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Towards a Coastal Spatial Data Infrastructure (CSDI) responsive to the needs of Integrated Coastal Zone Management: The GeoBretagne Experience (France)

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Abstract

The intensity and magnitude of change that characterize coastal areas now demand the implementation of collective processes and tools to enhance coastal zone knowledge and management.

Our hypothesis is that Coastal Spatial Data Infrastructures (CSDI) can contribute to Integrated Coastal Zone Management (ICZM) through a combination of technologies, policies and institutional arrangements to improve data access and sharing processes. However, their real contribution depends on the answers they provide to public bodies.

This article presents the first results of a project whose goal is to implement an SDI dedicated to marine and coastal areas as a sub-set of a regional (sub-national) SDI (Brittany Region, France). Based on interviews with key public ICZM stakeholders, this study examines the implementation of a data repository and a specific geoportal, and proposes a set of indicators for monitoring coastal areas.

Keywords: Coastal Spatial Data Infrastructure (CSDI), Repository, Geoportal, Indicator, Integrated Coastal Zone Management (ICZM), GeoBretagne

1 INTRODUCTION

1.1 Coastal areas and ICZM

The coastal area is a complex and vulnerable territory, home to many human activities and paroxysmal meteorology events. The combination of those factors involves both natural and anthropogenic hazards (Robin et al., 2004).

For purposes of preservation, the coastal zone has been the subject of increasing attention since the 1970s, generally expressed by the international concept of Integrated Coastal Zone Management (ICZM).

Cicin-Sain et al. (1998) describe the concept as the need to act collectively on the natural and anthropogenic processes that may threaten the sustainable future of the coastal environment and the activities that take place there.

The ICZM principle was recognized at the international level during the Earth Summit of 1992 with the adoption of Agenda 21, of which Chapter 17 is dedicated to the protection of seas and oceans, their coastal areas and biological resources (CNUED, 1993).

Since then, this principle has been incorporated into many international conventions (Ramsar, Convention on Biological Diversity...) and recommended by several organizations, agencies and states (Lozachmeur, 2005).

ICZM is a complex process that combines multiple actors and tools. While its interest is universally recognized, operation of the approach depends on methods and tools, especially for producing and sharing data (Williamson et al., 2004).

Technological advances over the past two decades in the field of Geographic Information Technologies and Communications provide a priori a favorable context. Indeed, it appears that the ICZM is enhanced by the implementation of methods and technological tools appropriate to the acquisition, storage, analysis, representation and communication of different kinds of data coming from various sources (Bartlett et al., 2004; Gourmelon et al., 2005; Vallega, 2005). In particular, geographic information systems (GIS) can put geo-referenced data acquired by different geomatics methods into a coherent framework, suitable for analysis and mapping of the data.

However, the clear advantages of GIS are hampered by institutional and organizational barriers that restrict their use by limiting access and sharing of spatial data (Williamson et al., 2004; Bersani, 2006; Strain et al., 2006; Gourmelon et al., 2010; Masser, 2010).

1.2 Coastal Spatial Data Infrastructure (CSDI)

At the beginning, Spatial Data Infrastructure (SDI)

Since the 1990's, the role of spatial information in decision making in many sectors has led to the development of a national SDI to better manage and share spatial data (Cromptvoets et al., 2004).

The development of SDIs responds to internationally needs to facilitate access, exchange and sharing of spatial data held by many producers to maximize its use, management and production.

According to Williamson et al. (2003), SDI is a core infrastructure that supports economic development, environmental management and social stability at all levels. Masser (2010) reinforces these goals by talking about better governance, sustainable environmental management, risk management, and modernization of administration. He emphasizes that the achievement of these goals calls for coordinated action by governments.

One of these coordinated approaches, the INSPIRE Directive 2007/2/EC of 14 March 2007, seeks to establish an Infrastructure for Spatial Information in the European Community. INSPIRE aims to overcome problems of availability, quality, organization, accessibility and sharing of geographic information that is essential to European environmental policy.

The implementation of INSPIRE is carried out by public authorities, building on the Infrastructures of Member States. In France, the Ministry of Ecology, Sustainable Development, Transportation and Housing (MEDDTL) is the national contact point for INSPIRE while the French National Council for Geographic Information (CNIG) is the national coordination structure under the Directive. Both bodies rely on the expertise and resources of the National Geographic Institute (IGN). Its obligation to implement the INSPIRE Directive requires France to modernize and harmonize the use of geographic information in its state services, particularly through implementation of the "[Geocatalogue](#)", a tool for centralizing metadata produced on national territory, and the "[Geoportail](#)", the window for viewing associated data.

In the same way as the first national SDI and European infrastructure, SDIs are being implemented at various levels (international, national, regional, local) (Masser, 2010). However, very few SDIs deal with specific areas, such as coastal and marine areas (Williamson et al.; 2004, Longhorn, 2005; Strain et al., 2006; Canessa et al., 2007; Gourmelon et al., 2009).

Coastal SDI and the French experience

CSDIs have been gradually implemented since the year 2000 in order to improve the accessibility and the availability of spatial data related to marine and coastal areas (Strain et al., 2006). While these initiatives are not always labeled "SDI", they share SDI objectives and concepts. In their early implementation, they are often separate entities, leading to confusion for coastal zone management (Strain et al., 2006).

However, the complexity of physical and institutional relationships that characterize the coastal zone and the overall approach promoted by the ICZM calls for the development of a seamless SDI that integrates data on land, marine and coastal areas (Longhorn, 2003; Williamson et al., 2004; Strain et al., 2006; Vaez et al., 2009).

In France, [BOSCO](#) was the first geoportal dedicated to the sharing of data about coastal areas in order to monitor the physical evolution of the coastline. BOSCO was developed in 1998 by the Centre for Maritime and River Technical Studies (CETMEF) and the Bureau of Geological and Mining Research (BRGM), (Metzler et al., 1999).

Since then, other initiatives for accessing and sharing marine and coastal data have been developed. Among these, the [Observatoire du Littoral](#) (2004) and the [Géolittoral](#) (2007) help to provide access to information and advance knowledge of the national coastal areas by further defining existing data. Their goals are to provide analysed and synthesised information to a wide audience.

Until recently such information was insufficiently accessible to public actors (Bersani, 2006), but a favorable context for data creation, availability and accessibility is gradually developing throughout France. This context is encouraged by the INSPIRE Directive, the Framework Directive Marine Strategy (DCSMM) to restore marine waters to a sound ecological status by 2020, and the National Plan of Adaptation to Climate Change (PNACC), which aims to present concrete operational measures by 2015 to meet and respond to new climate conditions (Raout et al., 2011).

At the regional level, different approaches to data sharing on coastal areas have been initiated since the mid-1990s, especially in the Provence-Alpes-Cote d'Azur region, with the creation of the Regional Centre for Geographic Information ([PACA-CRIGE](#)).

More recently, as observed in Canada (Canessa et al., 2007), pilot projects focused on a problem or a specific coastal issue are driving data sharing approaches. Projects are, for example, sharing knowledge initiatives about

coastal erosion (Bulteau et al., 2011) or accidental water pollution (Le Berre et al., 2011).

This article presents the first results of a study in which the actors and organizations involved in coastal management in Brittany (France) are involved in a partnership approach to sharing data related to coastal zones.

2 THE GEOBRETAGNE SDI AND ITS "COASTAL AND OCEAN" GEOPORTAL

In Brittany, the attractiveness of the coastal zones involves multiple dynamics that can be the starting point for environmental degradation and use conflicts (Le Tixerant, 2004).

This awareness led to creation of the "[Charter of the Brittany coast](#)" which advocates a co-development approach through a network of 150 partners, to define a new governance of coastal areas in Brittany and the tools necessary for implementation of this approach.

A system of observation, monitoring and predictive analysis of the coastal zone is currently being implemented to carry out that approach. It is based on the [GeoBretagne SDI](#) that was implemented in 2007 by the State and the Brittany Region.

GeoBretagne uses a partnership approach in establishing a data-sharing platform to improve knowledge of the Britain territories for public stakeholders. It provides a number of network services to its partners, who are co-signers of the "GeoBretagne agreement", and to a broad audience.

These partners, public bodies that include services of the State, local authorities at the regional, departmental and municipal levels, and associations, are engaged in a process of data sharing and public transparency.

In order to best meet their needs, "thematic groups" called "pôles métiers" have been set up, such as the thematic groups for "Urban planning" and "Tourism". They offer a forum for discussion of specific themes. Their members work together to organize improvements in the acquisition, sharing and public dissemination of specific data by involving all relevant partners. The "coastal and ocean" thematic group was established in October 2011 to meet the needs of the partners involved in the Brittany coastal area.

The Brittany Region decided to set up a "coastal and ocean" geoportal to address the specific goals of the Charter of the Brittany coast and the objectives of GeoBretagne. The company [Terra Maris](#) (SARL) and the research team [LETG-](#)

[Brest \(UMR 6554 CNRS\)-Geomer](#) have been given responsibility for needs analysis and process initialization.

The project has three research focuses:

1. to develop a spatial data and information repository on the “coast and ocean” theme;
2. to create a “coastal and ocean geoportal” that offers easy user-access;
3. to propose a set of reproducible indicators (people-relevant data) for understanding and monitoring changes affecting coastal areas.

2.1 Methodology

Study scope

The aim of the study is to promote the availability of relevant information that is quickly and easily accessible to public actors in the Britain coastal area. The information has to be concise and of operational benefit for the ICZM process. It is part of the goals of both the Charter of the Brittany coast and the GeoBretagne partnership approach.

The Charter of Brittany Coast considers all the territory of Britain as a coastal area. Therefore, the spatial scope of our study encompasses the four departments on land, and the marine boundaries to a limit of 12 miles (Figure 1).

Figure 1. Spatial scope of the Charter of the Brittany coast



Qualitative approach

Our study is based on a qualitative approach, suitable for studying opinions, attitudes, practices and individual uses. It is based on semi-structured interviews with resource people (*key informants*) (Tremblay, 1957). The goals of the study are to:

1. identify key issues and needs related to sharing and accessing spatial data concerning marine and coastal environment;
2. identify necessary information, technical and organizational solutions.

This kind of approach was preferred to a standard survey sent by mail or email, because it allowed us to ensure a satisfactory level of responses to our questions and to benefit from the professional framework, sometimes useful in illustrating specific comments (Gourmelon et al., 2009).

The "target population" was jointly identified, through discussion, by the Regional Council of Brittany and the researchers in charge of the study. The research population is composed of ICZM institutional actors and stakeholders, who are partners in both the Charter of the Brittany coast and Geobretagne. Eight internal departments of the Regional Council, one regional service of the State and 14 local authorities who are involved in ICZM projects participated in the survey. In addition to the interviews, four group meetings, held as part of the steering process of the study, allowed us to compare different point of views and to cross-check information previously collected.

A. "Coastal and Ocean" Repository

Development of the repository is based on the results of 23 interviews. The interviews aimed to:

- Identify the various actors working in the ICZM process (projects, GIS skills);
- Evaluate existing data and the needs expressed by the actors in terms of geographical and statistical information relevant to the management of their jurisdictions.

Existing geoportals, repositories of the interviewees, as well as reports and specific studies about "coastal and ocean" repositories were consulted to complete the inventory of existing data derived from the survey.

Another series of interviews with regional geographic information producers (Association of Marinas in Brittany, Regional Tourism Observatory) is currently underway to complete the repository. The final objectives are to identify a network of relevant producers for the "coastal and ocean" thematic group and to initiate a monitoring and animation process for the repository.

B. "Coastal and Ocean" Geoportal

The Britain region wanted to set up a "coastal and ocean" geoportal to provide consultation, sharing, viewing and updating data functions, based on open-source and interoperable solutions.

A prototype of the "coastal and ocean" geoportal has been designed as a subset of the GeoBretagne SDI. This approach is used by researchers in charge of the project to maintain technical, organizational and informational consistency with the SDI. Indeed, the Geobretagne SDI is based on the modular, interoperable and free solution [geOrchestra](#). This tool complies with the INSPIRE Directive and is supported by a community of users and developers who ensure its maintenance and sustainability.

The prototype will be tested in a second step by the network of ICZM actors, using a questionnaire to determine their level of satisfaction and to solicit their recommendations.

C. Indicators for monitoring coastal areas.

The interview grid was based on a list of indicators provided by the European [DEDUCE](#) and the [Observatoire du Littoral](#) (OL) and follows their procedures. Strongly operational in focus, to understand and monitor changes in coastal areas, the indicators selected were chosen to match more specifically the needs of the 14 local authorities involved in ICZM projects, which are our target population.

The objective of this series of interviews was to:

- List the indicators that are regularly used or produced by the actors;
- Identify among the indicators proposed by DEDUCE and OL those additional indicators that are of interest to the local authorities;
- Define data sources, production and representation methodologies for the indicators consistent with the Britain context, in compliance with DEDUCE and OL methodological procedures.

Interviews are currently underway (9/14). The analysis of these interviews will help to link the needs of ICZM actors with the resources of GeoBretagne in order to:

- identify information gaps;
- develop software tools to produce indicators relevant to the majority of the actors.

2.2 Results

The results available to date can be accessed on the cooperative website: <http://menir.univ-brest.fr/documentation/projet/consultation.php?pjt=18>

Needs of the IZCM actors

Interviews with the 24 respondents have allowed us to identify priority themes (Table 1) and needs in terms of quality and access to data (Table 2).

**Table 1. Priority themes identified
(cited at least once by the actor during the interview)**

Theme	Frequency
Updated shellfish Cadastre	79 %
Quality of bathing water / marine water	79 %
Mooring areas/ refit areas	79 %
Maritime and coastal regulations	71 %
Uses / ridership / use conflicts	71 %
Erosion / risk of coastal flooding	58 %
biodiversity	58 %

Table 2. Needs in terms of data quality and access

Data quality	Data access
Raw and fundamental data set	Unique geoportal avoiding multiple data searches
Most recent possible data	Data Downloading without framework agreements
Uniform data on all of Britain area	Network services for : posting, searching and downloading
Long series of environmental observations	

The analysis of these expressed needs has established a roadmap for the three project objectives: repository, geoportal and indicators.

"Coastal and Ocean" repository

Surveys, supplemented by consulting 19 geoportals and 7 specific reports and studies, have allowed us to identify nearly 300 spatial data related to ocean and coastal areas. The results are presented as a summary table organized by major themes. The table contains the main features of information resources: title, date of production, range of scale, availability, institution in charge and conditions of access. An analysis of their quality and relevance will complete the inventory.

The surveyed geographical information was compiled in three thematic areas (Figure 2):

- reference information: orthophotos, topographic scans ...
- Information concerning physical, biological, ecological features of the marine and coastal zone: bathymetry, coastal hydrodynamics, fauna and flora ...
- Information on data use: administrative framework, regulations, human activities (shipping, fisheries, tourism ...).

Figure 2. Thematic areas of the "coastal and ocean" repository

REFERENTIELS RASTER	Orthophotographies - Cartes Raster (SCAN Littoral, cartes marines (RNC)...)
REFERENTIELS VECTEUR	BD CARTO / BD TOPO (RGE) / ENC - Occupation du sol
ENVIRONNEMENT	Bathymétrie / Zéro hydrographique / Trait de côte / MNT
PHYSIQUE	Hydrodynamique côtière (courants, houles, marées)
CHIMIQUE	Météorologie (pluviométrie, température, vent, insolation)
ECOLOGIQUE	Géologie / Géomorphologie (types de côte) / Erosion / Submersion
	Biodiversité (Faunes / Flores)
	Qualité des eaux (réseaux de surveillance, paramètres physico-chimiques...)
USAGES	Limites parcellaires (Cadastré / BD Parcellaire) / Limites administratives
ADMINISTRATION	Sécurité - Navigation / Pêche professionnelle
REGLEMENTATION	Classement sanitaire / Aquaculture (Cadastré conchylicole / Pisciculture)
CONSERVATION	Limites portuaires / Zones de mouillage / Zonages réglementaires
	Extraction de matériaux marins / Dragage / EMR
	Urbanisation (PLU / POS / loi littoral) / Prévention des Risques
USAGES	Navigation commerciale
	Pêche professionnelle / Pêche de loisir / Aquaculture marine
	Activités d'extraction de matériaux (sables coquilliers / maerl)
	Activités de Dragage (clapage en mer)
	Activités nautiques (plaisance, clubs, planche à voile, surf, kayak...)
	Infrastructures en mer (Câbles, canalisations...) / Epaves
ACTIVITES HUMAINES	Pêche à pied / Activités conchylicoles / piscicoles
SOCIO-ECONOMIE	Activités agricoles / Activités industrielles
INFRASTRUCTURES	Tourisme / Randonnées / Patrimoine culturel
	Ports / Activités portuaires / Sauvetage en mer (Postes de secours, SNSM)
	Ouvrages de protection / Accès à la mer / Stationnement
	Traitement des eaux (prises d'eau de mer, station d'épuration...)
	Transports (voies navigables, gares maritimes, réseau électrique...)

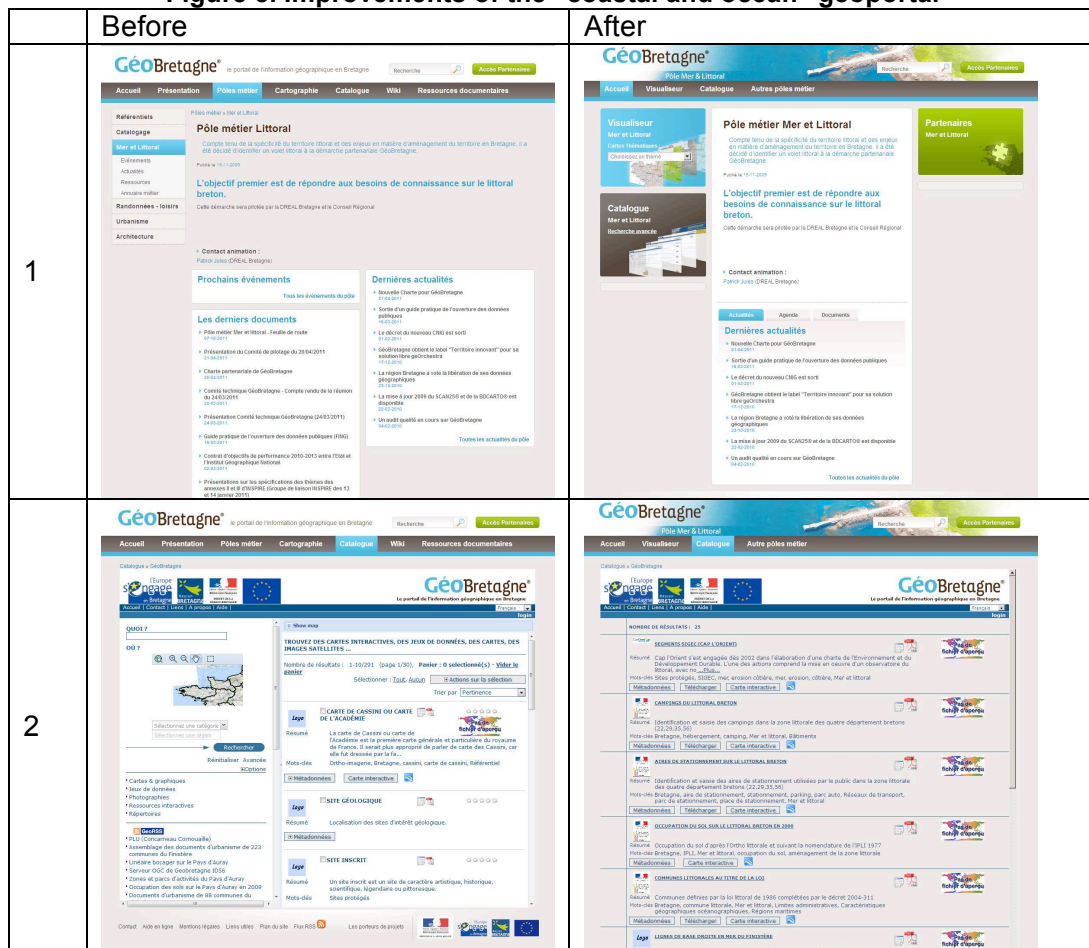
"Coastal and Ocean" Geoportal

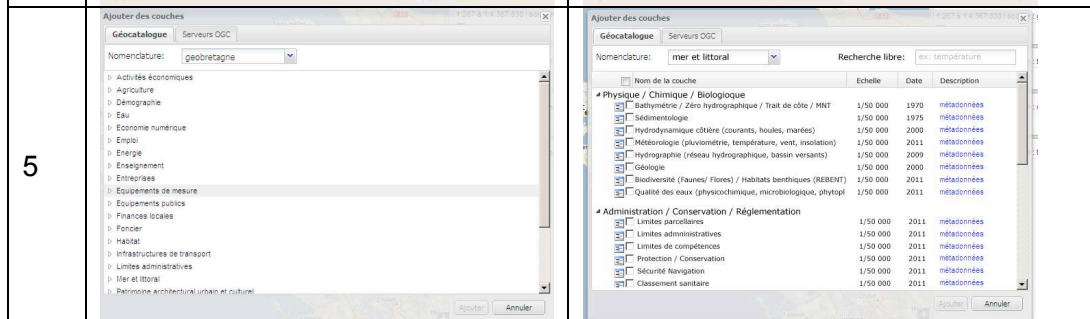
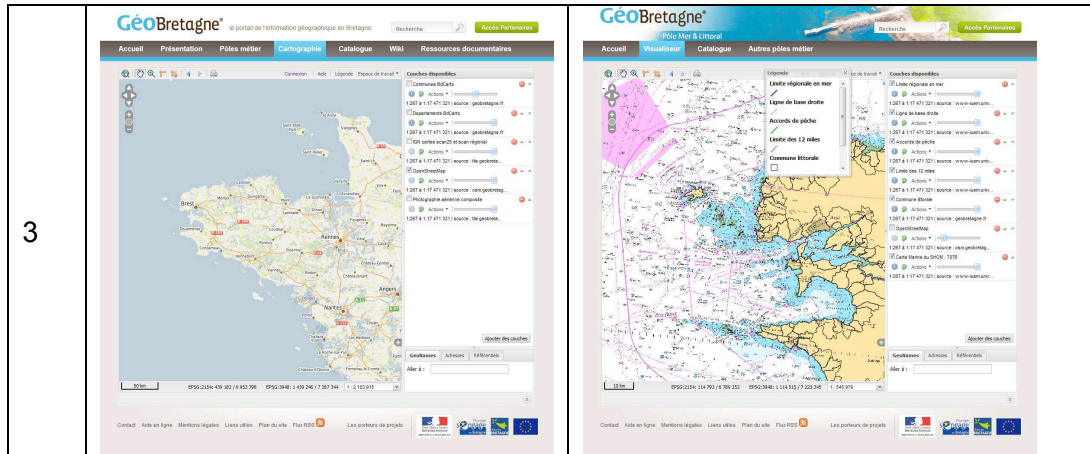
The adjustments made to the "coastal and ocean" geoportal focus on (Figure 3):

- improving accessibility and visibility of the geoportal by setting up a home page (Figure 3.1) that provides clear and quick access to key functions of the geoportal (catalog application GeoNetwork and viewer MapFishApp). A coastal thematic banner that immediately identifies the portal was developed;

- easier accessibility to the geoportal through direct access from the Geobretagne SDI home page. Direct access to metadata and repository data is now also available (Figure 3.2);
- The homepage of the GeoBretagne SDI now offers direct access to the "coastal and ocean" viewer (Figure 3.3). Several predefined thematic maps about marine and coastal areas are available from a drop-down menu (i.e. major administrative boundaries, land use, coastal regulations, water quality, coastal law) (Figure 3.4);
- Drawing maps "on demand" will be possible through the viewer based on specific key-words related to the marine and coastal domain (Figure 3.5). The feasibility of incorporating this function is to be confirmed.

Figure 3. Improvements of the "coastal and ocean" geoportal





Indicators for monitoring coastal areas

Interviews, currently underway, will assess the specific needs of Britain actors in terms of indicators. The analysis of the results will guide the identification of indicators in compliance with the DEDUCE and OL programs. Based on those methodological procedures, the GeoBretagne SDI will then be evaluated not only on its ability to provide spatial data and information (through the repository), but also on network services for indicator calculation (database and spatial queries) and output.

The indicators most frequently identified so far by 9 ICZM actors as significant to their needs at the local level are presented in Table 3.

Table 3. Significant indicators identified to date by 9 ICZM actors

Theme	Frequency
Water quality	33 %
Urbanization	33 %
Maritime economy (excluding tourism)	22 %
Coastal, marine and estuary waste	22 %
Semi-natural habitats and protected areas	22 %
Loss of cultural diversity	22 %
Increased sea levels and extreme weather	22 %
Sustainable Tourism	22 %
Pressure of coastal and marine recreation	22 %

3. CONCLUSION AND OUTLOOK

Coastal SDIs are currently implemented to meet the challenges of ICZM at different levels of governance. Although technical progress is undeniable, organizational barriers and the reluctance of many institutions to share their data still hamper the implementation of CSIDs (Strain et al., 2006; Canessa et al., 2007; Gourmelon et al., 2009).

This paper presents an approach focused on the needs of users (land managers, policy makers, and ICZM actors) to assess an SDI in Brittany (France).

The semi-structured interviews conducted with key ICZM public actors, supplemented by an inventory from leading GI producers, have allowed us to identify users' needs in information and technical terms. This step led to the first version of the repository describing nearly 300 data related to the marine and coastal areas in Brittany. This repository is intended to grow steadily thanks to

the "coastal and ocean" thematic group and its activities of animation, monitoring and outreach towards targets actors.

The "Coastal and Ocean" Geoportal, a subset of the GeoBretagne SDI will ensure access, sharing, viewing and updating of the inventoried data. The prototype will soon be evaluated by the project partners. In its current version, the geoportal does not allow data downloading. This function, which is central to the free flow of information, will be permitted through an agreement binding the GeoBretagne partners.

Results of the interviews will lead to the development of network services that will provide added value to the data within the "coastal and ocean" repository, offering ICZM actors tools for decision making. Through the GeoBretagne interface, tailored indicators will, on request, provide unique information for coastal management.

This study contributes to wider research on coastal SDIs that is carried out at various levels (international, national, sub-national, local), to assess their efficiency in helping to optimize the ICZM process. The scientific approach focuses on ICZM public actors, who are the users of these coastal web platforms, to analyze their uses and needs, and the obstacles they face, in order to propose a conceptual approach for the implementation of coastal SDIs.

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