EOS Trans. AGU 89(48): 485-486.

Humanity is poised to take the next major steps toward an interdisciplinary, worldwide revolution in the way we store, access, and analyze information. For the geosciences, our ability to gather data about the Earth and its space environment is unprecedented. We can obtain data and services via the Internet and grid systems from anywhere in the world, we can store and serve data with true interoperability, and we can deal with real-time data applications, assimilate data into models, build virtual observatories, and more. The challenges of organizing and using data effectively expand as data volumes, data complexity, the need for interoperability, and our ability to access data and information increase. In particular, there remains great reluctance among research scientists and others to invest time in good data management practices and thereby ensure that publicly funded data are openly available for use and reuse. The reason is simple: Research scientists are rewarded only for doing research. The science community lacks any recognized system for publishing and citing data sets and for rewarding efforts to make data sets freely available and interoperable.... [The] future of science and discovery will rely on data interoperability and easy access to the wealth of material that has been generated through the information age. Thus, developing virtual

observatories and an information commons requires thoughtful and strong action by scientific societies as well as by individual scientists. The eGY is an important step forward.

Baker, K. S. and C. L. Chandler (2008). "Enabling long-term oceanographic research: Changing data practices, information management strategies and informatics." Deep-Sea Res. II 55: doi:10.1016/j.dsr1012.2008.1005.1009.

Interdisciplinary global ocean science requires new ways of thinking about data and data management. With new data policies and growing technological capabilities, datasets of increasing variety and complexity are being made available digitally and data management is coming to be recognized as an integral part of scientific research. To meet the changing expectations of scientists collecting data and of data reuse by others, collaborative strategies involving diverse teams of information professionals are developing. These changes are stimulating the growth of information infrastructures that support multi-scale sampling, data repositories, and data integration. Two examples of oceanographic projects incorporating data management in partnership with science programs are discussed: the Palmer Station Long Term Ecological Research program (Palmer LTER) and the United States Joint Global Ocean Flux Study (US JGOFS). Lessons learned from a decade of data management within these communities provide an experience base from which to develop information management strategies, short-term and long-term. Ocean Informatics provides one example of a conceptual framework for managing the complexities inherent to sharing oceanographic data. Elements are introduced that address the economies-of-scale and the complexities-of-scale pertinent to a broader vision of information management and scientific research.

Buccella, A., et al. (2008). "Ontology-driven geographic information integration: A survey of current approaches." Comp. & Geosci.

Integrating different information sources is a growing research area within different application domains. This is particularly true for the geographic information domain which is facing new challenges because newer and better technologies are capturing large amounts of information about the Earth. This trend can be combined with increases in the distribution of GIS (Geographic Information Systems) on the Web, which is leading to the proliferation of different geospatial information repositories and the subsequent need to integrate information across repositories to get consistent information. To overcome this situation, many proposals use ontologies in the integration process. In this paper we analyze and compare the most widely referred proposals of geographic information integration, focusing on those using ontologies as semantic tools to represent the sources, and to facilitate the integration process

Craglia, M., et al. (2008). "Next-generation Digital Earth: A position paper from the Vespucci Initiative for the Advancement of Geographic Information Science." International Journal of Spatial Data Infrastructures Research 3: 146-167.

This position paper is the outcome of a joint reflection by a group of international geographic and environmental scientists from government, industry, and academia brought together by the Vespucci Initiative for the Advancement of Geographic Information Science, and the Joint Research Centre of the European Commission. It argues that the vision of Digital Earth put forward by Vice- President Al Gore 10 years ago needs to be re-evaluated in the light of the many developments in the fields of information technology, data infrastructures, and Earth observation that have taken place since. It focuses the vision on the next-generation Digital Earth and identifies priority research areas to support this vision. The paper is offered as input for discussion among different stakeholder communities with the aim to shape research and policy over the next 5-10 years.

Dwyer, N. and K. Kopke (2014). Report of International Coastal Atlas Network Workshop 6: Expanding Participation in Coastal Web Atlas Development and Use. Cork, Coastal and Marine Research Centre.

EXECUTIVE SUMMARY From June 16th to 17th, 2013, the International Coastal Atlas Network (ICAN) held a workshop on Expanding Participation in Coastal Web Atlas Development and Use, at the University of Victoria, British Columbia, Canada. The workshop (aka ICAN 6) engaged 29 participants from 9 countries, representing 22 organizations and multiple areas of scientific and technical expertise. This meeting was a follow-up to the successful 2011 workshop on Coastal Atlases as Engines for

Coastal & Marine Spatial Planning (aka ICAN 5) held in Oostende, Belgium, as well as workshops in 2009, 2008, 2007 and 2006. ICAN 6 provided an opportunity to discuss how the ICAN community could take advantage of now being an IODE project, to share its knowledge and aid capacity building among IOC member states in relation to coastal and marine data management. Moreover, ICAN has seen its membership grow in the last two years and given its extensive membership along the North and South American Pacific coasts it was a great opportunity to hear about atlas developments in those regions. Key activities at the workshop included:

- exploring the opportunities for ICAN in an IODE context and how to build synergies with other IOC projects; the activities of the Ocean Biogeographic Information System (OBIS) project of the IOC were presented as well as IOC's ICAM programme which highlighted how data management tools developed within ICAN can contribute to the goals of ICAM. Beyond the IOC, activities within the Group on Earth Observations (GEO) Coastal Zone Community of Practise (CZCP) are very relevant to ICAN, in particular the objective to develop a global coastal zone information system (CZIS). ICAN can help inform the development of such a CZIS.

- discussion of coastal atlas training needs and how ICAN members can contribute; in particular the training requirements of the African Coastal and Marine Atlas, and the Caribbean Marine Atlas were discussed. An overview of IODE training activities was presented and linkages on training between ICAN and ICAM related projects (e.g. SPINCAM II) were discussed. ICAN should also take advantage of the OceanTeacher platform developed by IODE.

- Atlas Stories - presentations from Atlas developers and users from North and South American Pacific coasts and beyond; the ICAN 6 Atlas Stories focused on CWA development around the Western Pacific Rim presenting new activities as well as updating the network on recent upgrades to previously discussed CWAs. The session started with the South American SPINCAM project which is developing atlases across five countries, followed by updates on the Oregon Coastal Atlas and the Washington State Coastal Atlas. Workshop participants also learned about Canada's CanCoast and ShoreZone and the session concluded with the introduction to SmartAtlas through the African Coastal & Marine Atlas experience.

- a small workshop within a workshop for atlas technical developers on how to become a new node in the ICAN interoperability portal, version 3; The latest version has multilingual search capability, semantic search and the ability to connect directly to map services and display the results in a map. It was agreed that the current interface will be upgraded to HTML5 in the coming period.

- a small workshop within a workshop focussing on Volunteered Geographical Information (VGI) and its implications for coastal atlases; within the EEA, systems have been developed using both crowdsourcing and citizen science approaches. SeaSketch is a software platform intended as an end-to-end mapping solution for marine spatial planning, which allows anyone, regardless of their technical abilities, to sketch prospective management plans and receive analytical feedback on the consequences of their designs. The Marine Regions project aims to develop a standard for georeferenced marine names and there is potential to link it to the ICAN portal. Esri is introducing the concept of a Living Atlas of the World delivered via ArcGIS Online (AGOL). ICAN members can take advantage of this concept by using it to leverage their existing Atlas holdings or by using the platform to build a new Atlas quickly.

- development of an ICAN work plan for the period 2013-2015. This included plans for developing a communications strategy, a handbook on how atlas developers and users can interact and building synergies with other IOC and non-IOC projects. It also looked at developing a coastal atlas training plan. At its core ICAN supports atlas development and interoperability approaches, therefore the Technical Committee presented its plans for developments in the next two years. The workshop concluded with the first face-to-face meeting of the new Steering Group, which was put in place after ICAN became an IODE project. This meeting saw two new members join the SG and leaders for the various work plan elements were appointed.

Since ICAN 6 there have been developments in relation to the work plan. A revised plan and associated budget request was submitted to the IODE Officers meeting held in March 2014. As IODE has a limited budget and a number of projects to support, not all work plan items will receive funding, however the funding allocated will be of significant assistance to maintain ICAN and help progress its work. ICAN is now on a sound footing as part of the IODE family of projects, although members should continue to seek

funding from other sources to advance the key technical activities. This ambitious work plan will require the commitment of all members to ensure that it can be implemented. A priority for 2014 is the redevelopment of the web site in order to make it easier to navigate and more responsive to user needs. Interoperability remains a core activity of ICAN and the technical committee has proposed a number of activities to progress further the developments in this area. A key technical concept which emerged at ICAN 6 was that of an atlas-in-a-box. The idea is that a new atlas developer can get started quickly on implementing and publishing a CWA with a minimal amount of technical/programming knowledge. The committee intends to scope the feasibility of such a development based on potential solutions such as SmartAtlas and ArcGIS Online. We would like to thank Rosaline Canessa and her team at the University of Victoria for their warm welcome and excellent hosting of ICAN-6 and we look forward to seeing you at the 7th International workshop (aka ICAN 7) which will be hosted by CSIR at Stellenbosch in South Africa from April 20th to 21st 2015, just before CoastGIS 2015

Dwyer, N., et al. (2012). Report of International Coastal Atlas Network Workshop 5: Coastal Atlases as Engines for Coastal & Marine Spatial Planning. Cork, Ireland, Coastal and Marine Research Centre.

EXECUTIVE SUMMARY: From August 31st to November 2nd, 2011, the International Coastal Atlas Network (ICAN) held a workshop on Coastal Atlases as Engines for Coastal & Marine Spatial Planning, at the UNESCO IOC/IODE headquarters in Oostende, Belgium. The workshop (aka ,ICAN 5,Ä) engaged 43 participants from 15 countries, representing 36 organizations and multiple areas of scientific and technical expertise. This meeting was a follow-up to the successful 2009 workshop on Formalizing the Network, Engaging the Mediterranean(aka ICAN 4) held in Trieste, Italy, as well as workshops in 2008, 2007 and 2006. ICAN 5 participants discussed the current and future potential of CWAs for coastal and marine spatial planning and explored the subject area in dedicated breakout sessions. A number of opportunities for how CWAs can contribute to the development of CMSP were identified whilst challenges were also highlighted. Other key activities at the workshop included

- Presentations from ICAN members who have raised the profile of ICAN via participation in workshops and conferences. Activities from a dozen different events were formally presented. This demonstrates the relevance of, and interest in, CWAs and the reputation that ICAN is garnering as the reference point for CWAs.
- A number of Atlas developers presented significant updates since ICAN 4, while the Atlas of Scotland, the European Commission Joint Research Centre Environmental Marine Information System and The European Atlas of the Seas were presented for the first time. There are now almost 60 members of ICAN who have formally agreed to ICAN Statement of Support.
- The meeting saw the organisation of a mini workshop on Atlas users. A number of Atlas developers presented on how users are engaged before, during and after initial Atlas developments. The results of a questionnaire which was disseminated to a large number of Atlas developers were presented. The mini workshop concluded that it would be useful for the ICAN developer community to prepare a concise help document on how to engage with the CWA end user.

A mini workshop was also organised on Semantic Frameworks and Ontologies and how to connect atlases to the ICAN Catalogue Services for the Web (CSW) Mediator. This provided an opportunity to demonstrate some of the activities and tools developed in the EU funded NETMAR project, that are of relevance in the development of the ICAN interoperability demonstrator ,in particular how an ontology can be constructed and delivered through NERC's vocabulary server. It also demonstrated a new version of the CSW mediator which uses alternative and more flexible technology that that used in the previous interoperability demonstrator.

The workshop also saw the official launch of the latest version of De KustAtlas, Belgium extremely successful CWA and there was also an opportunity to celebrate the publication in 2010 of the book Coastal Informatics: Web Atlas Design and Implementation. This book is a compendium of experience of many ICAN members and is a must read for anyone contemplating or currently developing a CWA. Since ICAN 5 there have been significant developments with regard to putting ICAN governance on a more stable footing. A decision was taken to request the Intergovernmental Oceanographic Commission (IOC) of UNESCO to approve ICAN as an official IODE project. This request was considered and approved at the IOC IODE Officers Meeting in February 2012. Therefore an IODE ICAN Pilot Project has been established. This is a

precursor to the establishment of a full IODE ICAN Project which will be proposed to the 22nd session of the IOC Committee on International Oceanographic Data and Information Exchange (IODE-XXII) in March 2013. The coming months will see the development of a work plan to be presented at that session. ICAN is entering a very exciting period in this new relationship with IODE and we look forward to seeing you at the 6th International workshop (aka ICAN 6) which will be hosted at the University of Victoria, Canada from June 16th to 18th 2013, just before CoastGIS 2013.

Dwyer, N. and D. J. Wright (2008). Report of International Coastal Atlas Network Workshop 3 on Federated Coastal Atlases: Building on the Interoperable Approach. Copenhagen, Denmark, European Environment Agency: 1-65.

With a foreword by Ronan Uhel of the European Environment Agency (EEA). EXECUTIVE SUMMARY: 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, 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:

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.

Ehler, C. and F. Douvere (2007). Visions for a Sea Change. Report of the First International Workshop on Marine Spatial Planning. Paris, Intergovernmental: 84 pp.

Haddad, T., et al. (2009). Transitioning to Free Open Source Software (FOSS) in the Oregon Coastal Atlas. Coastal GeoTools '09. Myrtle Beach, SC, USA, NOAA Coastal Services Center.

In early 2008 the Oregon Coastal Atlas completed a major transition to FOSS (free and open source software). While the previous version of the Coastal Atlas had relied on the open source University of Minnesota Mapserver for its online maps, all other aspects of the website such as content management, informational databases, scripting language and web server software had been non-open source in origin. At present all of these functions have been transitioned to FOSS equivalents. General website content management is now handled by Joomla CMS. Informational databases - including some simple spatial databases - are handled by MySQL. More complex geospatial datasets utilized in online analysis tools are stored in PostGIS. Interactive maps continue to be handled by UMN Mapserver on the server side, with ka-Map or OpenLayers on the client side, depending on the context. In addition, as part of the current process to connect the Oregon Coastal Atlas to the newly emerging International Coastal Atlas Network (ICAN), Web Map Services (WMS) and Web Feature Services (WFS) will be handled by UMN Mapserver, and both metadata and Catalog Services for the Web (CSW) will be handled by GeoNetwork an open source catalog application to manage spatially referenced resources through the web. This presentation will discuss the background of the Oregon Coastal Atlas, the FOSS packages now in use, lessons learned from this transition, and future goals of the project. For more information on the Oregon Coastal Atlas, please visit http://www.coastalatlas.net.

Horrocks, I. (2008). "Ontologies and the semantic web." Communications of the Association for Computing Machinery 51(12): 58-67.

How ontologies provide the semantics, as explained here with the help of Harry Potter and his owl Hedwig. While phenomenally successful in terms of amount of accessible content and number of users, today's Web is a relatively simple artifact. Web content consists mainly of distributed hypertext and hypermedia, accessible via keyword-based search and link navigation. Simplicity is one of the Web's great strengths and an important factor in its popularity and growth; even naive users quickly learn to use it and even create their own content. However, the explosion in both the range and quantity of Web content also highlights serious shortcomings in the hypertext paradigm. The required content becomes increasingly difficult to locate via search and browse; for example, finding information about people with common names (or famous namesakes) can be frustrating. Answering more complex queries, along with more general information retrieval, integration, sharing, and processing, can be difficult or even impossible; for example, retrieving a list of the names of E.U. heads of state is apparently beyond the capabilities of all existing Web query engines, in spite of the fact that the relevant information is readily available on the Web. Such a task

typically requires the integration of information from multiple sources; for example, a list of E.U. member states can be found at europa.eu, and a list of heads of state by country can be found at rulers.org.

Intergovernmental Oceanographic, C. (2008). IODE/JCOMM Forum on Oceanographic Data Management and Exchange Standards. Oostende, Belgium, IOC Project Office for IODE: 1-45.

Kopke, K., et al. (2009). The International Coastal Atlas Network: Building a Digital Atlas of the Global Coast. Proceedings of CoastGIS ‚Äô09, 9th International Symposium on GIS and Computer Cartography for Coastal Zone Management, Santa Catarina, Brazil, CoastGIS.

The International Coastal Atlas Network (ICAN) is an informal group of over 35 organizations, with representation from Europe, the Americas and Africa that has been meeting since 2006 to scope and implement data interoperability approaches to CWAs. The strategic aim of ICAN is to share experiences and to find common solutions to CWA development, whilst ensuring maximum relevance and added value for the end users. One of its major goals is to help build a functioning digital atlas of the global coast based on the principle of sharing distributed information. This will be achieved by organizing a cooperative interoperability network to integrate locally-maintained CWAs from around the world, across a variety of thematic areas, to help optimise decision making on different levels. 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. ICAN is developing several products for this purpose, such as 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. Furthermore, it will encourage and help facilitate global operational interoperability between coastal atlases in order to enhance data and information sharing among users. Further information on ICAN is available at http://ican.science.oregonstate.edu/. The ICAN initiative is currently overseeing the development of a prototype to demonstrate interoperability between the Oregon Coastal Atlas (OCA) and the Marine Irish Digital Atlas (MIDA). These two atlases utilise similar technology to provide interactive access to spatial data, while also complying with national and international metadata standards. The prototype allows a user to search both atlases using terms that differ semantically but essentially mean the same thing, and returns the metadata of all datasets matching the search criteria. This is facilitated by the use of ontologies which are used to describe and link atlas' terminologies in a consistent way, and Open Geospatial Consortium (OGC) catalogue services which allow standardised metadata search and access. The activities carried out in ICAN can inform the development of data and atlas services in different parts of the world, but also have implications for global spatial data infrastructures and other Internet mapping projects.

Kopke, K., et al. (2010). Improving participation of users in coastal web atlases. Littoral 2010. London, CoastNet.

In recent years significant momentum has occurred in the development of Internet based geospatial data resources for decision makers, scientists and the general public who are interested in the coast. The European Commission is supporting such activities through initiatives such as EMODNET and the European Atlas of the Seas. Coastal mapping plays an important role in informing decision makers on issues such as national sovereignty, resource management, maritime safety and hazard assessment. A key aspect of this trend has been the development of coastal web atlases (CWAs), based on web enabled geographic information systems (GIS). CWAs offer an innovative means to provide information not only to decision makers but also to wider audiences that include local coastal communities hence supporting informed communication between stakeholders of the coastal environment. An important element of CWA development is to ensure that the needs of the target audience are being addressed. It is therefore important to communicate with end users on a regular basis. Baseline Web information such as the IP address, data downloads, visitor numbers, etc. is very useful. However many CWA developers require more detailed information such as an indication of how data downloads have been used or more qualitative evaluation of CWA elements to enable Atlas improvement. CWA developers are now evaluating mechanisms that are popular and successful in web 2.0 applications such as like/dislike buttons. These tools might not provide a detailed user evaluation of the CWA, but can indicate trends and offer instant impressions of user opinion on information, format or layers in a CWA. User surveys have been used by CWA developers with varying

success. Targeted online surveys of a limited number of known frequent users have been used effectively to provide detailed feedback. Focus groups have also been used with success to complete semi-structured surveys when trying to gather answers to specific questions. It is important to demonstrate to users that the survey has a goal such as atlas improvements in order to motivate them to provide information. Enhancing users' sense of ownership achieved by web applications that allow more direct user input has been accomplished by some CWAs. The strengths and weaknesses of such an approach should be further explored by individual CWAs, as this could enhance the understanding of user needs and improve the relationship of the atlas developer to the user community. Atlas developers within the International Coastal Atlas Network who have worked on the Marine Irish Digital Atlas, the Belgian Coastal Atlas, Chesapeake Bay Atlases, the Washington Coastal Atlas and The Wisconsin Coastal Atlas have significant experience in gathering and analyzing user feedback. This can be of value to others researching methods to evaluate the impact of their Internet geospatial resources.

Lassoued, Y., et al. (2008). International Coastal Atlas Network: An Ontology-Based Mediator for Catalogue Services for the Web. JIGOT 2008, Journal of Informations Geographiques et Observation de la Terre (Days of Geographic Information and Earth Observation), Laboratoire des Sciences de l'Information et des Systemes (Laboratory of Information and Systems Sciences), Saint-Jerme, Marseille, France.

In recent years, significant momentum has occurred in the development of Internet resources for managers, decision makers, scientists and members of the public interested in the coast. Chief among these has been the development of coastal web atlases (CWAs), based on web-enabled geographic information systems (GIS). While multiple benefits are derived from these tailor-made atlases (e.g., speedy access to multiple sources of coastal data and information; economic use of time by avoiding individual contact with different data holders), the potential exists to derive added value from the integration of disparate CWAs, to optimize decision making at a variety of levels and across themes. However, current inventories within coastal atlases are insufficient for the purposes of interoperating between them. This paper describes the development of a semantic mediator prototype to provide a common access point to coastal data, maps and information from distributed CWAs. The prototype showcases how ontologies and ontology mappings can be used to integrate different heterogeneous and autonomous atlases (or information systems), using the Open Geospatial Consortium's Catalogue Services for the Web. Lessons learned from this prototype will help build regional atlases and improve decision support systems as part of a new International Coastal Atlas Network (ICAN).

Lassoued, Y., et al. (2009). Enhancing interoperability between web-enabled coastal atlases using an ontology-based metadata mediation approach. Proceedings of CoastGIS, 9th International Symposium on GIS and Computer Cartography for Coastal Zone Management. Santa Catarina, Brazil, CoastGIS.

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 (CWA), based on web-enabled geographic information systems (GIS). Those who have collaborated on CWA developments over recent years have now come together as part of the International Coastal Atlas Network (ICAN). 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. Integration of disparate CWAs will help optimize decision making at a variety of levels and across themes. The goal for CWAs integration is to allow efficient data search across heterogeneous distributed CWAs and to provide users with accurate responses to their requests. While trying to integrate CWAs, one must take into consideration the semantic heterogeneity problem. Not only do CWAs use different metadata structures and models, but also different terminologies (ontologies). The terminology used to describe similar data can vary between specialties or regions, which can further complicate data searches and integration. 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. Different languages (e.g., English, French) add further complications. From both a human and computational standpoint, users need assurance that the concepts, terminology, even the abbreviations that are shared between two or more individuals, systems, or organizations are understood by all to mean the same thing. In this way the quality of data

retrieval and subsequent data integration are greatly increased, as they are based on meaning rather than on mere keywords. This paper describes the development and usage of an ontology-based mediator for catalogue services. Such a mediator will help improve the quality of data searches by ensuring that terms from different ontologies are well translated before performing searches in the local catalogues. Implementation of such a mediator is a necessary first step in achieving the ICAN goal of distributed, but interoperable, CWAs.

Lassoued, Y., et al. (2008). Ontology-based mediation of OGC catalogue service for the Web requests: A virtual solution for integrating coastal web atlases. ICSOFT 2008, the 3rd International Conference on Data and Software Engineering, Porto, Portugal, Springer.

Maelfait, H. and K. Belpaeme (2010). "The Belgian Coastal Atlas: Moving from the classic static atlas to an interactive data-driven atlas." J. Coast. Conserv. 14(1): 13-19.

The Belgian Coastal Atlas was first published in hardback in 2004, with no intention to move towards a web version. The many requests for maps encouraged the developers to launch a web-based atlas in 2005. The interactive-nature of the maps was kept simple and the look of the maps was considered more important than the possibilities that GIS applications offered. Three years on, the Coordination Centre on ICZM would like to move from the more or less static web atlas to an interactive data-driven atlas, where sustainability indicators for the coast play a prominent role. The final product will be a policy supporting tool that will back the ICZM process for a wide range of coastal actors, planners and managers.

Meiner, A. (2010). "Integrated maritime policy for the European Union, Consolidating coastal and marine information to support maritime spatial planning." J. Coast. Conserv. 14(1): 1-11.

Launch of the Integrated Maritime Policy for the European Union in 2007 served as important factor that stimulates consolidation of coastal and marine information to support policy implementation. Policy action plan provides approaches for maritime governance, research and planning relevant to information. In particular, roadmap for maritime spatial planning stimulates development of coastal and marine GIS. Article reviews the current general status of coastal and marine systems and puts them in the context of the policy actions. Main focus is on formation of geospatial information platform for integrated assessment and ecosystem-based management of coastal and marine areas. Recent developments in data, indicator and information systems are summarized in European perspective: better characterization of maritime space and marine ecosystems, development of GMES Marine Core service and related in situ data collection; data harmonisation, interoperability and access, promoted by Shared Environmental Information System principles.

O'Dea, L., et al. (2007). Report on Coastal Mapping and Informatics Trans-Atlantic Workshop 1: Potentials and Limitations of Coastal Web Atlases. Cork, Ireland, University College Cork, Coastal and Marine Resources Centre: 1-75.

O'Dea, L., et al. (2007). Potentials and limitations of coastal web atlases: Outcomes of a transatlantic coastal mapping workshop. CoastGIS 2007. Santander, Spain.

O'Dea, L., et al. (2009). The Washington Coastal Atlas and the International Coastal Atlas Network: Connecting to the ICAN Prototype. Coastal GeoTools '09. Myrtle Beach, SC, USA, NOAA Coastal Services Center.

The Washington Coastal Atlas, first established in 1995, has proven to be a valuable resource to coastal and environmental managers. The Washington Department of Ecology developed the online atlas to assist local governments with their Shoreline Management Planning efforts. Interest and use of the atlas now extends to a broad audience, ranging from policy makers to the general public. Data layers available on the site include biological features such as wetlands and eelgrass beds, and physical features including drift cells and slope stability data. The atlas also includes 60 years of oblique aerial photos to view other shoreline features such as the level of development and presence of any shoreline modification. Coastal management issues do not stop at borders. The Washington Coastal Atlas is joining its neighbor, the

Oregon Coastal Atlas, in the International Coastal Atlas Network (ICAN) prototype to illustrate the practical benefits of collaboration and metadata/data sharing for coastal management on a regional and international level. The Washington Coastal Atlas will be the first to join the prototype using ESRI technology, providing a robust demonstration of how Open Geospatial Consortium (OGC) Catalog Services for the Web (CSW) and Web Map Services (WMS) are able to connect atlases built on either open source or proprietary software. This talk will present the Washington Coastal Atlas, the steps that will be taken to connect it with the ICAN prototype, and the expected benefits for coastal management in the Pacific Northwest region.

O'Dea, E. K., et al. (2011). "Potentials and limitations of coastal web atlases." J. Coast. Conserv. 15(1): 1-21.

A Coastal Web Atlas (CWA) is a valuable resource for a range of users including coastal managers as it provides easy access to maps, spatial data, coastal information and tools. A trans-Atlantic workshop on "Potentials and Limitations of Coastal Web Atlases", held in Ireland in July 2006, brought together atlas developers and coastal data experts from Europe and the United States to examine state-of-the-art developments in CWAs and future needs. This paper focuses on workshop outcomes, including what defines a CWA and an overview of international, national, state and regional atlas case studies from both sides of the Atlantic. Results of discussions are presented concerning issues related to design, data, technology and institutional capacity for existing CWAs based on the collective experience of workshop participants. A major outcome of the workshop was the initiation of an International Coastal Atlas Network. The insights provided give a framework for CWA developers and a useful point of reference for managers and policy makers on atlas potentials and limitations.

Taylor, K., et al. (2011). Introducing the International Coastal Atlas Network. American Fisheries Society 141st Annual Meeting, Advances in Coastal Atlases, Habitat Mapping, and Habitat Assessment Science to Support Fisheries and Ecosystem Decisions. Seattle, WA, USA, American Fisheries Society.

Over recent years, there has been significant development of national and regional coastal atlases based on web-enabled geographic information systems (GIS). These coastal web atlases (CWAs) are of great value to coastal decision makers, scientists and the general public. They can help users keep pace with changes in data quality and availability, associated information technologies, coastal landscapes/seascapes, vulnerabilities of coastal communities, and more. While multiple benefits are derived from these tailor-made atlases (e.g., speedy access to multiple sources of coastal data and information; targeted tools for user needs), the potential exists to derive added value from the integration of neighboring CWAs in order to optimize decision making at a variety of levels and across broader geographical regions. The International Coastal Atlas Network (ICAN: http://www.icoastalatlas.net) is an informal group of over 30 organizations from over a dozen nations who have been meeting over the past four years to scope and implement data interoperability approaches to CWAs. The mission/strategic aim of ICAN is to leverage the expertise of its members to find common solutions to CWA development. Working together, the members of ICAN share 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. ICAN 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. The presentation will discuss how ICAN has enabled individual CWAs (i.e., Washington Coastal Atlas, Oregon Coastal Atlas, Wisconsin Coastal Atlas, and others) to begin collaboration with other CWAs in their regions, particularly in terms of priority geographic data, sharing of knowledge and of technology. It will also share results from the most recent ICAN workshop in Oostende, Belgium held in August 2011.

Tikunov, V. S., et al. (2008). "Atlas information systems and geographical names information systems as contributants to spatial data infrastructure." Int. J. Digital Earth 1: 279-290.

Abstract National and international programs dealing with spatial data infrastructures (SDI) made it possible to compile a uniform digital base and a universal toolkit for the integrated description of territories on global to national scales. Atlas information systems (AIS) are considered to be an integrating tool for diverse information resources (modelling, visualisation and analysis), as well as for the elaboration of

various scenarios and the possible development of alternatives for such complex systems as those of nature-society-economy. As there is an increased use of digital maps at spatial data infrastructures all aspects related to geographical names are of particular importance in this application of AIS to SDI. It is important to realise a toponymic project, dealing with place-names and their variants depending on the language and time period when a specific place-name was used. The layer of geographical names is considered to be one of the three most important data components of AIS.

Tolvanen, H. and R. Kalliola (2008). "A structured approach to geographical information in coastal research and management." Ocean Coast. Mgmt. 51: 485-494.

In coastal areas different views, strategies, policies, practices and technologies about digital spatial data need to be viewed comprehensively. We propose a structured approach to enhance the use of geographical information in coastal applications in three different levels. The building of a Coastal Geographic Information System involves a clear determination of the specific information needs and user groups that correspond to the coastal area in question, and furthermore their evaluation prior to the actual implementation of the system. Second, primary coastal data can be effectively converted into coastal knowledge through enhanced conceptualisation, data combinations and spatial modelling, gaining better spatial data contents to facilitate research, administration and management. Third, Coastal Spatial Data Infrastructures should be promoted to facilitate inter-institutional collaboration and information sharing. The structured approach is presented using the case of the southwest Finnish archipelago coast as an example area.

Wright, D., et al. (2007). A Prototype Ontology Tool and Interface for Coastal Atlas Interoperability. American Geophysical Union Fall Meeting, San Francisco, CA, USA, American Geophysical Union.

Wright, D., et al. (2007). U.S./European partnerships in coastal atlases and coastal/ocean informatics. 27th Annual ESRI User Conference, San Diego, CA, Environmental Systems Research Institute (ESRI).

Wright, D., et al. (2007). Trans-Atlantic partnerships in coastal/ocean informatics and an International Coastal Atlas Network. Association of American Geographers Annual Meeting, San Francisco, CA, USA, Association of American Geographers.

Wright, D., et al. (2011). Introducing the International Coastal Atlas Network. Coastal GeoTools. Myrtle Beach, SC, NOAA Coastal Services Center.

Part of the Special Interest Meeting S04. Building Coastal Web Atlases to Support CMSP Goals: Best Practices, Lessons Learned, and Requirements The recently released National Ocean Policy, including the Framework for Effective Coastal and Marine Spatial Planning (CMSP), calls for the development of regional data portals and analytical tools to support comprehensive CMSP. Coastal Web atlases (CWAs) are online information resources that can help build collaborative relationships within and across state, regional, national, and international areas to foster more effective management of coastal and ocean resources and activities. The mission of the International Coastal Atlas Network (ICAN) is to share experiences and to find common solutions to CWA development, increasing awareness of the opportunities that exist for coastal and marine data sharing among policy makers and resource managers This special interest meeting will focus on the identification of best practices and lessons learned from the ICAN community, and will identify common elements that can be used from ICAN and other state and regional efforts to build a geospatial technology support network for regional CMSP. Attendees will be asked to share their knowledge of CMSP-related activities in their geographies, brainstorm on how they can work together within regions, and discuss potential opportunities for future collaborations.

Wright, D., et al. (2009). Introducing the International Coastal Atlas Network. Coastal Zone '09. Boston, MA, USA.

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 coastal web atlases (CWAs) are of great value to coastal decision makers, scientists and the general public,

especially with regard to helping users keep pace with changes in data quality and availability, the associated information technologies, coastal landscapes/seascapes, and in coastal communities, their vulnerabilities, identities, and more. While multiple benefits are derived from these tailor-made atlases (e.g., speedy access to multiple sources of coastal data and information; economic use of time by avoiding individual contact with different data holders), the potential exists to derive added value from the integration of disparate CWAs in order to optimize decision making at a variety of levels and across broader geographical regions. This panel will introduce the International Coastal Atlas Network (ICAN), 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 mission/strategic aim of ICAN is to leverage the expertise of its members to find common solutions to CWA development (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. The panel will share results from its latest workshop on the theme Federated Coastal Atlases: Building on the Interoperable Approach, where the strategic and governance structures of ICAN were developed. Also included will be a discussion for interested organizations of the benefits of membership in ICAN including: (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. And finally, the panel will report on the next phase in the development of a proof-of-concept prototype that inter-relates metadata and other information between two mature CWAs (the Oregon Coastal Atlas, www.coastalatlas.net, and the Marine Irish Digital Atlas, http://mida.ucc.ie). The approach leverages ontologies and semantic mediation (i.e., translations of terms and queries) using the Open Geospatial Consortium's catalogue services for the web (CSW), web mapping services (WMSs), and web feature services (WFSs), to our knowledge an unprecedented combination for coastal resource management.

Wright, D., et al. (2009). Building the Digital Coast with the International Coastal Atlas Network. Coastal GeoTools '09, Myrtle Beach, SC, USA, NOAA Coastal Services Center.

The International Coastal Atlas Network (ICAN) is a newly-founded informal group of organizations who have been meeting over the past two years to scope and implement data interoperability approaches to coastal web atlases (CWAs). The mission/strategic aim of ICAN is to share experiences and to find common solutions to CWA development (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.), while ensuring maximum relevance and added value for the end users. This includes a long-term view toward U.S. national and global-level operational interoperability, which will evolve as the ICAN community strives to increase awareness of the opportunities that exist for increased coastal and marine data sharing among policy makers, resource managers, and other strategic users of a CWA. We see ICAN participants as playing a leadership role in forging international collaborations of value to the participating nations and optimizing regional governance in coastal zone management. A major long-term goal is to help build a functioning digital atlas of the worldwide coast based on the principle of shared distributed information. This has been initiated by a prototype interoperability tool and network for the integration of locally-maintained CWAs as a detailed and reliable source of spatial information about coastal zones throughout the world, as well as a basis for rationally-informed discussion, debate and negotiation of sustainable management policies for regional governance.

Wright, D., et al. (2007). U.S./European partnerships in coastal atlases and coastal/ocean informatics. Coastal Zone '07. Portland, OR, USA.

Wright, D. J. (2007). "Exploration in the age of Digital Earth." ArcNews 28(4): 1, 8-9.

What might the concept of exploration and the notion of discovery mean to geographers and GIS practitioners today? Exploration of our planet through fieldwork and, hence, discovery of new places is still ongoing, but so is the exploration of environmental databases, even information spaces that do not necessarily include spatial data. Therefore, "discovery" of a place does not necessarily mean having to "be there" in the field. Presented in this context are the themes of data sharing and the benefits thereof in the United States and the emergence of cyberinfrastructures (i.e., the use of high-end information technology in day-to-day activities, not just for the occasional supercomputer job), which are taking hold in basic and applied research and also within the realm of digital government. Under the umbrella of cyberinfrastructures, exciting new research topics are being developed in the areas of Web GIS (e.g., modeling, algorithms, data structures, stability, performance, and other computing issues), ontological libraries and semantic interoperability within Web GIS, and networks of data and metadata clearinghouses that are being built with open-specification Web mapping services and Web feature services.

Wright, D. J. (2009). Spatial data infrastructures for coastal environments. Remote Sensing and Geospatial Technologies for Coastal Ecosystem Assessment and Management. X. Yang. Berlin, Springer-Verlag: 91-112.

Central to this chapter is a review and discussion of the data portal as the primary means for search, discovery and download of spatial data. Discussed are some of the most pressing challenges to effective implementation of portals within the broader context of a spatial data infrastructure or SDI. Potential solutions are featured via two major case studies of interest to practitioners in coastal ecosystem assessment and management. While there are numerous projects that can be pointed to as successful case studies to emulate, the projects highlighted, along with related efforts and initiatives, are significant demonstrations of innovation, implementation, and practice, from which lessons can be learned. And finally, as critical as a data portal may be to successful SDI implementation, so too are the partnerships behind the portals, which are discussed at chapter's end with a consideration of virtual communities as an emerging necessity.

Wright, D. J., et al. (2011). Coastal Informatics: Web Atlas Design and Implementation. Hershey, PA, IGI-Global.

The purpose of the book 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. This handbook provides a complete guide to CWA 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 CWAs (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 includes 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 B.Sc., M.Sc. or Ph.D. degree, in the classroom, but also potentially for distance education as well).

Wright, D. J., et al. (2010). Report of International Coastal Atlas Network Workshop 4: Formalizing the Network, Engaging the Mediterranean. Corvallis, OR, Oregon State University: 79.

EXECUTIVE SUMMARY: From November 16 to 20, 2009, the International Coastal Atlas Network (ICAN) held a workshop on Formalizing the Network, Engaging the Mediterranean at the Adriatico Guest House of the UNESCO International Centre for Theoretical Physics in Trieste, Italy. The workshop (aka ICAN 4) engaged 32 participants from 12 countries, representing 26 organizations and multiple areas of scientific and technical expertise. This meeting was a follow-up to the successful 2008 workshop on Federated Coastal Atlases: Building the Interoperable

Approach (aka ICAN 3) held in Copenhagen, Denmark, as well as the 2007 workshop on Coastal Atlas Interoperability(aka ICAN 2 in Corvallis, Oregon, USA) and the 2006 meeting Potentials and Limitations of Coastal Web Atlases(aka ICAN 1i n Cork, Ireland). ICAN 3 continued the momentum by identifying the additional opportunities for partnering on coastal web atlas development throughout Europe, demonstrating the atlas interoperability prototype to the European Environment Agency and its many partners, and initiating the development of a long-term strategy and governance model for ICAN. ICAN 2 examined best practices for achieving interoperability between atlases, and led to the design of a demonstration interoperability prototype using the metadata catalogues of two atlases. ICAN 1 examined state-of-the-art developments in coastal web atlases (CWAs) from Europe and the U.S., shared several case studies and lessons learned, and established key issues and recommendations related to the design, data requirements, technology and institutional capacity needed for these atlases. At the conclusion of ICAN 3 it was abundantly clear that ICAN had grown from a simple idea to the cusp of a formal virtual organization, which had captured the interest of the European Environment Agency (EEA), the European Commission, UNESCO, and several government agencies, companies, non-governmental organizations, and universities. However, much more work needed to be accomplished. Therefore, the activities of ICAN 4 included:

- Discussions of final implementation structures for governance (including formal procedures for receiving new members), technical activities, and continued identification of funding opportunities, so that ICAN can formally incorporate as a virtual organization (aka community of practice).
- Presentations on emerging atlases in European countries (especially the Mediterranean) and beyond that are making themselves relevant through policy, environmental and socio-economic indicator work and related themes.
- Continued progress on our ontology and semantic interoperability work, 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, as well as to the new NETMAR (Open Service Network for Marine Environmental Data) initiative, which has already developed conceptual framework documents in this area.

To this end, we also:

-- Held a small workshop within a workshop for atlas administrators on how to become a new node in interoperability prototype.
-- Initiated strategies on making further improvements to all those nodes (according to the Shared Environmental Information Systems (SEIS) principles of sharing information for multiple purposes, using data and systems that are accessible and interoperable).
-- Facilitated further work 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.

- Presentations and discussion of user issues, including better knowledge of our atlas users, their needs, and on continued inventory, assessment, and evaluation of atlases. To this end, we discussed as part of a small workshop within a workshop on how to improve the functionality of CWAs for general users, especially as the technology continues to change.
- Small group meetings on potential funding opportunities on both sides of the Atlantic (European Union, US National Science Foundation and government agencies) in order to continue the work of ICAN.
- Initiation of plans for a major ICAN presence at Littoral 2010 in London (European ICAN partners), as well as a standalone ICAN Americas meeting in Wisconsin, USA.

In addition, the ICAN workshop took place around a two-day Workshop on Maritime and Coastal Information Systems, organised by the EEA, Environmental Information and Observation Network (EIONET), which was open to ICAN 4 attendees as well. The main objective of this meeting was to inform the many participating countries of the EIONET National Reference Centre (NRC) network and to allow for a first exchange of views on scope and roles in the new formation for this entity. Four participants of ICAN 4 were invited to give presentations at the EEA/EIONET workshop, which allowed EEA/EIONET to explore collaboration opportunities as a result of ICAN's emergence. The US National Science Foundation (NSF) had originally awarded support for two ICAN workshops, so there will be a 5th international workshop (aka ICAN 5), at the headquarters of the UNESCO International Oceanographic Data and Information Exchange (IODE) in Oostende, Belgium, August 31 to September 2, 2011. IODE will co-host CoastGIS 2011 in

Oostende immediately following ICAN 5. Objectives of ICAN 5 will include follow-up activities that we did not have time to accomplish at ICAN 4, including:
- 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.
- Continued engagement and servicing of 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.
- Forming proposal teams and submissions to the next available and appropriate NSF and other grant competitions (e.g., NSF Partnerships for International Research and Education, NSF Community-Based Data Interoperability Networks, NOAA, European Framework Program, InterReg, and ESF).
- Exchanging lessons learned in spatial data infrastructure between the US, European INSPIRE and other national and regional efforts.
- Continued implementation and improvement of new governance, strategic planning, and technical working groups.

Wright, D. J., et al. (2009). The International Coastal Atlas Network: An Emerging Spatial Data Infrastructure Initiative. Third INSPIRE Conference, in conjunction with the Eleventh International Conference of the GSDI (GSDI 11), Rotterdam, The Netherlands, GSDI, International Journal of Spatial Data Infrastructure Research.

The International Coastal Atlas Network (ICAN) is a newly-founded initiative comprised of a partnership of over 30 organizations from more than a dozen nations. It aims to be a global reference for the development of coastal web atlases (CWAs), which are defined as collections of digital, web-enabled maps and datasets with supplementary tables, illustrations, and information that systematically illustrate the coast, oftentimes with cartographic and decision support tools. These atlases are playing an increasingly important role as elements of spatial data infrastructures at state and national scales, and in assisting regional decision- and policy-making across numerous themes including coastal vulnerability to climate change impacts and population pressures, coastal governance (boundaries, protected areas, etc.), coastal hazards mitigation, marine spatial planning, resource availability and exploitation. Many of these atlases offer discovery, view and download services in line with the INSPIRE Directive. Another strategic aim of ICAN is to take advantage of the expertise of its members to find common solutions to CWA development, and to encourage and facilitate global operational interoperability between CWAs for enhanced data sharing, and the translation of coastal science to coastal decision-making. The paper describes the rationale and development of several products that ICAN has been developing for this purpose, such as user and developer guides, handbooks and articles on best practices, information on standards and web services, expertise and technical support directories, education, outreach materials, and workshops. The long-term goal of ICAN is to enable U.S. national and global-level operational interoperability between CWAs, based on the principle of shared distributed information, which will also provide a basis for rationally-informed discussion, debate and negotiation of sustainable management policies for regional governance. This will evolve as the ICAN community strives to increase awareness of the opportunities that exist for increased coastal and marine data sharing among policy makers, resource managers, and other strategic users of CWAs. The paper describes the experiences of and lessons learned by ICAN participants as they have developed the structure and governance of the organization, partnered with similar initiatives, and played leadership roles in forging international collaborations of value to their participating nations. A major long-term goal is to help build a functioning digital atlas of the worldwide coast.

Wright, D. J., et al. (2008). Semantic mediation as a gateway to interoperability, with a case study of the International Coastal Atlas Network (ICAN). Geographic Information Science: 5th International Conference, GIScience 2008. Park City, UT, USA, Springer-Verlag.

Wright, D. J., et al. (2009). Interoperability between coastal web atlases using semantic mediation: A case study of the International Coastal Atlas Network (ICAN). Eos, Transactions of the American Geophysical Union, 2009 Fall Meeting, San Francisco, CA, American Geophysical Union.

Coastal mapping plays an important role in informing marine spatial planning, resource management, maritime safety, hazard assessment and even national sovereignty. As such, there is now a plethora of data/metadata catalogs, pre-made maps, tabular and text information on resource availability and exploitation, and decision-making tools. A recent trend has been to encapsulate these in a special class of web-enabled geographic information systems called a coastal web atlas (CWA). While multiple benefits are derived from tailor-made atlases, there is great value added from the integration of disparate CWAs. CWAs linked to one another can query more successfully to optimize planning and decision-making. If a dataset is missing in one atlas, it may be immediately located in another. Similar datasets in two atlases may be combined to enhance study in either region. But how best to achieve semantic interoperability to mitigate vague data queries, concepts or natural language semantics when retrieving and integrating data and information? We report on the development of a new prototype seeking to interoperate between two initial CWAs: the Marine Irish Digital Atlas (MIDA) and the Oregon Coastal Atlas (OCA). These two mature atlases are used as a testbed for more regional connections, with the intent for the OCA to use lessons learned to develop a regional network of CWAs along the west coast, and for MIDA to do the same in building and strengthening atlas networks with the UK, Belgium, and other parts of Europe. Our prototype uses semantic interoperability via services harmonization and ontology mediation, allowing local atlases to use their own data structures, and vocabularies (ontologies). We use standard technologies such as OGC Web Map Services (WMS) for delivering maps, and OGC Catalogue Service for the Web (CSW) for delivering and querying ISO-19139 metadata. The metadata records of a given CWA use a given ontology of terms called local ontology. Human or machine users formulate their requests using a common ontology of metadata terms, called global ontology. A CSW mediator rewrites the user's request into CSW requests over local CSWs using their own (local) ontologies, collects the results and sends them back to the user. To extend the system, we have recently added global maritime boundaries and are also considering nearshore ocean observing system data. Ongoing work includes adding WFS, error management, and exception handling, enabling Smart Searches, and writing full documentation. This prototype is a central research project of the new International Coastal Atlas Network (ICAN), a group of 30+ organizations from 14 nations (and growing) dedicated to seeking interoperability approaches to CWAs in support of coastal zone management and the translation of coastal science to coastal decision-making.

Wright, D. J., et al. (2007). Report on Coastal Mapping and Informatics Trans-Atlantic Workshop 2: Coastal Atlas Interoperability. Corvallis, OR, USA, Oregon State University: 43.

Zagonari, F. (2008). "Integrated coastal management: Top-down vs. community-based approaches." J. Env. Mgmt. 88: 796-804.

In this paper, a dynamic model is developed in which coastal quality can be improved, restored, or maintained by two distinct user groups; this is done by identifying a context that ensures an increase (or a greater increase) in coastal quality in terms of specific features that characterise the user groups. The results demonstrate that integrated coastal management is always better than non-integrated management. Moreover, when there is a low degree of interest in maintaining the coastal use over time, only integrated community-based (CB) coastal management will increase the coastal quality. Even when the interest in maintaining the coastal use over time is high, an integrated CB approach is preferred if the willingness to pay for coastal improvements is great and the marginal inefficiency of investments in coastal improvements is low, because the coastal quality improves to a greater extent; if not, only an integrated top-down (TD) approach to coastal management will increase the coastal quality. These results suggest that developing countries should always adopt a CB approach; in contrast, developed countries should adopt a CB approach where local stakeholders attach direct values to the coastal quality, and adopt a TD approach where the general population attaches indirect (option or existence) values to coastal quality.

Zhao, T., et al. (2008). Ontology-based geospatial data query and integration. Geographic Information Science: 5th International Conference, GIScience 2008. T. J. Cova, H. J. Miller, K. Beard, A. U. Frank and M. F. Goodchild. Berlin and Heidelberg, Springer-Verlag. Lecture No: 370-392.