POTENTIALS AND LIMITATIONS OF COASTAL WEB ATLASES: OUTCOMES OF A TRANSATLANTIC COASTAL MAPPING WORKSHOP

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ABSTRACT: A trans-Atlantic "Potentials and Limitations of Coastal Web Atlases (CWAs)" workshop, held in Ireland in July 2006, brought together key experts from Europe and the United States to examine state-of-the-art developments in CWAs, future needs and the initiation of a possible International Coastal Atlas Network. This paper focuses on results of discussions concerning issues related to design, data, technology and institutional capacity. Summarised outcomes examine strengths, weaknesses, threats and opportunities for existing CWAs based on the collective experience of workshop participants. The insights provided give a framework for developers of CWAs and a useful point of reference for policy makers.

KEYWORDS: ATLAS, WEB, GIS, COAST, MARINE

INTRODUCTION

Governments, industry sectors, academic institutions and Non-Governmental Organizations (NGOs) have a tremendous stake in the development and management of geospatial data resources. Coastal mapping plays an important role in informing decision makers on issues such as national sovereignty, resource management, maritime safety and hazard assessment. Efforts to improve data accessibility are driven by legislation on topics such as Environmental management, open access of public sector information and data standards and harmonisation. The development of Geographic Information System (GIS) based web mapping products has improved the usability of GISs by non-specialists. This, combined with the needs the coastal and marine community, has resulted in the growth of a niche group of interactive coastal web atlases (CWAs) around the world. The 2006 Green Paper on Future Maritime Policy in the European Union stated: "*a veritable Atlas of EU coastal waters… could serve as an instrument for spatial planning*" (European Commission 2006, p. 35), illustrating the increasing international recognition of the potential utility of CWAs.

While significant capacity in the last decade has been built in the field of coastal mapping via web GISs and web atlases, little has been done to take stock of the implications of these efforts or to compile lessons learned and best practices. To address this gap, funding was obtained through the U.S. National Science Foundation (NSF) and the Marine RTDI programme in Ireland to organize two trans-Atlantic workshops on coastal mapping and informatics. 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 in July 2006. This workshop brought together key experts from Europe and North America to examine state-of-the-art CWA developments, share lessons learned, determine future needs in mapping and informatics for the coastal practitioner community and identify potential opportunities for collaboration.

This paper focuses on the results of discussions concerning issues related to atlas design, data, technology and institutional capacity. A summary of outcomes is given, examining strengths, weaknesses, opportunities and threats (SWOT) for existing coastal web atlases based on the collective experience of workshop participants. More detailed information can be found in the workshop's final report (O'Dea *et. al.*, 2007). The insights shared in this paper will help in providing a framework for developers of coastal web atlases and related online tools, as well as a useful point of reference for policy makers concerned with the development of data standards, such as the European INSPIRE Directive and the development of marine policy.

What is a Coastal Web Atlas?

A coastal web atlas is ***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, and all of which are accessible via the Internet.*** Access to the various components can be provided in different ways (Fig. 1). The typical CWA contains a number of general features, including: geospatial data and metadata; a map area for data display; a legend and/or layer list; tools to interact with the map and data; data attribute tables; topical information; powerful server and software technologies; and a well-rounded atlas design to meet atlas and user needs.

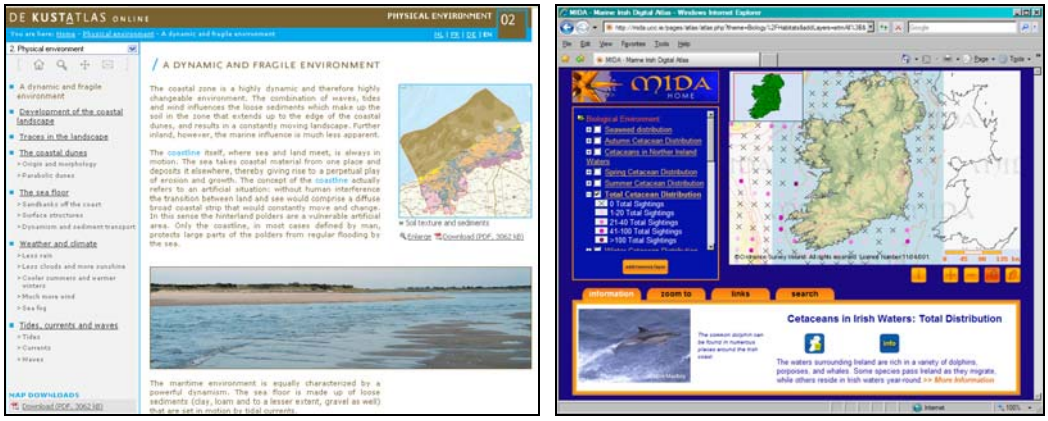

Figure 1. (l) De Kustatlas Online focuses on thematic topics which use maps to illustrate information, while making related geospatial data, charts and illustrations available; (r) The Marine Irish Digital Atlas centres on an interactive map where users can view data by theme and access additional information on the topics (users can also access maps from the text pages via links).

Coastal Web Atlas Case Studies

As part of the workshop, a number of representative coastal web atlas case studies from both sides of the Atlantic were presented by developers. The workshop report (O'Dea *et al.*, 2007) provides an overview of the case studies, which highlight key aspects of CWA development and operations such as atlas purpose, institutional support, technology and functionality (e.g., Fig. 2). Those included as case studies were: The UK Coastal and Marine Resource Atlas (http://www.magic.gov.uk); De Kustatlas Online, Belgium (http://www.kustatlas.be); The Marine Irish Digital Atlas (http://mida.ucc.ie/); The Oregon Coastal Atlas (http://www.coastalatlas.net); North Coast Explorer, Oregon (http://www.northcoastexplorer.info); and Mapping Tools for Coastal Management, Virginia (http://ccrm.vims.edu). These provided the basis of experience for the discussions during the workshop.

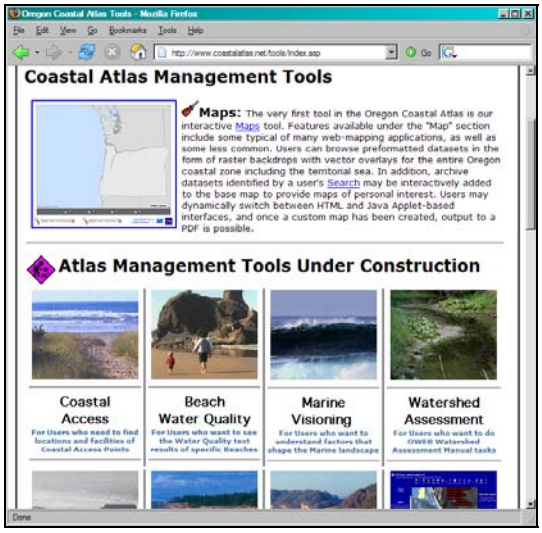

Figure 2. The Oregon Coastal Atlas, one of the case studies presented at the workshop, provides a suite of management tools which enhance the atlas.

STRENGTHS, WEAKNESSES, OPPORTUNITIES AND THREATS ANALYSIS

During the workshop, four working groups were established to identify issues related to atlas **design**, **data**, **technology** and **institutional capacity**. Each working group focussed its discussion by carrying out a Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis on its specific theme (Weihrich 1982). Tables 1 through 4 summarise the results, providing the top five strengths, weaknesses, opportunities and threats identified for each theme.

Table 1. SWOT Analysis of Atlas Design

ATLAS DESIGN	
STRENGTHS	**WEAKNESSES**
- **Intuitive structure** of web sites and map pages; - Inclusion of **contextual information** in order to better understand the data; - **Hierarchical** data organisation; - **Multiple user pathways** to retrieve maps and layers of interest; - **Tools** for data analysis and creating reports.	- 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.

THREATS	OPPORTUNITIES
- **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 IPR** issues impact atlas design in data quality and accessibility, and thus atlas functionality (e.g., spatial analysis using large scale data).	- **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).

Table 2. SWOT Analysis of Atlas Technology

ATLAS TECHNOLOGY	
STRENGTHS	**WEAKNESSES**
- **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 & W3C standards); - Progress in **network capacity & hardware** (e.g., processor speeds, storage capacity, monitor resolutions); - Contribution of **other technologies and tools** (e.g., XML, UML, 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).	- **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**.
THREATS	**OPPORTUNITIES**
- 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.	- **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).

Table 3. SWOT Analysis of Atlas-Related Data and Metadata

ATLAS-RELATED DATA AND METADATA	
STRENGTHS	**WEAKNESSES**
- **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.	- **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.
THREATS	**OPPORTUNITIES**
- **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.	- 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.

Table 4. SWOT Analysis of Atlas-Related Institutional Capacity

ATLAS-RELATED INSTITUTIONAL CAPACITY	
STRENGTHS	**WEAKNESSES**
- **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.	- 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.
THREATS	**OPPORTUNITIES**
- 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;	- **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.,

- Over or **poor marketing** means user expectations not met; - **Challenges of collaboration**: partner doesn't deliver up to specifications.	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).

Synthesis: Identification of Cross-Cutting Issues

The various points raised by the four working groups were analysed and a number of cross-cutting issues were identified among those which were relevant to more than one theme (atlas design, data, technology and institutional capacity). These issues are presented in Table 5.

Table 5. Cross-cutting issues of existing CWAs

CROSS-CUTTING ISSUES OF EXISTING COASTAL WEB ATLASES	
STRENGTHS	**WEAKNESSES**
1. **Standards and specifications** are maturing and **gaining wide acceptance**. 2. International and national **regulations are driving the need** for data and encouraging their availability. 3. Academic institutions and research organisations can take advantage of **emerging technologies** to design innovative products. 4. Development of **web atlases can aid in collaboration** between institutions and sharing of methods.	1. **Metadata is often inadequate**, inaccurate or out of date. 2. **Data management is difficult** due to the large quantities of data, difficult-to-support formats and their appearance on multiple portals. 3. **Data access limitations**, licencing and desire to recoup costs are restrictive. 4. There are **limitations** in the ability to **display** certain data types and to perform **data analysis**.
THREATS	**OPPORTUNITIES**
1. The **Google Earth paradigm** challenges atlas developers to meet design expectations of users. 2. **Data policies and IPR** impair accessibility and re-use of data. 3. **Erratic funding** affects the ability to develop and maintain atlases and leads to staff turnover issues. 4. **Credibility**: Atlases may not meet actual user needs and expectations; data quality may be poor; changing technologies may be disruptive.	1. **Community building and collaboration** can leverage the expertise of atlas developers. 2. **E-Gov and SDI initiatives** are helping to increase interest in CWAs among policy makers and regulators. 3. Atlases enable **identification of data gaps** and provide the ability to **pull resources together** to fill gaps and improve data. 4. Use **emerging technologies**, including Open Source and OGC standards, to enhance data sharing, presentation and online analysis.

CONCLUSIONS AND RECOMMENDATIONS

As a result of the *Potentials and Limitations of Coastal Web Atlases* Workshop, a number of conclusions and recommendations were developed. The following list provides a summary of those given in the final workshop report, where they are provided in greater detail (O'Dea *et al.*, 2007). This list provides an overview of the

existing status of CWA development and highlights significant issues which need to be addressed, both by the coastal mapping community as well as those with a stake in the management of data relevant to the coastal zone.

1. CWAs provide a range of data related services.

RECOMMENDATION: Methods for providing additional CWA services should continually be explored to better meet user needs.

2. Workshop outcomes demonstrate that CWA developments in the United States and Europe are using similar technologies and standards.

RECOMMENDATION: Collaboration among American and European researchers should be actively supported in order to advance CWA design and implementation.

3. New legislation and policies are driving the production of quality coastal datasets and improved data availability.

RECOMMENDATION: The CWA community must provide input to policy development to help raise awareness of issues, including data accessibility. Methods for effective outreach to decision makers must be improved.

4. Data cost, licensing and intellectual property considerations can limit data availability in an atlas.

RECOMMENDATION: CWA developers and data managers should develop a collective approach to inform policy makers of limitations that data cost, licensing and IPR issues impose on users.

5. Much data is still inaccessible or of variable quality.

RECOMMENDATION: Data owners should be encouraged to devote resources to properly cataloguing their data and improving its quality.

6. Consolidation of international standards and specifications is making atlas development easier.

RECOMMENDATION: CWA developers must be aware of the latest standards and specifications and strive towards their implementation. Data providers should also be encouraged to implement them.

7. CWAs are using cutting edge technology to develop effective web resources.

RECOMMENDATION: CWA developers should keep informed of emerging technologies and look for opportunities to implement them.

8. Database management systems (DBMSs) are crucial for efficient content management.

RECOMMENDATION: Efficient, flexible and easy to use spatial data management systems need to be used for improved content management.

9. A common ontology for coastal and marine data is necessary to enable exchange and integration of data.

RECOMMENDATION: The CWA community should be informed about ontology developments and consider implementing them.

10. The recent emergence of Google Earth and other virtual globes have revolutionised public expectations with respect to geospatial data visualisation.

RECOMMENDATION: The CWA community needs to evaluate the impact of such viewers on their own initiatives and determine if there is the potential to work with or incorporate elements of virtual globes in next version CWAs.

11. Existing CWAs offer limited functionality for analysis and value added outputs.

RECOMMENDATION: CWAs should offer a suite of analysis tools and value added outputs. Developers should explore the utility of various technologies to help in development.

12. Existing atlases are generally designed to meet the basic needs of a broad range of users, but are sometimes too complicated for general audiences.

RECOMMENDATION: Development must be responsive to user needs. Developers should consider designing multiple versions to offer a range of services. Regular user feedback is crucial for atlas success.

13. The erratic nature of funding can compromise maintenance and ongoing CWA development.

RECOMMENDATION: Different financial models need to be examined to determine the best methods for continued CWA support, such as sponsorship, subscriber-only areas and spin-off initiatives.

14. Ongoing dissemination and publicity of CWAs is important to atlas success.

RECOMMENDATION: Regular methods should be explored for effective outreach such as Email lists, publicity, events, brochures, giveaways and other innovative ideas to increase awareness.

15. There is limited capacity to measure the impact of CWAs in the coastal community.

RECOMMENDATION: Better methods need to be developed in how to measure impacts of CWAs in the coastal community.

16. The emergence of various CWAs has resulted in a concomitant growth of expertise in the area of online CWA design and presentation.

RECOMMENDATION: It is vital to develop links within the CWA community to enhance collaboration, build on lessons learned and identify best practise.

Further Developments

The second workshop in the series, entitled *Coastal Atlas Interoperability*, was held at Oregon State University in Corvallis, Oregon in July 2007. A report on this workshop is currently being compiled. The success of these two workshops has led to the decision to continue the series, under the banner of the newly established International Coastal Atlas Network (ICAN). The next workshop, planned for July 2008, is being discussed at the time of writing. More information on the workshops, as well as ICAN, can be found at http://workshop1.science.oregonstate.edu/.

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