A FRAMEWORK FOR EVALUATION OF MARINE SPATIAL DATA GEOPORTALS WITH CASE STUDIES

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Abstract

Need for Marine Spatial Data Infrastructure (MSDI) as a component of National Spatial Data Infrastructure (NSDI) is widely recognized. "MSDI is not only relevant to hydrographers and government planners - many sectors have an interest in marine spatial data, whether they are data users, data providers, or data managers"[10]. MSDI encompasses marine and coastal geographic and business information. For efficient use of Marine Spatial Data it is necessary to ensure a valid and accessible distribution. Geoportal is specialized web portal for sharing spatial information on different levels using Internet. This paper re-examines the implementation of MSDI and what it means to data custodians and end users. Several Geoportals are reviewed (German and Australian) to determine their web services functionality, capabilities and the scope to which they support the sharing and reuse of Marine Spatial Data to assist development of Croatian MSDI Geoportal. This framework is on his way to provide context to better understanding the information bases on spatial data standards and as a tool for evaluation of MSDI dissemination - Geoportal.

Key words: MSDI, Marine Data, Marine Spatial Data, Geoportals, Evaluation.

1 INTRODUCTION

Coastal zone is recognised as a complex system which management need to involve various methodologies and stages to achieve results based on sharing knowledge and expertise between scientists, authorities and stakeholders [16].

Technology development led to inadequate and slow traditional approach to spatial data exchange. In order to establish effective spatial data management, it is necessary to develop a spatial data infrastructure (SDI). SDI provides a basis for spatial data, use and implementation at different levels of society [17].

In order to allow economy and industry to develop more efficiently, a standardization of spatial data, services, processes and other relationships linked to spatial data are performed as important directions of development [4]. While an SDI can be considered as the collection of technological and non-technological components and arrangements intended to create such an open environment, the SDI concept also reflects the increasing importance of interconnectivity in working with geographic information [29].
A key component of an SDI that facilitates accessibility and access to spatial datasets to end user is a Geoportal. In general, a Geoportal acts as a gateway to digital spatial data content and services made available within the concept of an SDI. The Geoportal Achieves this goal through the linking of geoformation oriented websites and databases [11]. Besides the technical components that connect data 'islands' via the internet, other aspects such as licensing agreements, data transfer standards, and data access policies, must also be put in place to ensure consistent and reliable access [28].

Resch and Zimmer (2013) [22] tried to find way how to optimize Geoportal to the end user. As they assumed that most developers of geo-portals focus on functionality and technology rather than on the user and their needs. Their work extends approach of He et al. (2012)[9], they integrating the concept of user experience and by performing a study involving qualitative interviews with persons who use geo-portals in their professional life, to establish a set of user experience design guidelines for map-based geo-portal development. They also shown, in their study [9], need for evaluation of Geoportal before its development. They detect a number of weaknesses in the design of Geoportal. These weaknesses are related to the breaches of some general design rules, such as providing adequate feedback mechanism and making important components visible.

2 MARINE SPATIAL DATA INFRASTRUCTURE

Marine Spatial Data Infrastructure (MSDI) is the component of an SDI that encompasses marine geographic and business information in its widest sense. This would typically include seabed topography (bathymetry), geology, marine infrastructure (e.g. wrecks, offshore installations, pipelines and cables), administrative and legal boundaries, and areas of conservation, marine habitats and oceanography [14].

MSDI is a frame which provides the integrated management of spatial data and information in the marine (maritime) environment covering processes such as: technology, policy, standards, data, people, and organizations [8][20].

MSDI should be established according global, regional and national conventions and policies of each maritime country. There are a large number of MSDI stakeholders that need to be coordinated [5].

Stelzenmüller et al. (2013a, 2013b) revealed emerging challenges, such as the lack of operational objective data access and stakeholder involvement, through a generic framework for the implementation of ecosystem- based marine management [26][27].

2.1 Who is responsible for development of marine components?

The Hydrographic Offices (HO) are uniquely placed to play a central role in the development of marine components of all SDIs. Significant support for all aspects of functioning HOs is International Hydrographic Organization (IHO)[20].

The IHO is an intergovernmental consultative and technical organization that was established in 1921 to support the safety of navigation and the protection of the marine environment [12]. Currently, the IHO has 81 Member States. According Pharaoh (2007) “The Hydrographic Office (HO) is an important part of the National Geo-Spatial Data Infrastructure and, of course, the IHO has an important role to play in coordinating the requirements and demands for data collection, interoperability, dissemination, access, standards, security, pricing policy and possible funding models” [20].

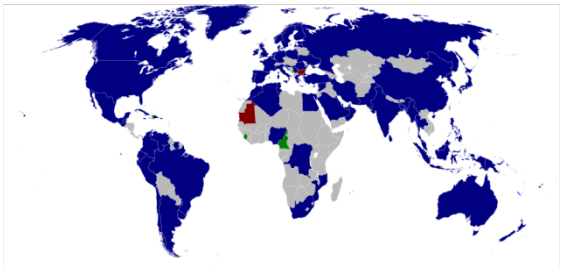

Fig 1. IHO Members [13] (Source: International Hydrographic Organization)

2.2 Croatian MSDI status and development of MSDI Geoportal

In Croatia the development of a MSDI currently takes place merging information concerning the field’s coastal engineering, hydrography and surveying, protection of the marine environment, maritime conservation, regional planning and coastal research. This undertaking is embedded in a

series of regulations and developments on many administrative levels from which specifications and courses of action derive.

Central role in development of MSDI in Croatia has a Hydrographic Institute of the Republic of Croatia (HIRC). To set up a conceptual framework for this MSDI in Croatia HIRC with other providers of marine data and partners need to build a reference model, develop models to support common workflows in marine applications and evaluate meta-information systems and MSDI of other countries.

2.3 Methodology

Nivala et al. (2008) [19] try to find way to check usability of web mapping sites through interviews. They methodology was reliable in accordance with that time (2008), nowadays it must be expand in accordance with technology development.

„Evaluating how other countries built their MSDI is main importance to learn where obstacles are and errors are likely to occur. To be able to look at other initiatives from a neutral point of view it is necessary to construct a framework for the evaluation of MSDI and their Geoportal"[24].

Indicators for evaluate MSDI and their Geoportal will be based on several resources. Base framework is develop by Rüh et al. (2012) explained in their paper „A framework for the evaluation of marine spatial data infrastructures to assist the development of the marine spatial data infrastructure in Germany (MDI-DE)- Accompanied by international case-studies"[24]. They develop framework based on ISO and OGC standards and use it on two case studies: Canada and two Australian Geoportals (AMSIS and IMOS). In Boris Blagonić thesis „Utility cadastre in local spatial data infrastructure" [2] we can find several useful indicators for reviewing Geoportal which are added to framework.

Enclosed MSDI case studies in this paper are: Germany (GeoSeaPortal) and Australia (AMSIS).

3 MARINE SPATIAL DATA GEOPORTALS AND EVALUATION FRAMEWORK

3.1 Geoportals

„The Internet is the *de facto* standard of today's global communications. It is host to millions of corporate and organisational Web sites and Web portals where various types of information services are provided and accessed. Spatial database vendors and users alike have closely followed the advances of the Internet to develop and adopt new software tools and solutions that have basically revolutionised the ways spatial information is processed and used" [30].

Important activities of SDI (and MSDI) are distributing and use of spatial data. Advancement of technology helped the development of geoportal service. Geoportals are specialized Web pages used to discover, view and access spatial information and additional geographic services via the Internet. Geoportal is a gateway to Web-based spatial information and information services [28].

According to Giff et al. (2008) the Geoportal achieves this goal through the linking of spatial information oriented websites and databases. In the context of an SDI it is propagated that there should be an entry point (a National Geoportal) to the following network of services. The National Geoportal is expected to serve as a one-stop shop providing access to geo-information (GI) content and GI services so that they can be easily shared and reused. [8].

3.2 Building the framework– evaluation methology

Table 1 show possible indicators for evaluating SDIs developed by Rüh et al. (2012)[24], divided by areas: policy, standards, access, data, people and performance.

Tab. 1: Possible indicators for evaluating SDIs (source Rüh et al. (2012)[24])

Area	Possible indicators
Policy Level – *Policy*	1 existence of a government policy for SDI 2 handling of intellectual property rights, privacy issues, pricing 3 objectives for acquisition and use of spatial data
Management Level – *Standards*	(1) standardisation arrangements for data dissemination and access network (2) institutional arrangements of agencies involved in providing spatial data (3) organisational arrangements for coordination of spatial data (4) definition of core datasets (5) data modelling (6) interoperability
Management Level – *Access Network*	• access pricing • delivery mechanism and procedure • access privileges • value-adding arrangements
Operational Level – *Access Network*	• type of network • data volume • response time
Operational Level – *Data*	• data format • data capture method • definition of core datasets • data maintenance • data quality and accuracy
Other Influencing Factors – *People*	1. number of organisations and people involved 2. opportunities for training 3. market situation for data providers, data integrators, and end-users
Performance Assessment	– degree of satisfying the objectives and strategies – user satisfaction – diffusion and use of spatial data and information – turnover and reliability

Rüh et al. (2012)[24] sets a similar approach for the assessment of SDIs like Najar et al. (2007) [18]. They propose three main components: data and metadata, web services and standards (see Table 2).

Tab. 2: Indicators for comparing SDIs on the basis of web services and data management according Najar et al. (2007) [18]

Component	Indicator	
	Technical	*Organizational*
Data and metadata	– Data capture process – Definition of core datasets – Data format and conceptual model – Data management – Data quality and accuracy – Common modelling language and tools – Harmonization of data and metadata	1. Custodianship 2. Data sharing and partnerships agreements 3. Business models 4. Coordinating arrangements

Web services	1. Application profile 2. Clearinghouse and geoportal	14. Clearinghouse organization
Standards	15. Interoperability	16. Organizational arrangements for standardization

Thematic SDI related to marine and coastal spatial data is known as Marine Spatial Data Infrastructure (MSDI), and their main components are mainly the same. Therefore, indicators that are used for SDI we can also use for MSDI.

Tab. 3: Indicators for the evaluation of marine spatial data infrastructures adapted from (Rüh et al. (2012) [24])

Area	**Indicator**	
	Technical	*Organizational*
A – Data	1 Core datasets	3 Degree of involvement of different agencies/institutions
	2 Coordinate reference systems	
B – Metadata	1 Availability of Metadata/Metadata catalogue (CSW)	3 Coordination
	2 Data quality and accuracy	
C - Services and Interfaces	1 Availability of Services	4 Access privileges
	2 Performance (response time, Data management)	
	3 Clearinghouse and geoportal	
D – Standards	1 Interoperability	
E – Modelling		1 Existence of a government policy for SDI
F- Geoportal - (acess to data)	1 Visibillity 2 Accessibility 3 User interface functionalities	

As Rüh et al. [23] explained, the Area (A) deals with the organizational and technical indicators regarding data. Data is starting point for development MSDI. Indicator core datasets (A1) show us what basic reference spatial data is covered by a country's MSDI. Indicator A2 - coordinate reference systems lists all the supported CRS of the MSDI. The last indicator (A3) looks at the degree of involvement of different stakeholders.

In second area – B, we can see what is behind available data respecting metadata (B1), is it searchable and is there CSW (metadata catalogue). Indicator B3 (coordination) is used because metadata should be homogeneous inside the MSDI and it would be good if there is a central coordination unit dealing with implementing metadata rules.

Interoperability has been shown in C area. It should be pointed out importance of marine spatial data standalone service availability. The indicator C1 (availability of services) lists all the available services. C2 indicate response time with working with that data, their performance. "Furthermore the system has to be able to cope with large data sets and there should be an update cycle with short intervals which is well documented. The MSDI should have a central entry point to access its data which is the geoportal resp. clearinghouse (indicator C3). It is important that there is a search functionality and map viewer.

Additionally indicator C4 (access privileges/custodianship) asks if there was a focus on a role model which deals with actors or stakeholders of the system when the MSDI was modelled" [24]. Area D has one indicator - interoperability. D1 analyses which standards are used.

E area is the modelling area of MSDIs from an organizational viewpoint. It considers the existence of a government policy for (M)SDI (indicator E1) and thus answers the question if the government backs up the developments.

Along existing Geoportal indicator C3, the last area focuses on access Geoportals. According to Blagonić's thesis [2], first indicator for evaluation MSDI portal would be visibility F1 (how can we find Geoportal on internet? Is there backlinks on official government web pages?). Accessibility (F2) level of content and services show is there option for other languages and is there help for users. User interface functionalities (F3) bring quality use of provided data on map viewer/editor (navigation, zoom, pan, editing tools).

4 EVALUATION CASE STUDIES

4.1 German GeoSeaPortal

Deutschland-Online Geo-Data has been started as a Deutschland-Online initiative in 2003., with members who are representatives from ministries, mapping agencies, communities, and SDI initiatives. Private companies are invited to take part on a project basis. All Deutschland-Online Geo-Data projects have to use the German SDI rules and standards, which are defined by the German SDI initiative GDI-DE [3].

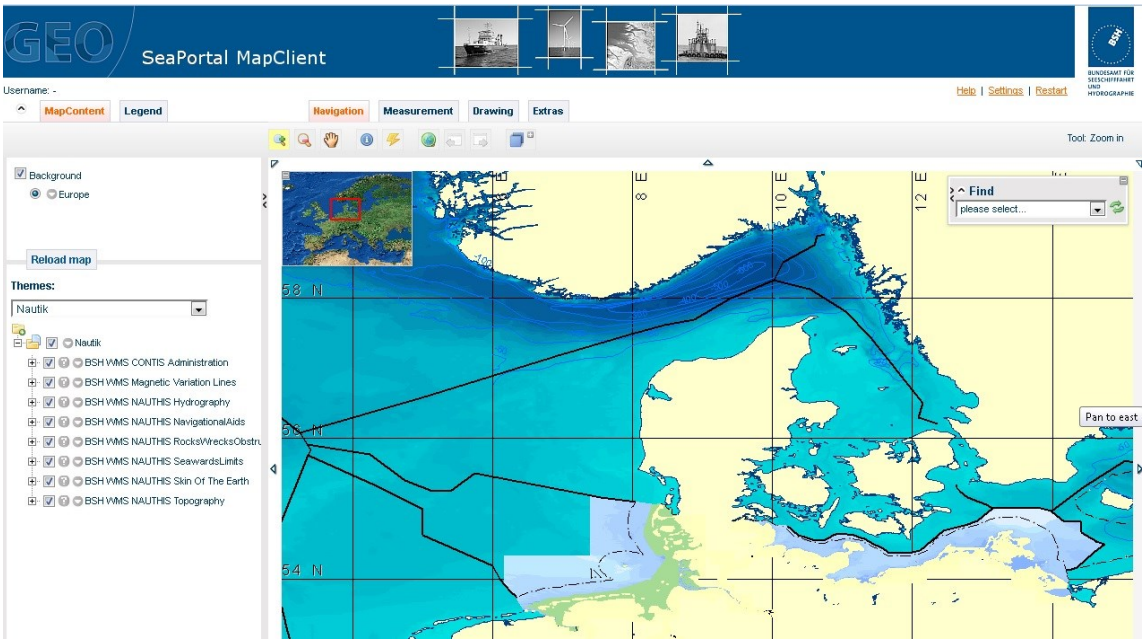

Fig 2. GeoSeaPortal

According to Rüh et al. (2012) and Geoportal.de, "in Germany currently the development of a marine data infrastructure takes place with the aim to integrate existing technical developments(NOKIS – a metadata database in Germany –and the spatial data infrastructure of the German Federal Maritime and Hydrographic Agency [GDI-BSH]) as well as merging information concerning the fields coastal engineering, hydrography and surveying, protection of the marine environment, maritime conservation, regional planning and coastal research" [23][6].

Tab. 4: Evaluation of German efforts

Area	Indicator	
	Technical	*Organizational*
A	1++	3++
	2++	
B	1++	3++
	2++	
C	1+/-	4++
	2 +	
	3++	
D	1++	
E		1++
F	1++ 2++ 3++	

* ++ very good, + good, +/- not appraisable, - not so good, -- bad

GeoSeaPortal with it core datasets (Geological, Navigational, Marine environment, Spatial planning, Oceanography, Tide Gauge Stations) and good metadata search engine deserve very good degree on Core datasets part of evaluation (A1). Also, very good is support for coordinate reference systems. GeoSeaPortal consists of two components: MapClient [15][25] and GeoSeaPortal [7] (metadata search application). Metadata search application supports the search for, and maintenance of metadata via intuitive web interfaces. As well as making locally stored and managed metadata available to users via standardized interfaces. The system implements the OGC CSW 2.0.2 interface, as well as the ISO Metadata Application Profile V1.0 (ISO19115/19119) and the DE Profile for Catalogue Services (B1). Area C describes availbility of services, because lacking services availability and bad web page navigation we gave +/- not appraisable. German GeoSeaPortal is accordant with OGC and ISO standards (D1). On organizational level deserve BSH very good score based on available documentation about establishment and all processes related to the topic. There is only one objection, some of documents as some parts of Web pages are only on German.

Access to GeoSeaPortal is very good in all of three technical segments visibility (F1), accessibility (F2) and user interface function (F3). On BSH official web page there is link to GeoSeaPortal at several places, we can it also find on other governance web places. Very good organized help for users in MapClient User Guide. On user interface functionalities side, GeoSeaPortal allows users to:

- Navigate through map area part of the window (pan, zoom in and out)
- Measure (distance or area)
- Draw (point, polyline, area, text or activate coordinates on click)
- Change spatial reference system,
- Change scale
- Save and load their own project
- Send map via e-mail
- Add data and services (WMS, WFS, ArcIMS, AGS, GeoRSS, Inspire View Services, SOS)
- Print.

4.2 Australian Marine Spatial Information System AMSIS

Australian Spatial Data Infrastructure (ASDI) has been coordinated by Australia and New Zealand Land Information Council (ANZLIC) since 1986, with the aim of making Australia's spatially referenced

data, products, and services accessible to all. Australian MSDI consist of two systems Australian Marine Spatial Information System (AMSIS) and Integrated Marine Observing System (IMOS).

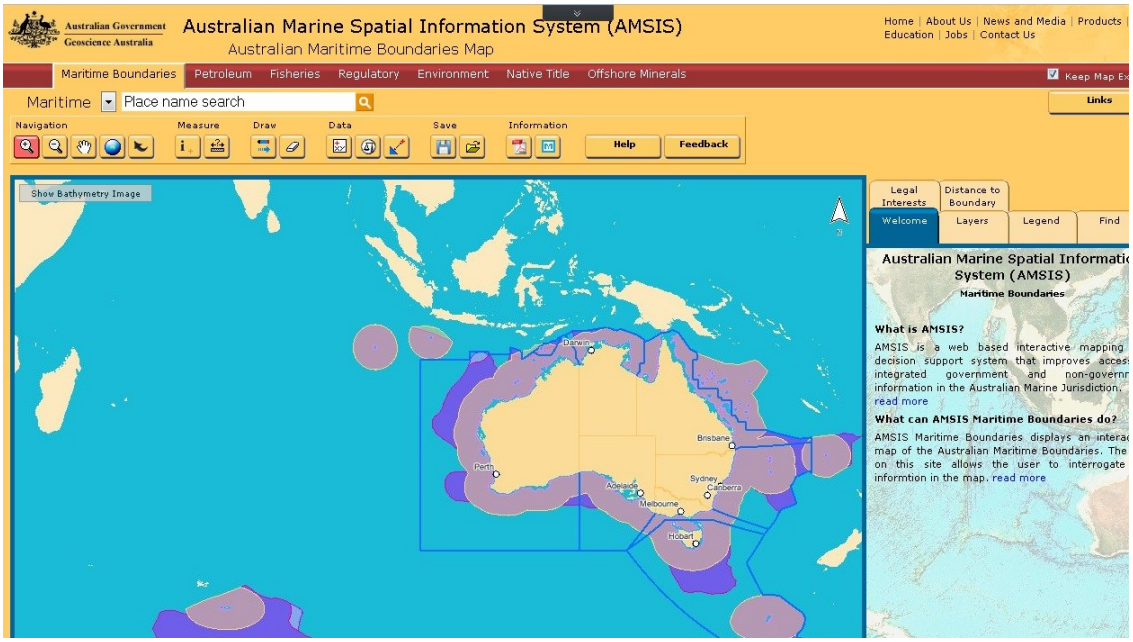

Fig 3. AMSIS

AMSIS offers categories of core datasets which belongs the Australian marine jurisdiction: administrative boundaries, bathymetry coastal and offshore gazetteer, transport information's, utility cadastre, environmental management and geology through a web based interactive mapping and decision support tool. It has been developed and supported by government agency Geoscience Australia.

Tab. 5: Evaluation of Australian efforts

Area	Indicator	
	Technical	*Organizational*
A	1 ++	3 ++
	2 +	
B	1 ++	3 ++
	2 +	
C	1 ++	4 +/-
	2 +	
	3 ++	
D	1 +	
E		1 ++
F	1+/-	
	2+	
	3+	

* ++ very good, + good, +/- not appraisable, - not so good, -- bad

Core datasets provide AMISIS very good score in first field (A1) of evaluation table. There no much information's about Coordinate reference system on Geoportal. Core datasets provide documentation about Coordinate reference system where we can see that WGS84 datum is used in AMISIS. AMSIS

contains data from agencies and industry sources like the Australian Fisheries Management Authority (AFMA), the Australian Maritime Safety Authority (AMSA), the Australian Hydrographic Service (AHS), the Department of Environment and Conservation and many others. It can be concluded from this that the datasets are coming from a wide range of agencies/institutions and thus giving indicator A3 a very good score like Rüh et al. (2012) also conduct [24].

In area B, AMSIS Australian efforts score very well in indicator 1 and 3. Central metadata catalogue doesn't exist, even a CSW, but there are all the layers provided in AMSIS through the Australian Spatial Data Directory (ASDD). „The metadata guidelines of ANZLIC include five metadata elements regarding data quality in the core metadata fields: lineage, positional accuracy, attribute accuracy, logical consistency and completeness" [24].

AMSIS offer a geoportal which include everything an average geoportal offers from search functionality to map viewer and so on leading to a "very good" in indicator C3.

Area D means Standards which we can refer to B3 regarding metadata standards for AMSIS and for standards for services see C1.

The last area focuses on access Geoportals. First indicator for evaluation MSDI portal is visibility F1, there is link for AMSIS on government official web pages, but it has bad place (navigation) and there is no defined path in web page address. Accessibility (F2) level of content and services show is there option for other languages and is there help for users, there is no other language option (only English) and there is good indexed help. AMSIS user interface functionalities (F3) bring beside usual (navigation, zoom, pan and editing tools) there special options like Distance to Boundary, Legal Interests, Advanced Find etc.

5 CONCLUSIONS

Anyone involved with hydrography has long understood the importance of managing such data efficiently, and making it usefully available to end-users, whether they be mariners, oil companies or the scientific community. MSDI is not only relevant to hydrographers and government planners - many sectors have an interest in marine spatial data, whether they are data users, data providers, or data managers [10]. A framework for evaluation of MSDI and Geoportals can be first step in challenging task establishing MSDI and component Geoportal. Study case Germany shown good side of use framework referring on the Rüh et al. (2012) [24] though AMSIS is not much behind. This framework is on his way to provide context to better understanding the information bases on international spatial data standards. Central role in development of MSDI in Croatia has a Hydrographic Institute of the Republic of Croatia (HIRC). To set up a conceptual framework for this MSDI in Croatia, HIRC with other providers of marine data and partners need to build a reference model, develop models to support common workflows in marine applications and evaluate meta-information systems and MSDI of other countries. The research is focused on the development of the evaluation framework with special emphasis on the implementation of the MSDI geoportal in Republic of Croatia. International experience of MSDI development, the existing standards for spatial data (OGC, ISO, etc.), standards of the International Hydrographic Organization (IHO), the INSPIRE directive and Law on National spatial data infrastructure are also considered as part of the research and framework model. Intention is to develop unique MSDI model that fits users and producers of such data using analysis tools for the evaluation of best practices. Framework for evaluation can be used to avoid a number of weaknesses in designing specific MSDI Geoportal. Advancement of Cloud Computing technologies have provided access to geoportal development to a wider audience. There are lot efforts to include geoprocessing and optimization of spatial data in accordance with better data initiatives in scope of Cloud Computing to reach better usability [1][31].

REFERENCES

[1] Baranski, B., Foerster, T., Schäffer, B., & Lange, K. (2011). *Matching INSPIRE quality of service requirements with hybrid clouds.* Transactions in GIS, 15(s1), 125-142.

[2] Blagonić, B. (2012): *Utility cadastre in local spatial data infrastructure*, thesis, Faculty of Geodesy University of Zagreb, Croatia.

[3] Brüggenmann, H. (2009): *Public-private SDI challenges in Germany*, GSDI 11 15-19 June 2009, Rotterdam.
[4] *Croatian National Spatial Data Infrastructure (NSDI)*: http://www.nipp.hr, 12.12.2014.
[5] Duplančić Leder, T., Leder, N., Tavra, M. (2014): *Geospatial Data in Marine SDI Services*, 6th International Maritime Science Conference / Vidan, Pero ; Twrdy, Elen ; Leder, Nenad ; Mulić, Rosanda (ur.). Split: Faculty of Maritime Studies Split, 465-469.
[6] *Geoportal.de*, http://www.geoportal.de 26. 04. 2014.
[7] *GeoSeaPortal*, http://gdi.bsh.de/terraCatalog/Start.do 26. 04. 2014.
[8] Giff G., van Loenen, B., Crompvoets, J., Zevenbergen, J. (2008): *Geoportals in Selected European States: A Non-Technical Comparative Analysis*, GSDI 10, Feb 2008, Trininad.
[9] He, X., Persson, H., & Östman, A. (2012): *Geoportal usability evaluation*. Int. J. Spat. Data Infrastruct. Res, 7, 88-106.
[10] Heaps, W. (2011): *Marine Spatial Data Infrastructure as Backbone for Coastal Mapping*, Hydro International, Volume 15, Number 1.
[11] Huet, M. (2007): *Marine Spatial Data Infrastructure, An IHO Perspective: Data, products, standards and policies*, International Hydrographic Bureau, Monaco, February 2009. http://www.iho.int/mtg_docs/com_wg/MSDIWG/MSDIWG_Misc/Marine_SDI_Seminar_Havana_2009/MH_MSDI_IHO_Perspective.pdf 20. 04. 2014.
[12] International Hydrographic Organisation: *About IHO*, http://www.iho.int/srv1/index.php?option=com_content&view=article&id=298&Itemid=297 20. 04. 2014.
[13] *International Hydrographic Organisation Members*, http://www.iho.int, 24.4.2014.
[14] International Hydrographic Organization (2009): *Spatial Data Infrastructures „The Marine Dimension" –* Guidance for Hydrographic Offices, Edition 1.0., Published by the International Hydrographic Bureau, Monaco.
[15] *MapClient User Guide*, version 3.0, http://gdi.bsh.de/mapClient/help/en/help-en-mapClient.pdf 10. 4. 2014.
[16] Malvárez, G.C., Pintado, E., G., Navas, f., Giordano, A. (2013): *Coastal spatial data infrastructure: So far so good?*, Proceedings of the 10th Global Congress on ICM: Lessons Learned to Address New Challenges, EMECS 2013 - MEDCOAST 2013 Joint Conference, Volume 1, 695-706.
[17] Masser, I. (2005): *GIS worlds: creating spatial data infrastructures* (Vol. 338). Redlands, CA: ESRI press.
[18] Najar, C., Rajabifard, A., Williamson, I. P., & Giger, C. (2007). A framework for comparing Spatial Data Infrastructures on the basis of web services and metadata management: an Australian-Swiss case study.
[19] Nivala, A. M., Brewster, S., & Sarjakoski, T. L. (2008). Usability evaluation of web mapping sites. The Cartographic Journal, 45(2), 129-138.
[20] Pepper, J. (2009): *The role of IHO in SDI MSDIWG findings*, IHO SDI Seminar 9. 2. 2009., Havana.
[21] Pharaoh, A. (2007): *IHO Perspective on a Marine Spatial Data Infrastructure*, EuroSDR Land & Marine Information Workshop, Malahide, 21-23 March 2007. http://www.eurosdr.net/km_pub/no52/workshops_docs/ws1/ws1_3.pdf 23.07. 2013
[22] Resch, B., & Zimmer, B. (2013). User experience design in professional map-based Geo-Portals. *ISPRS international journal of geo-information*, *2*(4), 1015-1037.
[23] Rüh C., Bill, R. (2012): *Concepts, Models and Implementation of the Marine Spatial Data Infrastructure in Germany (MDI-DE)*, Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, [Volume I-4, 2012 XXII ISPRS Congress, 25 August – 01 September 2012, Melbourne, Australia.
[24] Rüh C., Korduan, P. ,Bill, R. (2012): *A framework for the evaluation of marine spatial data infrastructures to assist the development of the marine spatial data infrastructure in Germany (MDI-DE)- Accompanied by international case-studies*, GSDI World Conference 2012, , 14 – 17 May 2012, Québec City, Canada. http://www.gsdi.org/gsdiconf/gsdi13/papers/113.pdf 29.4.2014.
[25] *SeaPortal MapClient*, http://gdi.bsh.de/mapClient/initParams.do, 10.4.2014.
[26] Stelzenmüller, V., et al., 2013a. Monitoring and evaluation of spatially managed areas: a generic framework for implementation of ecosystem based marine management and its application. Marine Policy, 37, 149-164.
[27] Stelzenmüller, V., et al., 2013b. Practical tools to support marine spatial planning: a review and some prototype tools. Marine Policy, 38, 214-227.
[28] Tavra, M., Cetl, V.(2013): *MSDI and Geoportals in Selected European States: A Comparative Analysis*, Proceedings of SDI days 2013, State Geodetic Administration, 2013. 92-97
[29] Vancauwenberghe, G. (2013). *SDI development to lower the impedance of the data exchange network*, The 16th AGILE conference, Leuven, Belgium.
[30] Yeung, A. K., Hall, G. B. (2007): *Web-Enabled Spatial Database Systems*, In Spatial Database Systems, Springer Netherlands, 367-407.
[31] Yue, P., Zhou, H., Gong, J., & Hu, L. (2013). Geoprocessing in Cloud Computing platforms–a comparative analysis. International Journal of Digital Earth, 6(4), 404-425.