2013

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Rodolphe Devillers
Memorial University Of Newfoundland

Debora M. De Freitas
University Of Wollongong

Publication Details

R. Devillers and D. M. De Freitas, 'The use of GIS and geospatial technologies in support of coastal zones management-results of an international survey' (Paper presented at the CoastGIS 2013 Conference: Monitoring and Adapting to Change on the Coast, Victoria, British Columbia, Canada, 18-21 June).

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Keywords
international, gis, results, management, zones, coastal, support, technologies, survey, geospatial

Disciplines
Arts and Humanities | Law

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The use of GIS and geospatial technologies in support of coastal zones management—results of an international survey

Rodolphe Devillers[1] *& Débora M. De Freitas*[2]

[1] Department of Geography, Memorial University of Newfoundland, St. John's, NL, A1B 3X9, Canada
rdeville@mun.ca
[2] Australian National Centre for Ocean Resources & Security (ANCORS), University of Wollongong, NSW, 2522, Australia
debora@uow.edu.au

Abstract

This paper reports on the results of an international survey looking at the use of Geographic Information Systems (GIS) and other geospatial technologies in support of coastal zones management. The survey, conducted in fall 2012, was answered by 328 respondents coming from 59 different countries. It aimed at assessing the proportion of people using such technologies, identifying which specific technologies are used, how often they are used, what they are used for, etc. A set of questions also asked more specifically about the potential of using volunteered geographic information (VGI) in the context of coastal zones management. Results indicate that 92% of the respondents' organizations use geospatial tools, with 89% of those using GIS tools. They also indicated that although possibly useful, the use of VGI in this context may be challenging, mainly due to a perception that the quality of those data may not be sufficient.

Introduction

The management of coastal resources is continuously challenged by complex environmental processes, the diversity of stakeholders, natural resource uses, and multiple management scales (Cicin-Sain and Belfiore, 2005; Croke *et al*., 2007). To help capture some of this complexity, the study and management of coastal zones relies on a range of technologies that support data collection, management, analysis, and dissemination (Alder, 2007). The visual capability of geospatial technologies, such as geographic information systems (GIS), has proved to be important in bridging the gap between communication, information, and stakeholders' participation in better understanding and managing coastal resources (McCall and Minang, 2005; De Freitas *et al.*, 2011). Spatial scenarios and modelling techniques are increasingly used to represent complex coastal problems and processes such as water quality, pollutant dispersion, land clearing, and erosion.

While GIS and geospatial technologies more generally (e.g., GIS, Remote Sensing, GPS) play an important role in coastal zones management (Bartlett and Smith, 2004; Green, 2010), few national studies have explored the use of GIS in coastal zones (e.g., US NOAA Coastal Resource Management Customer Survey - http://www.csc.noaa.gov/survey/) and there is a lack of study providing quantitative data on this question at a global level. This paper presents the results of the first international survey done on the use of GIS and geospatial technologies for coastal environments around the world.

Method

A survey composed of 20 questions was designed to answer a number of basic questions related to the use of GIS and geospatial technologies in support of coastal zones management. The survey was meant to take a short time to answer in order to maximize the number of respondents. The survey was administered on the Web using the online survey software SurveyMonkey and was advertised broadly on mailing lists related to coastal zones, general thematic mailing lists (e.g. fisheries management, oil and gas, engineering), online thematic groups (e.g., LinkedIn), and emailed to individuals and organizations known to work in this field, encouraging people to circulate it amongst their own networks.

The first five questions aimed at describing the organizational context of the respondent. Question 1 asked for the type of organization the respondent works for (e.g., government, private, education, non-governmental organization). Question 2 asked for the main field of activity the organization operates in (e.g., fisheries, environ-

ment/conservation, hydrography, transportation). Question 3 asked for the size of the organization. Question 4 asked for the country where the organization is based in and Question 5 asked for the country the organization mainly works on.

The survey was not advertised as a survey on GIS/geospatial tools, but on coastal tools generally in order to first quantify the proportion of respondents that do not use GIS/geospatial tools, and the reason for doing so. Question 6 asked respondents if GIS or geospatial tools were used in their organizations. If they answered "No", Question 7 asked the reasons for not using such tools and respondents were directed to the end of the survey and encouraged to leave additional feedback (Question 8).

If respondents have answered "Yes" to the Question 6, Questions 9 to 17 aimed at specifying the nature of the use made of GIS and geospatial technologies. Question 9 asked respondents if their organization was considered as being mainly a data producer, a data user, or both. Question 10 asked respondents if GIS specifically are used by their group/division. If they answered positively, Question 11 asked if they used proprietary/commercial or open-source GIS software. Question 12 asked if they used desktop or Web-based GIS. Question 13 asked for the specific software used and the frequency of use for each of them (e.g., ArcGIS, MapInfo, Quantum GIS, CARIS). Question 14 asked for the nature of the tasks being done with the GIS (e.g., data management, data analysis, map production, modelling). Question 15 asked for the level of importance GIS has in the organization to support decisions compared to other technologies.

Questions 16 and 17 asked about other geospatial technologies used by the organization, such as remote sensing, GIS, surveying tools or GPS-enabled mobile devices. Question 16 asked what tools are used and the respective frequencies of use. Question 17 asked for an opinion on the future trend of use for each type of tool (e.g., likely to increase, decrease or remain the same).

The last three questions focused on the possible use of volunteered geographic information (VGI), a new form of crowd-sourced geospatial data (Goodchild, 2007), to support the work of the respondents. Question 18 asked respondents if they would consider using VGI for their work. If they answered in the negative, Question 19 asked for reasons for not considering it. Question 20 allowed respondents to elaborate on those answers by writing comments.

Results

The survey was completed by 328 respondents, including 258 that completed the entire survey. Respondents came from a broad range of sectors, including the government (23.2%), academia (36.3%), the private sector (31.4%) and non-government organizations (4.9%), with 4.3% self-identified as 'other' types. The main field of operation of these organizations are, by order of importance, education and research (31.7%), environment and conservation (22.9%), and urban and coastal planning (8.5%). Most organizations are either small (44.2% have less than 100 full-time employees), or large (27.7% have more than 1000 full-time employees). In terms of geographic representation, respondents came from 59 different countries, with a majority coming from western countries, including by order of importance the Unites States of America (19.5%), Canada (8.5%), New Zealand (7.6%), France (6.7%), Spain (4.3%), Australia (4%) and the United Kingdom (4%).

Out of 324 respondents, 92% said that their group or division is using geospatial tools. Out of the 22 respondents (8%) that do not, 59.1% said they do not need such tools, 22.7% said they do not have the necessary financial resources to do it, 18.2% said they do not have the necessary expertise, and 18.2% are considering using geospatial/GIS tools in the future.

From respondents that do use geospatial tools, only 4.1% consider their organization or themselves as being solely a data producer, 35.3% as being solely a data user, and 57.9% as being both a producer and user of data. 89% of respondents that said they used geospatial tools are using GIS software. In terms of the type of GIS technology used, 88% of respondents said they are using proprietary/commercial GIS software, while 55% said they are using open-source GIS software. This last percentage can be questioned as in a later question few people identified open-source software in the list of GIS software used. This difference may be explained by the fact that a number of people could have considered software like Google Earth or Google Map as being open-source GIS software because they are freely available. The specific GIS software used are largely dominated by ESRI ArcGIS (Figure 1A), with more than 85% of the respondents saying they use ArcGIS on a daily basis or frequently, while 27% said the same for MapInfo, 14% for Quantum GIS, 8.6% for CARIS, etc. GIS software is used for diverse tasks. The most common usages made of GIS software are the production of maps and data analysis, with 87% of respondents saying they always or often use GIS for map production and 83% always using GIS for performing data analysis, while 76% always or

often use GIS for data management, 57% for data sharing, 54% for the production of other data visualizations, and 46% for modelling exercises.

GIS technologies are the geospatial technologies used the most on a daily basis, while other technologies such as satellite images, aerial photographs, GPS-enabled mobile devices, surveying tools, and maps and nautical charts are all said to be frequently used by more than 55% of the respondents (Figure 1B). Less than 10% of the respondents said they do not to use any one of these technologies. When asked about what they thought trends in the use of these technologies could be in the future, 67% of the respondents thought GIS use would increase in the future, 59% thought the same for satellite imagery, 57.5% for GPS-enabled mobile devices, while the majority of respondents believed that the use of aerial photographs, surveying tools or maps is likely to remain the same, or even decrease (>5% for aerial photographs and maps).

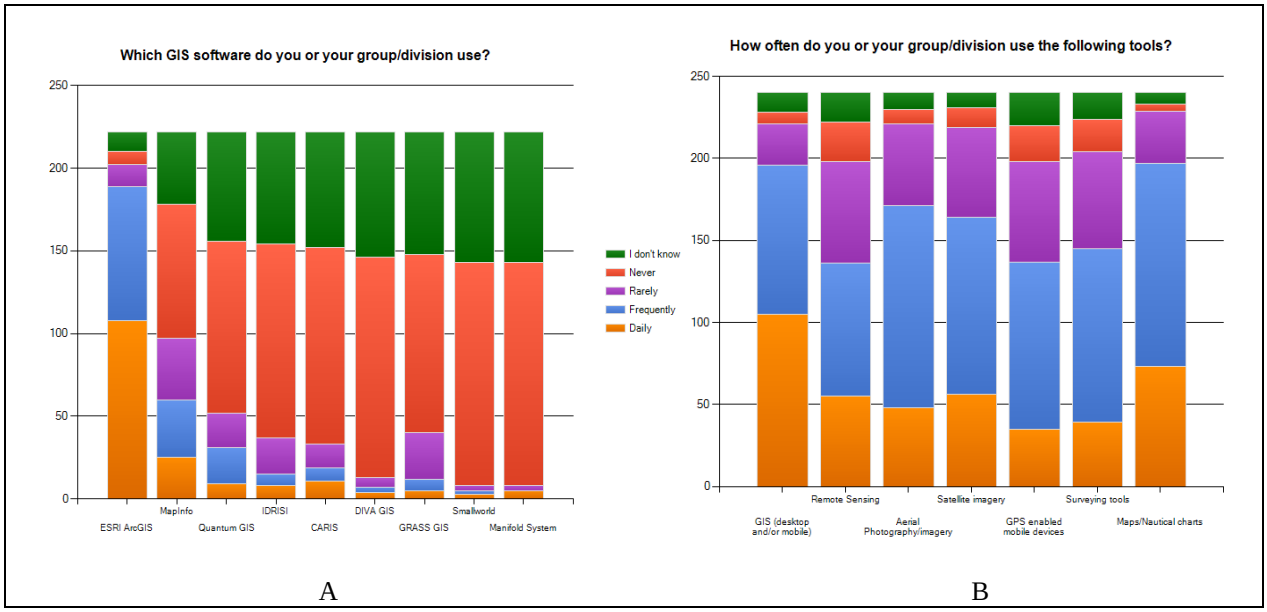

Figure 1. Responses to questions 16 (A) and 13 (B). A – GIS software used and the frequency of use. B – geospatial tools used and the frequency of use.

The last section of the questionnaire focused on the potential utility of VGI in the context of coastal zones, a new form of crowd-sourced geographic information increasingly used on terrestrial applications (e.g., OpenStreetMap). After having provided respondents with a brief description of what VGI is, 39.4% of the respondents thought VGI could be very useful, 25.8% said they were not familiar with VGI but could consider it, 21.2% thought it could be useful in some specific cases only, and only 2.1% thought it could not be useful (Table 1). While this feedback is very positive, many respondents shared concerns about using VGI. 83.1% of the respondents have listed the quality of the data as a potential problem, a concern typically shared by users of VGI data generally, while 53.2% have raised possible liability issues when using such data, and 31.2% mentioned possible copyright issues. Comments left by respondents on this question revealed the importance for a number of people of being able to ensure that data are collected and processed through a rigorous and statistically sound process that ensures data quality, something that is believed to be maybe even more difficult to ensure in the marine environment.

Table 1. Answer to question 18 asking "Would you or your group/division be interested in using VGI data for your work?"

Answers	% responses
It could be very useful	39.4
I have never used such data but could look into it	25.8
It could be useful in some cases	21.2
It would not be useful	2.1
I don't know	11.4
Other (please specify)	2.5

Discussion and conclusions

This paper has reported on the results of what we believe is the first international survey exploring the use of GIS and geospatial technologies in support of coastal zones management activities. Respondents to the survey came from a large number of countries and from a mix of sectors, disciplines and organization sizes. Results indicate that a large majority of organizations operating in coastal zones use geospatial technologies in the context of their work. While GIS are the geospatial tool the most broadly used on a daily basis, being considered as a key tool within the organization, most professionals use a broad range of geospatial technologies on a regular basis, including satellite imagery, aerial photos, GPS-enabled mobile devices, maps and nautical charts. If the use of aerial photographs, surveying tools, and maps and nautical charts was thought to remain the same in the future, the use of GIS, satellite imagery and GPS-enabled mobile devices is believed to increase. Most respondents are open to the use of VGI in the context of their work but shared a number of concerns about the quality of the data as well as possible liability and copyright issues.

While it is a well-know fact that GIS and geospatial technologies are useful tools in support of coastal zones management, no study have attempted to quantify the amount of users, the reasons for not using those tools and the nature and trends in the use of those technologies. This study provides a first estimation of the use of GIS and geospatial technologies in the context of coastal zones management. It aimed at answering basic questions and more in-depth follow-up surveys could help better understand a number of aspects, such as the use of geospatial tools in specific sectors, the level of training and expertise in GISciences of coastal zones professionals or the needs in terms of new technologies and methods. The methods used to reach the possible participants (i.e., online survey in English language) has likely biased the results by putting a stronger emphasis on professionals from developed countries and more effort could be made in the future in order to reach coastal zones professionals from developing countries by trying to reach other professional networks and possibly offer the survey in different languages.

Generally, the study confirmed the belief that GIS and geospatial tools are broadly used in coastal zones management, showing here again that location and geography matters when it comes to the management of complex environments.

Acknowledgments

We acknowledge all of the participants that have contributed to the online survey. Thanks are also due to Roger Longhorn for having provided feedback on the survey design, to Craig Brown, Norma Serra and Yassine Lassoued for having tested preliminary versions of the online survey and to Cassandra Lee for having provided feedback on the manuscript. We also thank the Canadian Natural Sciences and Engineering Research Council (NSERC) for having covered part of the costs related to this study.

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